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The Methane Emissions Mitigation Research and Devleopment Act

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Acknowledgments



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Executive Summary

Photo: McCaul (2021)

Executive Summary

Methane is a potent greenhouse gas and significant source of near-term climate warming, making emissions from the U.S. oil and gas sector an important opportunity for rapid mitigation. Emissions from leaks, venting, incomplete combustion, and aging infrastructure also create public health and environmental justice concerns. However, uncertainty remains in their scale and location because existing measurement approaches vary in coverage, detection limits, and quantification methods.

H.R. 752, the Methane Emissions Mitigation Research and Development Act, addresses these gaps through federal investment in research, technology development, measurement standardization, and collaboration. The bill authorizes $295 million for FY2026–2030, including $200 million for the Department of Energy to support technical assistance and a Methane Emissions Measurement and Mitigation Research Consortium, and $95 million for the National Institute of Standards and Technology to establish testing and intercalibration facilities. The report finds that H.R. 752 addresses key weaknesses in methane monitoring, particularly limited standardization and coordination across technologies and institutions. Because ground-based, aerial, and satellite systems have distinct strengths and limitations, an integrated framework is more effective than reliance on any single technology. However, improved measurement will not automatically reduce emissions, which also depends on repair costs and feasibility, operator incentives, and regulatory requirements.

The report identifies challenges involving detection tradeoffs, mitigation economics, consortium governance, and international coordination. It recommends a tiered framework for selecting detection technologies, stronger links between research and mitigation incentives, transparent consortium governance and conflict-of-interest safeguards, and alignment of U.S. measurement standards with international frameworks. Success should be measured through improved detection and measurement, adoption of mitigation technologies, effective coordination, and reductions in U.S. oil and gas methane emissions.

Glossary

Anthropogenic: refers to emissions, sources, or activities derived by human activity.

Atmospheric lifetime: how long a greenhouse gas persists in the atmosphere before chemical decomposition.

Carbon dioxide (CO_2): oxidized carbon made of one carbon atom bonded to two oxygen atoms.

Carbon dioxide equivalent (CO_2e): a unit of measurement to compare the climate impact of different greenhouse gases based on how much heat they trap compared to carbon dioxide over the same period.

Cryogenic cooling: is a method for the liquefaction of natural gas that involves a reduction in volume of the gas for more efficient shipping and transport.

Downstream: unintentional methane leaks and emissions after the oil and gas production process, involving the transportation and processing of crude oil and natural gas.

Environmental justice: the equitable distribution of environmental services and ensuring that all individuals regardless of race, ethnicity, or socioeconomic status have equal access to a healthy environment.

Flaring: The intentional combustion of natural gas during the oil extraction process to prevent unsafe pressure buildup, or dispose of excess gas.

Fossil fuel: a compound mixture and fuel source derived from ancient fossilized plant and animal matter.

Fossil fuel life cycle: the progression of methane across extraction, infrastructure, transport, storage, and use.

Frontline community: low-income and primarily communities of color that are disproportionately exposed to environmental burdens, including the worst impacts of climate change.

Fugitive emissions: those emissions which could not reasonably pass through a stack, chimney, vent, or other functionally-equivalent opening but rather escape through a leak in the component infrastructure.

Glossary

Greenhouse gas (GHG): atmospheric gases including water vapor, carbon dioxide, and methane that trap heat and moderate the temperature of the earth.

Hydraulic fracturing (Fracking): the injection of water, sand, and/or chemicals underground to crack bedrock that frees up trapped oil or gas reserves.

Incomplete combustion: occurs when methane or other hydrocarbons is not fully burned due to insufficient oxygen or poor combustion conditions. Instead of producing only carbon dioxide and water, the process may release other chemical byproducts such as black carbon.

Industrial life cycle: refers to the natural progression of an industry through stages of introduction, growth, maturity, and decline, impacting market strategies and competitive dynamics.

Infrared radiation (IR): characterized by wavelengths between 780 nm and 1 mm along the electromagnetic radiation spectrum. IR is categorized as IR-A (780 nm-1.4 μm), IR-B (1.4-3 μm) and IR-C, also known as far-IR (3 μm-1 mm).

Leak Detection and Repair (LDAR): the identification and repair of volatile organic compounds (VOCs) and volatile hazardous air pollutants (VHAPs) according to U.S. Environmental Protection Agency guidelines.

Light Detection and Ranging (LiDAR): is a remote sensing method that uses light in the form of a pulsed laser to measure distances to a target to produce three-dimensional spatial mapping, and in methane gas-mapping, the transmission of lasers within the methane absorption spectrum to map how the plume is traveling across space and time.

Liquefied Natural Gas (LNG): is extracted natural gas that has been cooled to a liquid state (liquefied), to about -260° Fahrenheit, for shipping and storage.

Methane (CH_4): a hydrocarbon that is a primary component of natural gas.

Glossary

Methane plume: continuous methane emissions emerging from a specific location that can be visualized for the repair of leaks through techniques such as LiDAR or satellite observation systems.

Natural Gas: fossil fuel, primarily methane, formed by decayed organic matter in the absence of oxygen, under high pressure and temperature.

Pyrolysis: the heating of an organic material, such as methane, in the absence of oxygen. As a mitigation technique, this splits methane into hydrogen gas and carbon, preventing the formation of carbon dioxide as a byproduct.

Remote sensing: a technique for detecting methane at shortwave infrared wavelengths across space, and can be used in the presence or absence of a pilot or crew, for instance with satellite or aerial observation.

Research and Development (R&D): scientific studies aimed at measuring, mitigating, or removing methane, and the development of technology to collect these data, driving innovation from an initial inquiry into the commercial market.

Spatial Resolution: defined by the size of each pixel within a digital image and the area on Earth's surface represented by that pixel.

Spectroscopy: the study of, and the practical methods for examining, the interaction of electromagnetic radiation (light) and specific wavelengths absorbed, primarily in the 1.65 - 7.7 µm for detection of methane.

Super-emitter: a point source (a single location) which releases a disproportionately large amount of a greenhouse gas.

Upstream: onshore and offshore sources of methane during oil and fossil gas exploration, drilling, production operations, and raw gas processing.

Vapor recovery system: commonly used to capture methane emissions from these tanks and a variety of other low pressure vented gas sources.

Glossary

Volatile Hazardous Air Pollutants: Volatile Organic Compounds including Benzene, Formaldehyde, and Toluene that carry health risks such as carcinogenicity.

Volatile Organic Compounds (VOCs): molecules that contain carbon that can evaporate under general indoor temperature and pressure conditions.

Wellbore: A drilled hole used to find and extract oil or gas.

Zero non-emergency flaring: eliminate the practice of burning off unused natural gas during the oil extraction process, either to discard excess or prevent unsafe pressure changes in equipment.

Acronyms

AML	Agriculture and Markets Law
API	American Petroleum Institute
CH_4	Methane
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide Equivalent
DOC	Department of Commerce
DOE	Department of Energy
ECL	Environmental Conservation Law
EM	Electromagnetic (spectrum)
EPA	Environmental Protection Agency
ESA	European Space Agency

Acronyms

FAO	Food and Agriculture Organization of the United Nations
FY	Fiscal Year
GHG	Greenhouse Gas
IEA	International Energy Agency
IMEO	International Methane Emissions Observatory
IPCC	Intergovernmental Panel on Climate Change
IR	Infrared
LAM	Live Animal Market
LDAR	Leak Detection and Repair
LiDAR	Light Detection and Ranging
LNG	Liquefied Natural Gas
LWIR	Long-Wave Infrared
MARS	Methane Alert and Response System
$MMTCO_2e$	Million Metric Tons of Carbon Dioxide Equivalent
MWIR	Mid-Wave Infrared
NASA	National Aeronautics and Space Administration
NGO	Non Governmental Organization
NIR	Near-Infrared



1. Introduction

Photo: Ant (2020)

Introduction

Methane emissions have become an increasingly important focus of climate policy due to their significant contribution to near-term global warming and the substantial opportunities for rapid emissions reductions. Addressing methane leakage from the oil and gas sector requires not only effective regulation but also advances in scientific understanding, measurement capabilities, and mitigation technologies.

This report examines H.R. 752, the Methane Emissions Mitigation Research and Development Act, which proposes a federal research and development framework to strengthen methane detection, measurement, and mitigation in the United States. The legislation focuses on building the scientific knowledge, technical infrastructure, measurement standards, and cross-sector collaboration needed to support future methane reduction efforts.

The report first outlines the environmental and public health impacts of methane emissions and the rationale for government intervention. It then examines H.R. 752 and its major provisions before assessing the scientific basis of the bill's three research streams: detection, measurement, and mitigation. The report next considers key implementation challenges and scientific uncertainties, evaluates how program success could be measured, and concludes with findings and recommendations for strengthening implementation.

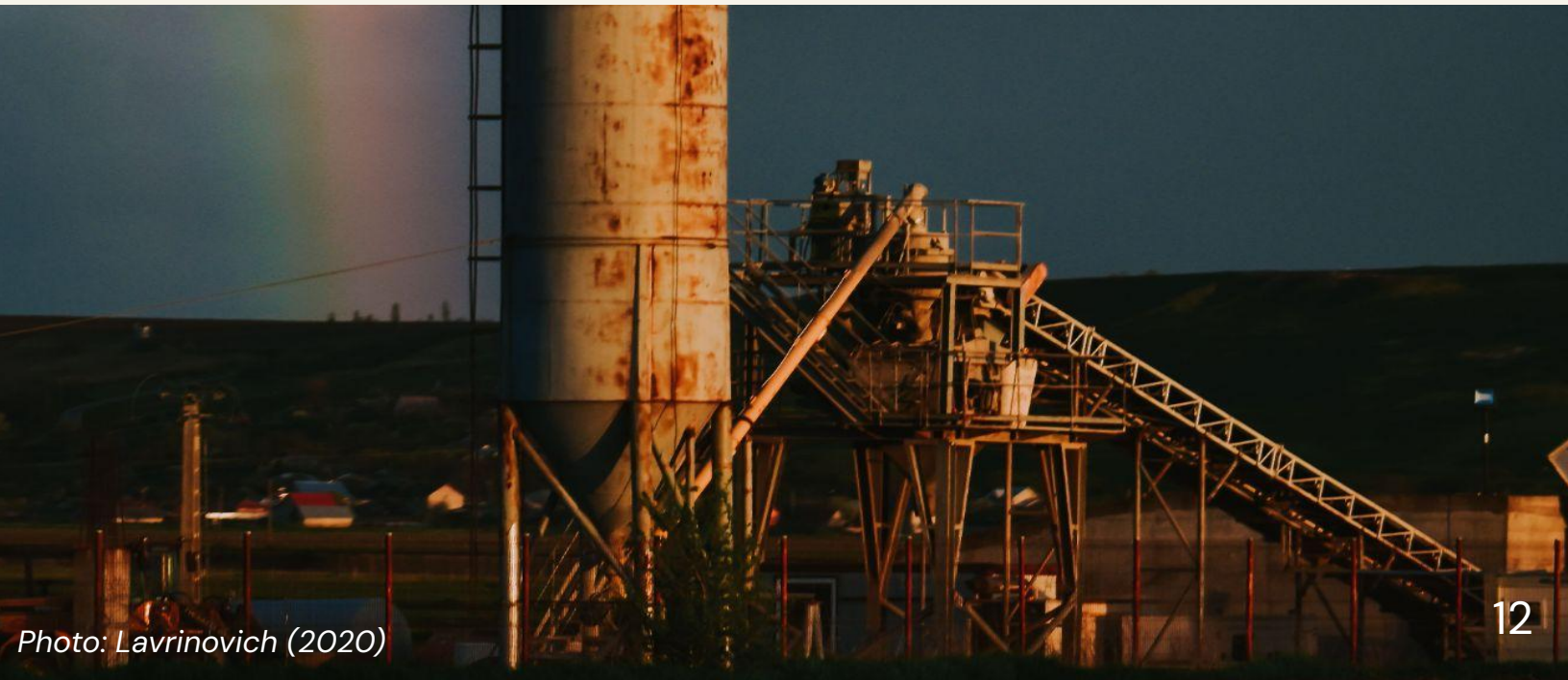


Photo: Lavrinovich (2020)



2. The Environmental Problem

Photo: Hemz (2023)

2.1 The Impact of Methane on the Environment and Public Health

The increase in emissions of greenhouse gases, which trap heat in Earth's atmosphere, has resulted in a steady increase in Earth's average surface temperature since the Industrial Revolution. Methane is one of the three major greenhouse gases alongside carbon dioxide and water vapor, and has contributed to approximately 30% of this global temperature rise (International Energy Agency [IEA], 2025a). Compared to these other greenhouse gases, methane's chemical properties make it particularly impactful. Consequently, targeted reductions in methane emissions can deliver critical climate benefits rapidly, offering one of the most immediate levers for slowing global warming (The United Nations Intergovernmental Panel on Climate Change [IPCC], 2021).

Although it has a lower abundance in the atmosphere than carbon dioxide, methane has a higher global-warming potential. It absorbs infrared wavelengths more widely and efficiently, making it a more potent heat-trapping gas over shorter time scales (Krol, 2023b; U.S. Environmental Protection Agency [EPA], 2026b). Over 20 years, methane traps roughly 80 times more heat than an equivalent amount of carbon dioxide (IPCC, 2021; IEA, 2022–2025).

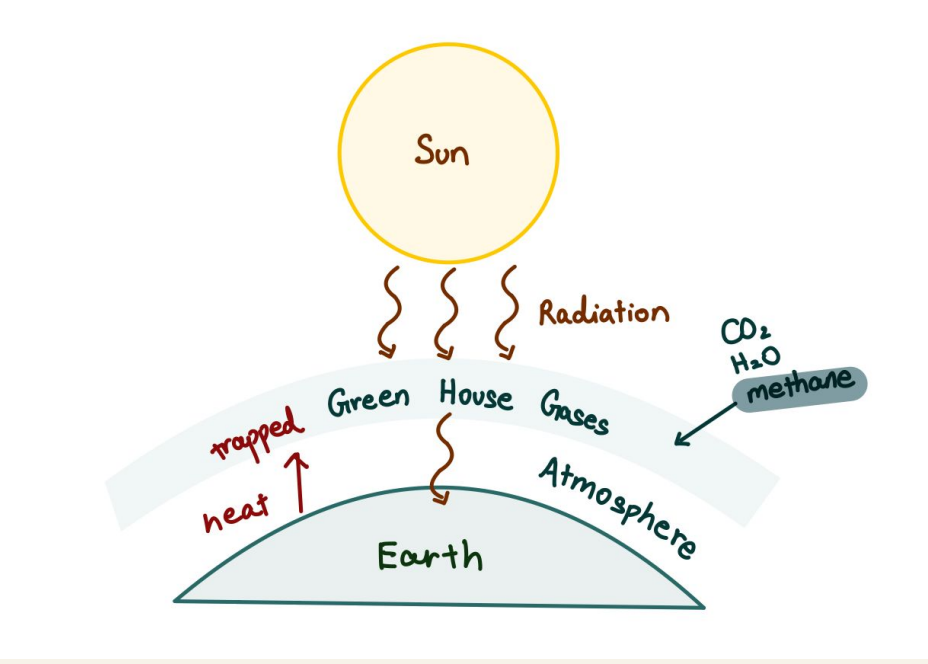


Figure 1: *The Greenhouse Effect. Methane, a greenhouse gas, absorbs solar heat reflected from Earth's surface and releases it in all directions, including back to Earth's surface, trapping heat in Earth's atmosphere. Source: Xie (2026).*

In addition to its high heat-trapping potency, methane naturally undergoes a chemical breakdown into other greenhouse gases that worsens its cumulative effect. The oxidation (loss of electrons) of methane in the atmosphere produces carbon dioxide and water vapor, both greenhouse gases with associated heat-trapping effects (Schmidt, 2004; EPA, 2025). Thus, although methane's atmospheric lifetime is significantly shorter than that of carbon dioxide (7-12 years and over 300 years, respectively), its natural chemical breakdown exacerbates the cumulative climate impact, adding the long-term warming effects produced by carbon dioxide's persistent chemical properties (Archer et al., 2009; National Aeronautics and Space Administration [NASA], 2026).

This warming effect is also indirectly amplified through the increasing of water vapor concentrations. Because warmer air can hold more water vapor, atmospheric temperature rise caused by greenhouse gases increases both evaporation and atmospheric water vapor capacity, leading to further heat trapping (NASA, 2022; Krol, 2023b; EPA, 2025).

While methane, alongside other greenhouse gases, exists naturally and helps maintain Earth's thermal balance, human activity has caused these concentrations to exceed natural levels at an unprecedented rate and scale. In these quantities, greenhouse gases form a blanketing layer in the atmosphere, preventing infrared radiation from the sun from returning to space and causing global temperatures to rise (NASA, 2023; NASA, 2024). This warming amplifies the frequency, duration, and severity of extreme weather events including heatwaves, flooding, droughts, and wildfires (IPCC, 2021).

Anthropogenic activities account for approximately 60% of total global methane emissions, driven primarily by agriculture (40%), the fossil fuel energy sector (35%), and waste management (20%), as illustrated in **Figure 2** (Climate and Clean Air Coalition, n.d.). While agricultural and waste emissions tend to be widely dispersed, emissions from the fossil fuel energy sector are more spatially concentrated (IEA, 2025b; Center for Strategic and International Studies, 2023). The largest 5% of leaks from the oil and gas industry account for approximately 50% of the total leakage volume (Brandt et al., 2016). These emissions occur throughout the oil and gas supply chain, during extraction, processing, and transport through fugitive leaks in aging pipelines, storage facilities, and pressure valves, alongside routine venting and inefficient flaring.

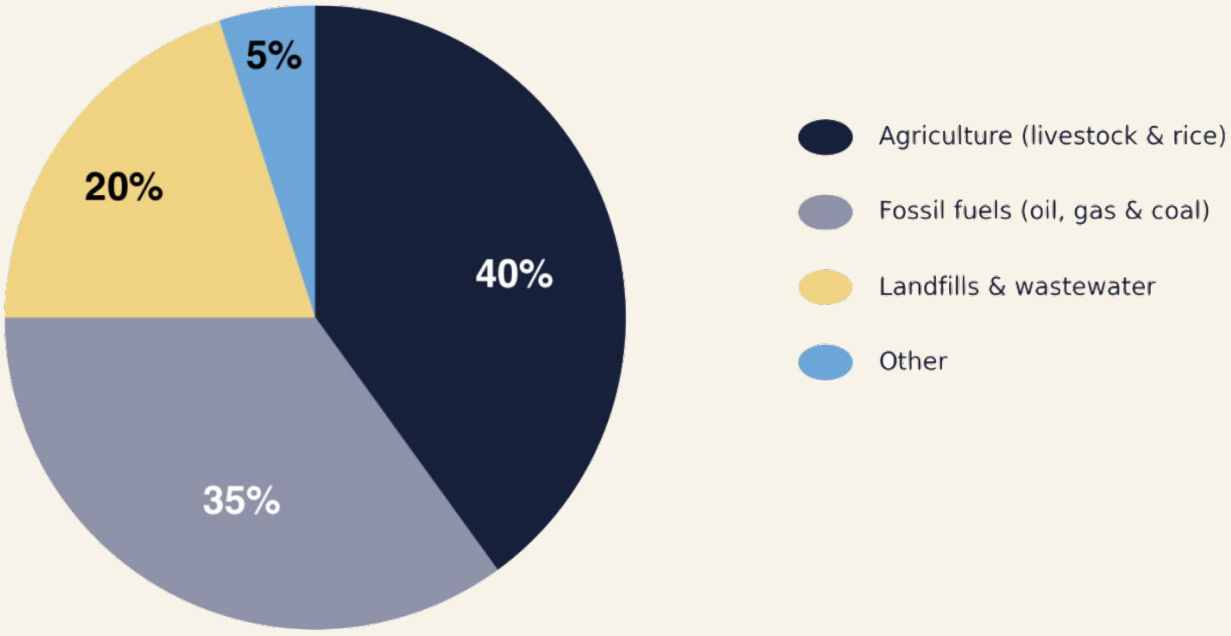


Figure 2: Methane - Main Anthropogenic Sources. *Source: Climate and Clean Air Coalition, Global Methane Assessment (n.d.).*

2.2 The Oil and Gas Industry and Sources of Methane Emissions

Because emissions from this sector can be very large yet also localized, targeting the U.S. oil and gas sector presents an opportunity for easily and effectively reducing methane emissions over the shortest period of time. The sector releases millions of metric tons of the gas each year and has pushed atmospheric concentrations to unprecedented levels since the start of the industrial era (IEA, 2025a, 2025b; IPCC, 2021). Because natural gas is primarily composed of methane, the industry's vast infrastructure represents a continuous risk for emissions. Throughout the fossil fuel life cycle- from extraction and processing to storage, transportation, and final combustion- anthropogenic methane reaches the atmosphere through two main pathways: fugitive leakage and incomplete combustion.

Leakage occurs when methane escapes from weak points in infrastructure, such as loose pipe connections, cracks, and damaged valves, prior to its intended use. Incomplete combustion occurs when methane is burned but, due to oxygen insufficiency, is not fully converted into carbon dioxide and water. Compounding these issues is methane's chemical nature; because the gas is colorless and odorless, leaks and diffuse emissions remain notoriously difficult to detect and monitor across complex industrial networks (Climate and Clean Air Coalition, n.d.; U.S. EPA 2026).

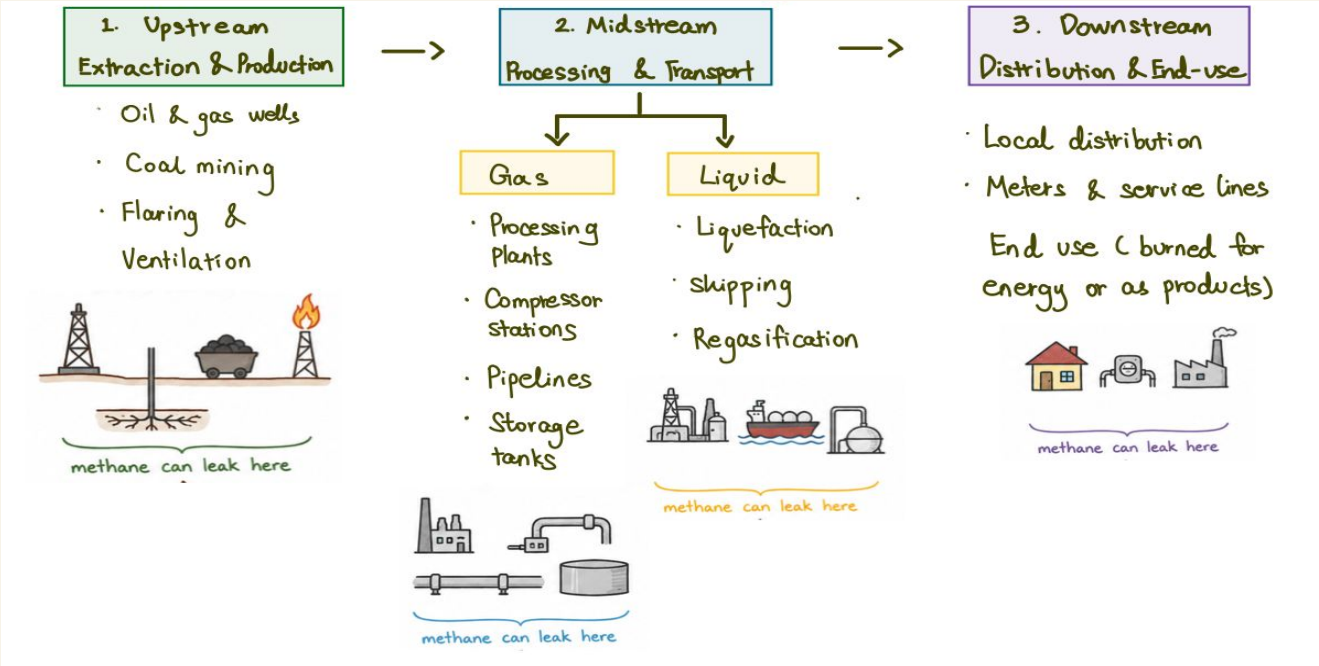


Figure 3: *Methane Fossil Fuel Life Cycle. Possible emission pathway points through upstream, midstream to downstream. Source: Xie (2026).*

These two emission pathways recur at nearly every stage of the energy supply chain, beginning most significantly in the upstream extraction and production phase. Oil and gas wells are among the largest single contributors to the problem, with gas production accounting for 41% and 18% of total U.S. oil production methane emissions, respectively. Together, these upstream activities represent about 60% of the sector's emissions, equating to approximately 129 million metric tons of carbon dioxide equivalent in 2022 (EPA, 2026).

Leakage is persistent during the drilling and completion of wells, particularly when well-control systems fail to contain pressure inside the wellbore (Occupational Safety and Health Administration, 2024). Hydraulic fracturing, or fracking, further exacerbates this risk by injecting high-pressure fluids underground to increase gas movement. During the subsequent flowback and well-completion stages, uncaptured methane is frequently vented directly into the atmosphere before the well enters regular operation (Water Resources Mission Area, 2019; Global Methane Initiative, n.d.; Howarth, 2015). Even beyond active production, methane continues to escape from abandoned or orphaned wells that lack proper plugging. In the United States, more than two million inactive, unplugged wells emit roughly 280,000 metric tons of methane annually (Department of Environmental Conservation, n.d.; Peltz, 2021; Merrill et al., 2023).

Alongside oil and gas extraction, upstream operations also encompass coal mining and routine flaring, both of which are major emission sources. Coal mining disrupts geological formations, altering pressure conditions and releasing methane stored in coal seams through underground ventilation systems, surface fissures, and abandoned mines. Combined, active and abandoned coal mines account for approximately 8% of total U.S. methane emissions (EPA, 2025; EPA, 2026a; Kholod et al., 2020). Meanwhile, incomplete combustion is a chronic issue in oil and gas production due to the practice of gas flaring, where operators burn excess natural gas that cannot be captured or transported. While federal inventories typically assume these flares destroy about 98% of the methane, empirical studies have found an average destruction efficiency of only 91.1% (Plant et al., 2022). This discrepancy means that unlit or inefficient flares allow massive volumes of pure methane, along with hazardous co-pollutants and particulate matter, to escape directly into the atmosphere (Ohio EPA, 2014; World Bank, n.d.; Plant et al., 2022).



Photo: Dmay (2025)

Once extracted, methane moves into the midstream phase of processing, storage, and transport, where expansive physical networks create immense detection challenges. Gathering, transmission, and distribution pipelines span roughly three million miles across the United States. Because much of this aging infrastructure is buried underground or underwater, leaks are difficult to measure and frequently underestimated. Furthermore, transporting methane over long distances often requires converting it into Liquefied Natural Gas (LNG) by cooling it to -162°C, which reduces its volume by a factor of 600. Maintaining this cryogenic liquid state requires precise pressure and cooling systems throughout loading, storage, and regasification. Any temperature or pressure fluctuations during this midstream transit can cause the liquid to revert to gas, resulting in boil-off venting and subsequent atmospheric leaks (U.S. Department of Energy, n.d.).

In the final downstream stage of distribution and end-use, methane reaches industrial facilities and household consumers, introducing pollution directly into local communities. On the industrial side, methane serves as a critical feedstock for petrochemical production, including plastics, hydrogen, and ammonia fertilizers. On the consumer side, local distribution systems deliver methane to households to generate heat and electricity. The burning of methane in residential gas stoves is a clear example of how ordinary end-use contributes to the crisis. Orange flames on a stove indicate incomplete combustion, a process that not only releases unburned methane into the atmosphere but also emits a toxic mix of indoor air pollutants, including nitrogen dioxide, benzene, formaldehyde, and particulate matter (Sagar, 2020). Throughout the stages of the fossil fuel life cycle, infrastructure remains a pervasive source of methane emissions and subsequent environmental degradation.

2.3 Socioeconomic Impacts of Methane Emissions

Beyond its role in driving rapid global climate change, methane pollution imposes costly burdens on public health, local communities, and the broader economy. Methane threatens human health through two broad pathways: indirect risks from increased climate hazards, and direct risks as a form of toxic pollutant.

Indirectly, methane-driven warming amplifies the frequency, duration, and severity of extreme weather events, including deadly heatwaves, intense flooding, and severe wildfires (IPCC, 2021). These compounded natural disasters create direct physiological stress, degrade regional air and water quality, disrupt local infrastructure, and place unprecedented demands on emergency response systems (IPCC, 2021). The resulting economic impacts are vast, resulting in billions of dollars in climate-related property damage, lost agricultural yield, reduced workforce productivity, and rising municipal adaptation costs (IPCC, 2021).

Directly, methane emissions threaten human health due to the hazardous co-pollutants that escape alongside the gas. Leaks and incomplete combustion in industrial infrastructure release nitrogen dioxide, nitrogen oxides, carbon monoxide, volatile organic compounds such as formaldehyde and benzene, and particulate matter. Nitrogen dioxide irritates the respiratory system and is associated with asthma, while benzene and formaldehyde are classified as carcinogens (U.S. Environmental Protection Agency [EPA], 1994, 2003, 1990). Other byproducts, such as fine and ultrafine particulate matter, can penetrate deep into the lungs and bloodstream, where they can damage respiratory, cardiovascular, and nervous systems. Many such toxic pollutants can also react in the atmosphere to form other chemical byproducts. In the presence of sunlight, for instance, nitrogen oxides and volatile organic compounds combine to form ground-level ozone, worsening air quality and adding to the public health burden of methane (EPA, 2013).

The social and economic consequences of these emissions fall disproportionately on frontline communities living in close proximity to industrial facilities. An estimated 18 million Americans live within half a mile of an active oil or gas well, exposing them to chronic, elevated concentrations of airborne toxins (Proville et al., 2022; Earthworks & FracTracker Alliance, 2022). This proximity creates significant health equity and environmental justice concerns. From an economic perspective, these health burdens translate into substantial quantifiable social costs, including elevated healthcare spending, emergency room visits, lost workdays, and depressed property values near industrial sites. Because private operators do not bear these health and environmental costs, they remain unpriced market externalities, compounding the societal burden of ongoing methane emissions (Buonocore et al., 2025).

2.4 The Government's Role in Addressing Methane Emissions

Addressing industrial methane pollution requires strategic public intervention because methane emissions impose environmental and economic costs that are not fully addressed by private markets or by existing state regulations. Economic theory and environmental policy underscore three key reasons for federal intervention in methane emissions reduction.

First, methane emissions generate significant negative externalities which are costs imposed on people who are not directly involved in an activity. When methane escapes from oil and gas infrastructure, companies generally do not bear the full costs of the resulting climate change, environmental degradation, or public health impacts; those costs fall instead on communities, taxpayers, and future generations. Because these broader costs are not reflected in market prices, firms have little incentive to reduce emissions beyond what is privately profitable, and methane pollution remains much higher than is socially desirable. Government intervention is, thus, necessary to correct this market failure and align private operational incentives with broader societal health and environmental goals.

Abandoned oil and gas wells illustrate this dynamic clearly. An estimated 3.4 million oil and gas wells across the United States have been abandoned (Riddick et al., 2024). Many no longer produce enough oil or gas to remain profitable, and when operators cease production or declare bankruptcy, responsibility for the resulting environmental harm does not disappear. It shifts to state and federal governments, since these orphaned wells are left with no solvent party to plug them (Agerton et al., 2023). In the meantime, unplugged wells continue to leak methane and other pollutants into surrounding communities.

Second, pervasive information gaps and technical monitoring challenges prevent effective self-regulation. Measuring leaks is difficult: many emissions occur through small leaks that are hard to detect, while others stem from large but infrequent "super-emitter" events that traditional monitoring often misses. As a result, researchers have repeatedly found that actual emissions are likely significantly higher than official estimates (IEA, 2022–2025; Menon, 2022). Incomplete information makes it difficult for policymakers, communities, and even operators to grasp the true scale of the problem, and because no single company can capture all the benefits of better emissions data, private markets tend to underinvest in this kind of research. This results in the responsibility falling to the government to publicly fund research and standardized measurement frameworks.

Finally, methane pollution is an issue that spans across state and national boundaries. Oil and gas infrastructure exist in multiple states, and methane released in one location contributes to climate impacts felt nationally and globally. This creates a collective action problem: a state that adopts strong methane regulations bears the costs of enforcement while the benefits are shared broadly. States with weaker rules may attract operators seeking lower compliance costs. This dynamic discourages individual states from adopting strong protections on their own. Because methane pollution affects interstate markets and national environmental goals, many policymakers argue that some degree of federal coordination is necessary; the Constitution's Interstate Commerce Clause provides a basis for federal involvement in matters that extend across state lines (Congressional Research Service, 2021).



3. The Legislation

Photo: Boguslavsky (2023)

3.1 Legislative Overview

In response to the growing near- and long-term health and environmental risks posed by rising methane emissions, U.S. Representative Sean Casten introduced H.R. 752: The Methane Emissions Mitigation Research and Development Act to Congress on January 28, 2025. The bill proposes the establishment of federal research, technology development, and coordination initiatives that target methane emissions mitigation within its industrial life cycle (H.R. 752, 2025).

The first two programs of the bill are implemented through an amendment to the Energy Policy Act of 2005. The third program is established separately from this amendment and administered by the Department of Commerce through the National Institute of Standards and Technology. It focuses on creating infrastructure required for methane mitigation technology development, as well as standardizing measurement and monitoring methods.

Program	Location in Legislation	Description
I. Technical Assistance Program	Sec. 2(a) → Sec. 969E(a)	Provides technical support to the DOE across methane leak measurement, detection, and prevention strategies
I. Research Consortium	Sec. 2(a) → Sec. 969E(b)	Coordinates methane emissions research and data sharing between federal agencies, industry groups, NGOs, and universities
I. Testing & Intercalibration Facilities	Sec. 2(c)	Creates infrastructure for testing and standardizing new methane measurement and detection technologies and methods

***Table 1**: Structural Overview of Major Programs Outlined in H.R. 752*

3.2 Detailed Provisions of the Programs

I. Technical Assistance to the Department of Energy

Section 969E(a) directs the Secretary of Energy, in coordination with the Environmental Protection Agency, Secretary of Commerce, and relevant federal agencies, to establish a science-based methane emissions detection and mitigation research, development, and demonstration program. This program provides technical assistance to the Department of Energy through cooperative agreements with state and local governments, universities, and private-sector entities.

These agreements provide targeted support for the prediction, quantification, and mitigation of methane emissions caused by natural gas infrastructure (including production sites, pipelines, and storage facilities). This includes an updated review of leak detection and repair (LDAR) technologies and strategies, and the creation of publicly accessible best-practice resources for infrastructure design, construction, maintenance, monitoring, and incident response.

In addition, the program supports efforts to identify high-risk infrastructure, mitigate methane emissions in coal mines, map emissions from natural sources, and improve atmospheric measurement under variable weather conditions. This is achieved through the development and application of the following technical capabilities:

- Data analytics and machine learning for detection and pattern recognition
- Spectroscopic databases for remote sensing
- Isotopic analysis for source attribution
- Light Detection and Ranging (LiDAR) technologies for remote sensing

II. Methane Emissions Measurement and Mitigation Research Consortium

Section 969E(b) prompts the Secretary of Energy to establish and operate a Methane Emissions Measurement and Mitigation Research Consortium that will define research priorities, promote interagency and cross-sector data sharing and research collaboration, and create a multiyear agenda with clearly defined technical goals and milestones. In turn, it provides a mechanism for consensus and compromise on research strategies between diverse stakeholders.

This collaboration will involve federal agencies including the National Institute of Standards and Technology, national laboratories, oil and gas operators, vendors of methane detection technologies, higher education institutions, community organizations, and non-governmental organizations.

Reporting Requirements: Federal support will span ten years, with a review after five years. The Secretary of Energy must submit an initial report to Congress within 18 months describing available LDAR technologies, research gaps, and data-sharing activities, followed by annual progress reports.



Photo: Zuzanna (2023)

III. Facilities for Testing and Intercalibration

Section 2(c) directs the Secretary of Commerce to establish national facilities for methane measurement testing, intercalibration, and standards development within one year of enactment of H.R. 752. The purpose of these facilities is to improve methane detection and quantification methods, supporting development of measurement standards, providing testing environments for methane monitoring technologies, improving remote sensing accuracy, and developing methods linking methane concentrations to emission rates and evaluating technologies across different source types, geographic regions, atmospheric conditions, and monitoring platforms.

Reporting Requirements: The Secretary of Commerce is required to submit a report to Congress summarizing activities, findings, and progress within two years of enactment.

3.3 Allocation of Authorized Appropriations

Programs I and II are integrated into the Energy Policy Act and would therefore be implemented through existing Department of Energy funding structures, with both receiving shared appropriations outlined in Section 2(a)(7). The authorized funding for these programs is specified only through 2030. Program III, by contrast, is established as a distinct federal initiative and would be implemented through explicit authorized appropriations outlined in Section 2(c)(4), and includes a continuous annual provision after 2030, suggesting an expectation of continued federal support beyond 2030.

The authorized appropriations for all three programs are summarized in **Table 2**:

Program	Authorized Funding 2026-2030 (USD)	Authorized Annual Funding After 2030 (USD)	Administering Agency
I & II	$200M - authorized collectively under Sec. 969E	None specified	U.S. Department of Energy
III	$95M	$23M	National Institute of Standards and Technology

***Table 2**: H.R. 752 Authorized Appropriations Summary.*

3.4 Public and Private Stakeholder Perspectives

Support for the Legislation

Many climate advocates, public health groups, researchers, and environmental organizations support H.R. 752 because methane reduction presents opportunities for slowing near-term climate and health impacts. Climate stakeholders posit that even minor reductions have the potential to slow climate tipping points (IPCC, 2021). They also highlight current monitoring systems' failures to detect leaks, leaving policymakers and communities without accurate information about the true scale of emissions (Menon, 2022; IEA, 2022–2025). Addressing leaks and emissions also improves air quality, reduces health risks, and prevents explosions, risks that are disproportionately higher for frontline and low-income communities who are located closer to energy infrastructure (Johnston et al., 2020; Menon, 2022). Lastly, better technologies would also make it more efficient and potentially cost-effective for operators to find and repair leaks. Because much of the escaping gas is itself a saleable product, faster detection can offset some compliance costs. Finally, supporters argue that nationally coordinated, federally supported research helps prevent a "race to the bottom," in which operators relocate to states with weaker environmental protections.



Photo: Grey (2020)

Opposition to the Legislation

Although the bill focuses on research and technological development rather than direct regulation, some industry groups and policymakers have raised concerns. Industry organizations such as the American Petroleum Institute (API), the American Exploration and Production Council (AXPC), and the Independent Petroleum Association of America argue that methane regulation could increase costs for energy producers or complicate operations (Nadig, 2024). Small and independent operators may face greater compliance challenges because new leak detection technologies, inspection, and reporting pose an unequal financial burden compared to large operators. Industry representatives also contend that state governments are better positioned to regulate methane emissions because they understand local conditions. They point to existing voluntary emissions reduction programs that have already reduced emissions.

Some policymakers oppose the bill on broader ideological grounds, arguing that federal involvement may interfere with market processes and that private firms — not taxpayers — should fund research tied to their own operations. Others worry that stricter U.S. methane policies could disadvantage domestic producers relative to international competitors operating under less restrictive rules. A different line of criticism comes from the opposite direction: some observers argue that the bill is too modest, contending that voluntary, research-focused measures without binding mandates will not drive emissions reductions quickly enough.



4. The Science Behind the Proposed Solutions

Photo: Qi (2026)

H.R. 752 proposes a direct and comprehensive federal strategy for reducing the United States' contributions to global atmospheric methane levels. Rather than a regulatory approach, the bill focuses on research and technology development to enhance federal capabilities in managing emissions from diverse sources, funding three complementary streams of research: methane detection, measurement, and mitigation techniques.

This section outlines the role of each of these streams in the overall methane emissions mitigation process, highlighting specific technology examples with their applications and underlying scientific mechanisms.

The Integrated Mitigation Framework: Leak Detection and Repair

Leak detection and repair (LDAR) describes the operational framework for identifying, quantifying, and reducing fugitive methane emissions from leaks in the fossil gas supply chain, and is a central component of the methane mitigation strategy proposed in H.R. 752.. These frameworks integrate methane detection, measurement, and mitigation, requiring and enabling oil and gas operators to identify and repair emissions sources.

In practice, LDAR programs serve both an operational and a regulatory function, helping oil and gas industry operators reduce both fugitive emissions and associated capital losses. EPA best-practice guidelines provide procedures for identifying and repairing equipment leaks, conducting monitoring, and maintaining records (U.S. EPA, 2007). As emissions mitigation science and technology matures, LDAR frameworks increasingly incorporate advanced detection, measurement, and mitigation technologies, yet best-practice guidelines require updating. Key LDAR technologies are examined in the following sections (Wilde, 2025).

4.1 Stream I: Methane Detection

I. Overview

Because it is colorless and odorless, atmospheric methane cannot be detected or pinpointed without specific technologies designed for this purpose (EPA, 2024). The R&D supported by the bill advances detection technologies and methods across a wide range of spatial scales, encompassed by three broad categories of detection: ground-based, aerial, and space-based. Together, the technologies within each of these categories address different needs in emission detection, pinpointing sources from super-emitters (individual sources that release disproportionately large quantities of methane) to minor equipment leaks that can evolve into more significant contributors.

Observing Earth's land and atmosphere from space is the most effective way to identify methane plumes across large distances, making this platform useful for detection at regional, national, and international scales. Plumes from super-emitters typically span several kilometers, but can reach tens of kilometers as methane disperses through the atmosphere if sources remain unidentified (NASA Jet Propulsion Laboratory, 2022). Satellite-based detection systems offer high spatial coverage that can enable the identification of these large plumes and help pinpoint exact sources within them. While specific resolutions vary across satellite systems, their capability is generally limited due to significantly lower spatial resolution relative to aerial and ground-based detection counterparts. In addition, satellites' persistence in orbit around Earth enables long-term atmospheric monitoring, although with intermittent coverage of different regions due to constant changes in position relative to Earth (providing low to moderate temporal resolution).

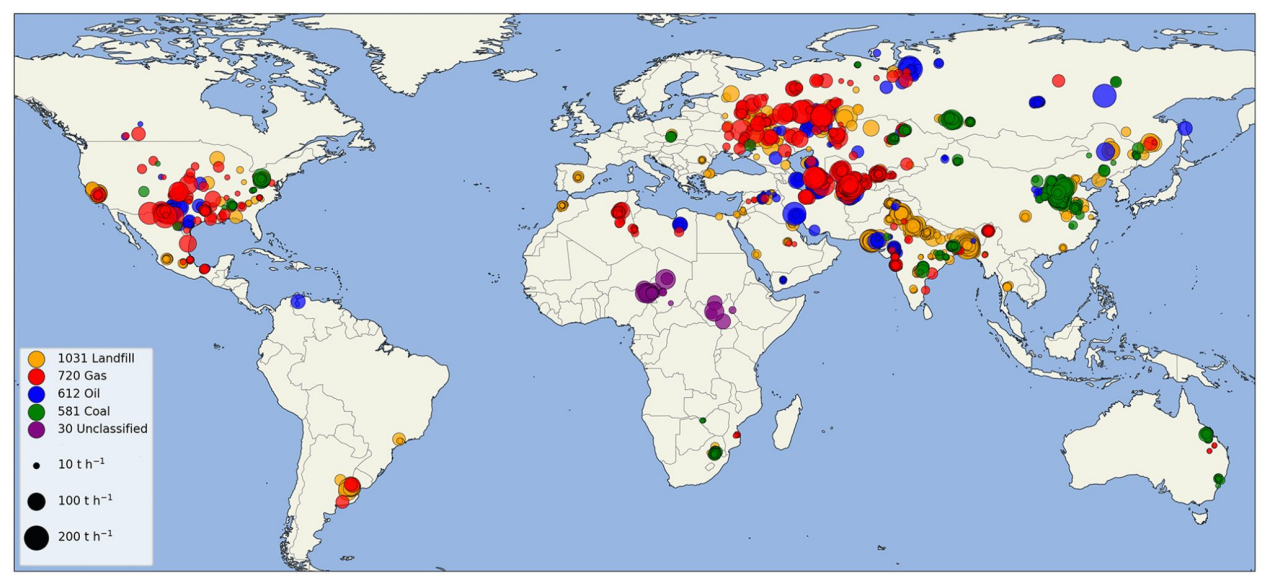


Figure 4: *Methane plumes detected by TROPOMI in 2021. 2974 plumes were detected, categorized by emission type (circle color) and source rate (circle size). 30 detections in central Africa were labeled "unclassified." Reproduced from: Schuit et al. (2023).*

By contrast, ground-based detection systems provide significantly higher spatial resolution that enables highly specific identification of source location. These systems can offer either continuous or on-demand monitoring. Fixed sensors are permanently installed at oil and gas facilities to alert operators in real time, allowing leaks to be identified and addressed promptly, while handheld systems such as optical gas imaging cameras (OGI) enable targeted on-site detection (International Association of Oil & Gas Producers, 2025). The high resolution but low coverage of these technologies make them most valuable for identifying component leaks or conducting facility surveys.

Aerial detection methods increase coverage relative to ground-based systems without significantly compromising spatial resolution, which is reduced in satellite detection. These methods involve either manned aerial vehicles (fixed-wing planes or helicopters) or unmanned aerial vehicles (UAVs; drones and balloons), with each method offering specific advantages and uses. Drones detect plumes over a smaller area during inspections, allowing for high-resolution data that can be obtained from difficult or unsafe conditions for workers to access (International Association of Oil & Gas Producers et al., 2025). Fixed-wing aircraft build out routine aerial surveys that can be used to record consistent data and make maps of methane leakages (International Association of Oil & Gas Producers, 2025).

II. Detection System Characteristics and Tradeoffs

Each detection platform comes with unique advantages and limitations determined by a set of interdependent technological specifications. Although these specifications vary substantially within each category, they can be generalized and are summarized in **Table 3.**

Spatial resolution describes the size of the area represented by an individual pixel of data, with higher spatial resolution enabling greater precision in locating methane emission sources. There generally involves a tradeoff between spatial resolution and coverage. Sensors capable of capturing smaller areas typically survey smaller regions, while sensors designed for broad geographic coverage often have coarser resolution. In turn, ground-based systems typically provide very high spatial resolution over localized areas while satellite platforms provide broader regional and global coverage at lower spatial resolution (Jacob et al., 2022).

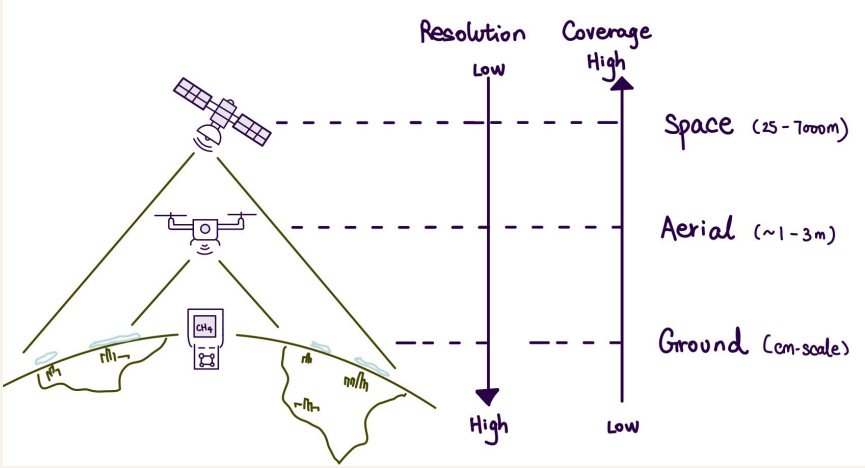


Figure 5: *General relationship between sensor altitude (height from Earth's surface), spatial resolution, & coverage. Altitude increases coverage but generally decreases resolution. Source: Xie 2026)*

Temporal resolution describes the frequency of detection measurements. Continuous monitoring systems provide the highest temporal resolution by collecting uninterrupted observations over extended periods. For satellites, temporal resolution is determined by orbital factors and is commonly understood in terms of return time, which is the time it takes to return to a given position relative to Earth. Return periods can vary substantially, ranging from 1 to 50+ days (Veldman et al., 2026).

This return period is a function of altitude (the height from Earth's surface) and, in turn, coverage: satellites with higher orbital altitudes will measure larger regions (at lower spatial resolutions), and take less time to return to a given position, enabling more frequent measurements. Conversely, satellites closer to Earth's surface will capture smaller regions and take more time before they are able to take a repeat measurement. Aerial detection campaigns are similarly episodic, with survey frequency and duration varying according to mission-specific objectives (Frankenberg et al., 2016). Ground-based systems may provide continuous measurements when permanently installed, or intermittent measurements when deployed manually using handheld instruments.

Finally, detection limits describe the minimum methane concentration or emission rate that a sensor can reliably identify (Liu et al., 2012). Ground-based systems generally achieve the lowest detection limits because they measure close to emission sources. By contrast, aerial and satellite platforms typically have higher detection limits but are optimized for detecting larger emission events (such as methane super-emitters) across much larger areas (NASA JPL, 2022).

	Ground	Aerial	Space
Spatial Resolution	High (cm-scale)	Moderate (~1–3m)	Low (25 - 7000m)
Detection Limit	Low	Moderate	High
Coverage	Low	Low - Moderate	High
Temporal Resolution	High (continuous)	Moderate (campaign-based)	Low - Moderate (orbit-dependent)
Best For	Component leaks	Facility surveys	Super-emitters

Table 3: *Summary of general characteristics, trade offs, and best uses for ground-based, aerial, and space-based detection systems.*

As a result of these complex technological tradeoffs, individual instruments have limited detection capabilities. A robust LDAR process must therefore combine multiple detection platforms, as well as instruments within each platform, to efficiently target emissions sources (Jacob et al., 2022). However, processing raw data is time-consuming, complex, and requires expertise, especially when dealing with large aerial or satellite surveys. Significant further R&D is required to make these systems interoperable, interpretable, and accessible to the public on one platform.

This bill prioritizes the delivery of such a public platform and a report on the present status of research. It also specifically calls for investments in LDAR technologies and machine learning to both spur innovation in technologies and data processing. Understanding the complementary roles of these technologies requires first examining the physical principles that enable the detection of invisible gases.

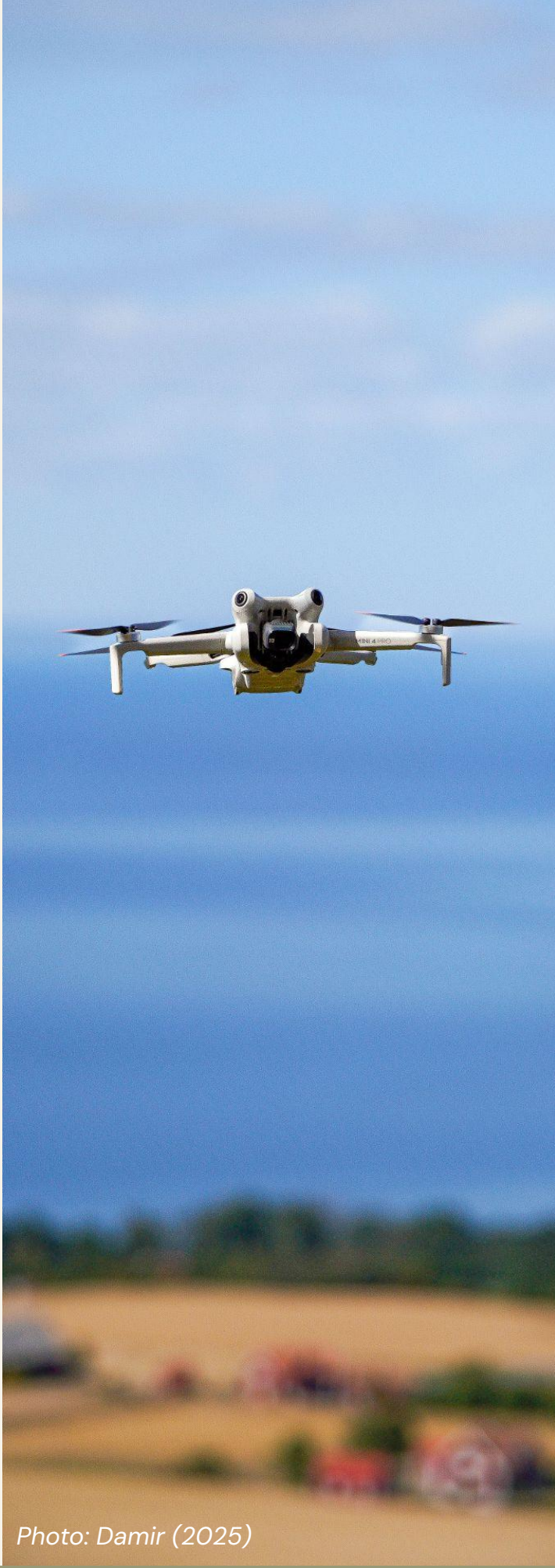


Photo: Damir (2025)

III. Spectroscopy: Methane's Interaction with Electromagnetic Radiation

Due to the fact that methane cannot be seen or otherwise directly detected, remote sensing techniques are used to indirectly identify its presence from distant observation locations. The most common remote sensing technique for methane detection is spectroscopy, which is used uniformly across ground-based, aerial, and space-based detection systems (Veldman et al., 2026).

Spectroscopy leverages one fundamental scientific principle: that substances interact in unique ways with the electromagnetic (EM) spectrum of radiation. Specifically, individual elements absorb different frequencies or wavelengths of light, resulting in a characteristic absorption signature or "fingerprint" (Jacob et al., 2022).

The EM spectrum refers to the full breadth of wavelengths of light, encompassing ultraviolet radiation to gamma rays (short wavelengths with high energy), and infrared radiation to radio waves (long wavelengths with lower energy). Visible light sits between these extremes and takes up only a small fraction of the entire spectrum. Gases like methane absorb specific wavelengths when EM radiation passes through them, producing a characteristic spectral signature. This results from the unique vibrational frequencies of their molecular bonds (Liou, 2002). Methane is invisible because it does not absorb any wavelengths within the visible portion of the EM spectrum.

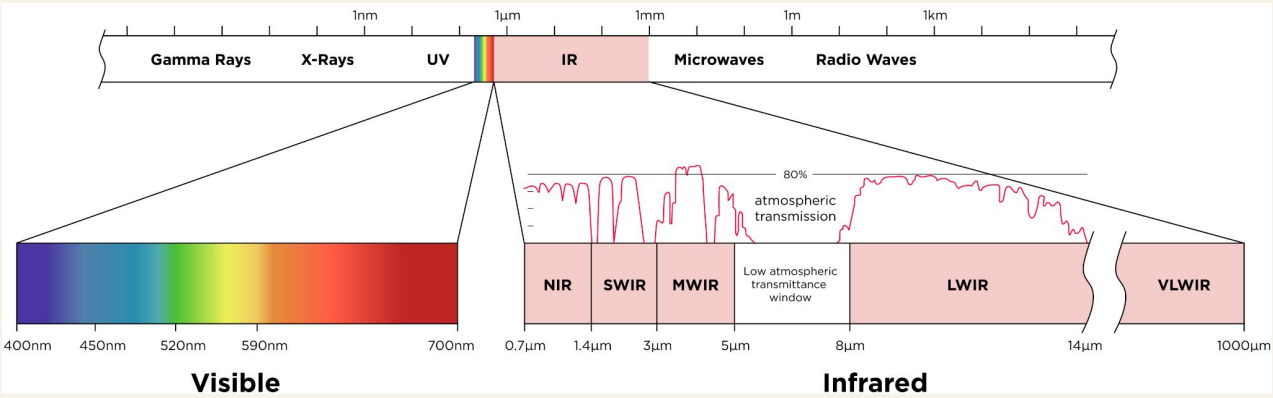


Figure 6: *The electromagnetic spectrum of light, highlighting the visible and infrared portions of the spectrum. Wavelengths are indicated as tick marks and decrease from left to right. The infrared spectrum is broken down into near-infrared (NIR), shortwave infrared (SWIR), mid-wave infrared (MWIR), long-wave infrared (LWIR), and very long-wave infrared (VLWIR). Methane absorbs wavelengths of light across each of these subdivisions of the infrared spectrum. The low atmospheric transmittance window indicates wavelengths of light that are absorbed by atmospheric gases (such as carbon dioxide, water vapor, and methane) at higher rates, reducing overall electromagnetic transmittance. Reproduced from: Infiniti Optics (n.d.).*

Not all methane detection methods use remote sensing or spectroscopic techniques. Catalytic sensing, for example, is an in-situ (on site; directly at the source) detection technique that measures the heat evolution from gases when they undergo chemical oxidation during combustion (Liu et al., 2012). This particular method is restricted by requiring the sensor to be placed directly within or near the plume, and therefore cannot be used for identifying accidental leakages or identifying fugitive emissions on large spatial scales.

Spectroscopic methods circumvent this challenge by enabling detection at longer distances. These methods rely on and use a variety of radiation sources including solar energy, light from lasers, and thermal radiation from Earth's surface (Jacob et al., 2022). **Figure 7** shows how some of these forms of radiation are directed through methane plumes to a detection system.

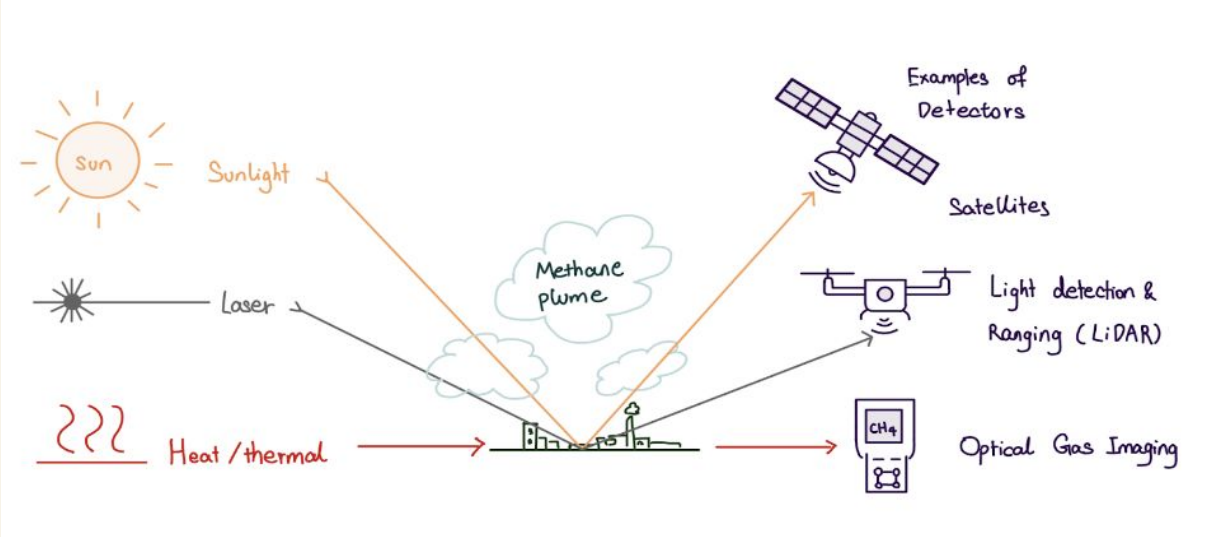


Figure 7: *Depiction of electromagnetic transmittance to detectors from different sources. Detection systems receive light frequencies from different sources, including sunlight, lasers, or thermal radiation. If this radiation has passed through methane gas, specific infrared frequencies will be removed, indicating the presence of methane. Source: Xie (2026).*

Satellite-based remote sensing most commonly uses solar EM radiation for passive spectroscopic detection. This type of spectroscopy is considered passive because it measures naturally occurring sunlight rather than generating its own. Incoming solar radiation travels through Earth's atmosphere, passing through gas clouds before reaching the surface. Some of this energy is then backscattered (reflected) to space and measured by satellite sensors. These instruments typically focus on shortwave infrared (SWIR) wavelengths, where methane has particularly distinctive absorption features (Jacob et al., 2022). The use of SWIR is limited by its dependence on the availability of sunlight and cannot operate at night.

	Visible to Near-Infrared (VNIR)	Shortwave Infrared (SWIR)	Thermal Infrared (TIR)
Wavelength Range	~400–1,000 nm	~1,000–2,500 nm	~8,000–12,000 nm
Sources	Reflected sunlight	Reflected sunlight	Emitted from Earth
Advantages	Captures land surface imagery → mapping	Highest sensitivity to methane → source attribution	Works at night → continuous monitoring
Disadvantages	Cannot independently detect methane*	Depends on solar light; unavailable at night	Lower sensitivity to methane; requires thermal contrast

**Methane does not absorb VNIR wavelengths, so this technique must be used in tandem with other ranges (like SWIR).*

Table 4: *Summary of several types of radiation used in remote sensing spectroscopy for methane detection. SWIR is most commonly used in spectroscopic methane detection because methane has the highest sensitivity to these wavelengths.*

Some remote sensing techniques pair SWIR with other frequency ranges to strengthen detection capabilities. Thermal infrared radiation (TIR) enables continuous monitoring as this radiation is continually emitted by Earth's surface, increasing temporal resolution. However, TIR measurements depend on sufficient thermal contrast between gas plumes and their surroundings and are therefore not sensitive to near-surface methane (Jacob et al., 2022). As such, TIR measurements are considered more effective from low-flying aircraft than satellites to better capture this contrast (Varon et al., 2018).

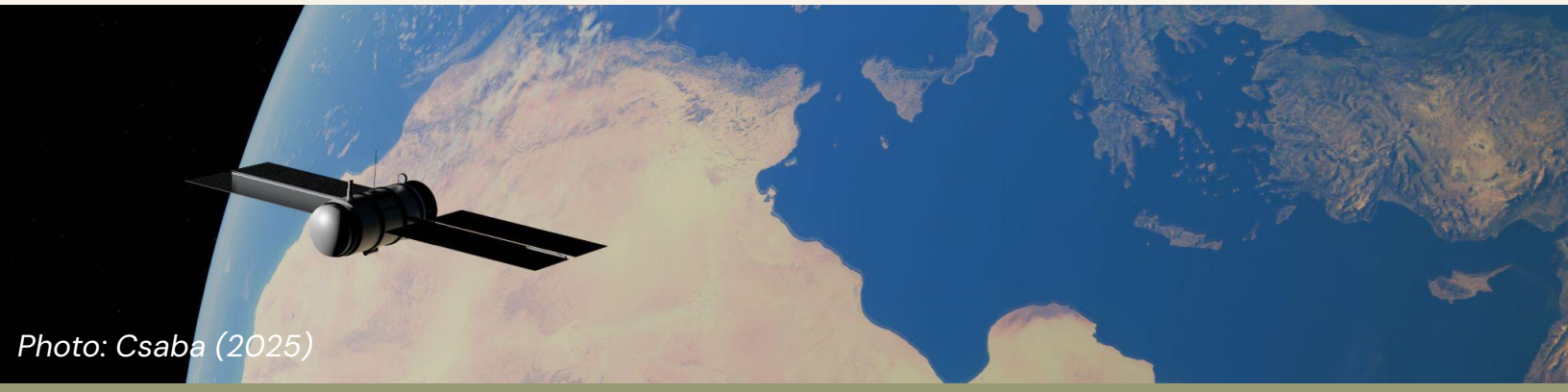


Photo: Csaba (2025)

IV. Comparison of Detection Systems: TROPOMI and Tanager-1

There are over 25 satellites currently in Earth orbit to monitor methane emissions (IEA, 2025a). These satellites vary significantly in their technical specifications, such as the ranges of electromagnetic frequencies they are designed to detect, and differ accordingly in their detection capabilities. However, sensors are not restricted to individual frequency ranges, and often combine multiple ranges of electromagnetic frequencies, as different kinds of spectral data can be complementary and can improve efficiency and accuracy in methane detection.

Despite overlaps in spectral detection ranges, different systems can still differ significantly in the kinds and qualities of data they produce, and in turn, detection results. The Tropospheric Monitoring Instrument (TROPOMI) is the only methane monitoring system with daily global coverage. It was developed and is operated by the European Space Agency (ESA) upon commission by the Netherlands Space Agency (NLSA). TROPOMI's optimization for land coverage comes at the expense of spatial resolution, with each pixel of data representing 7 square kilometers of land (NASA Earthdata, n.d.). **Figure 8** shows how these characteristics result in large-scale mapping without the ability to spatially locate point sources. The imagery from TROPOMI is primarily used as an initial screening level to identify undocumented super-emitters and Persistent Potential Source Regions (PPSR), after which additional detection layers facilitate facility- and equipment-scale leak sources.

In contrast, the Tanager-1 is a satellite developed by the non-profit organization Carbon Mapper that is specialized to provide high-resolution methane plume mapping. Using hyperspectral imaging, a technique that combines infrared spectroscopy with visible imaging using the visible-to-shortwave-infrared (VSWIR) spectrum (a combination of VNIR and SWIR), this system generates imagery that shows the location and shape of a methane plume, as well as contextual landscape detail from a 30 meter spatial resolution (Duren et al., 2024; Bhargava et al., 2024; Carbon Mapper). An example of the resulting hyperspectral image is shown in **Figure 9.**

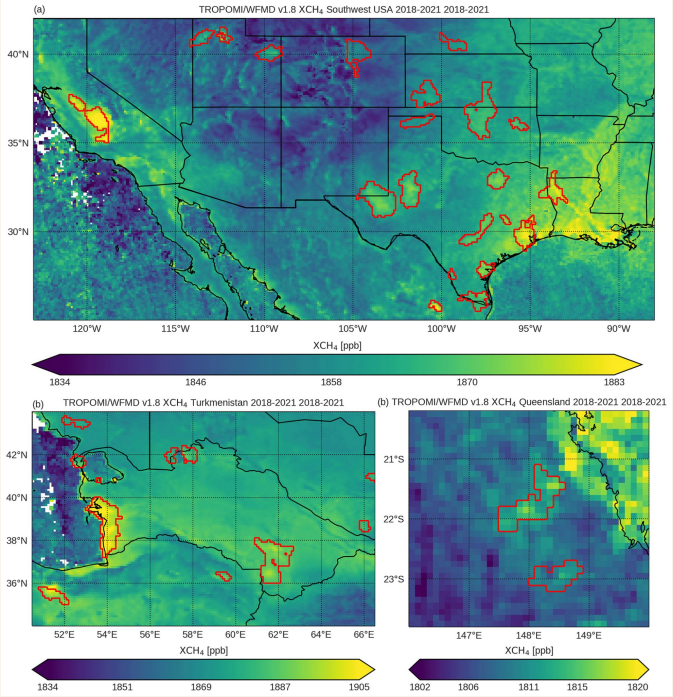


Figure 8: *TROPOMI observations with a 7 km spatial resolution, showing highlighted methane persistent point-source regions (PPSRs) across multiple global regions. Top: Southern United States. Bottom Left: Turkmenistan. Bottom Right: Queensland, Australia. Reproduced from: Vaneslow et al. (2024).*

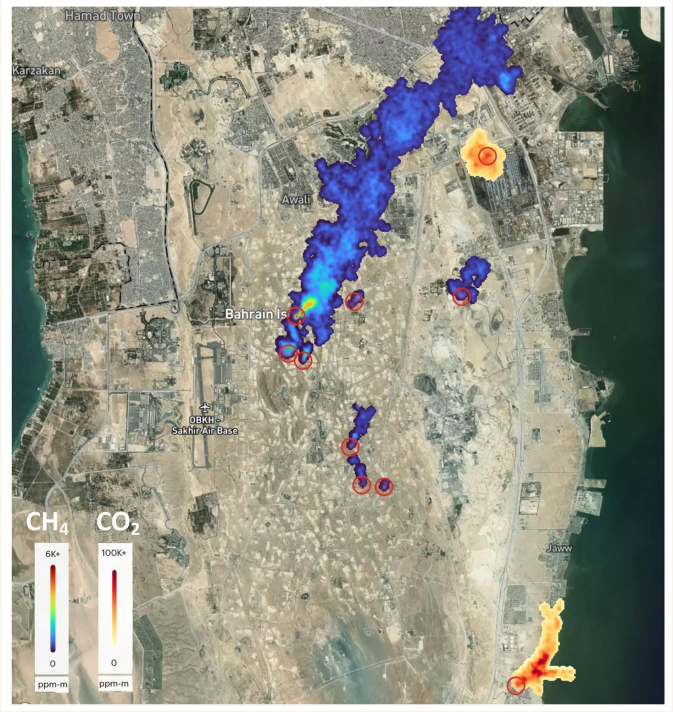


Figure 9: *Carbon dioxide and methane plumes captured by Tanager-1 with a 30 m spatial resolution in Bahrain, attributed to oil and gas production and gas-fired power plants, respectively. Reproduced from: Duren et al. (2025).*

The map generated by Tanager 1 shows clear geographic dispersion of multiple plumes. The TROPOMI data shows regions where persistent emissions have led to elevated regional methane levels, but distinguishing between individual plumes and sources requires observation at higher resolutions. This comparison illustrates how similar technologies with overlapping techniques (such as the shared use of SWIR wavelengths) can result in significantly different data and results and importantly, that these systems rely on one another for source identification. Technology maturation can reduce technology-specific tradeoffs, i.e. between spatial resolution and coverage, and help integrate different kinds and qualities of data, helping to optimize the operational efficiency of LDAR frameworks.

H.R. 752's establishment of cooperative partnerships between federal agencies for technology demonstration seeks to ensure the continued maturation of these technologies. At the same time, its proposed Research Consortium helps streamline research through data sharing, and the facilities for testing and intercalibration program helps to establish protocols for integrating multiple detection platforms.

4.2 Stream II: Methane Measurement

Effective methane emissions mitigation relies not only on the identification of sources of leaks and plumes, but also on the quantification of methane emissions. Accurate emissioans quantification is essential for validating and comparing emissions from diverse sources, which vary substantially in their emission rates and overall contributions (Jacob et al., 2022; Veldman et al., 2026). Targeting sources with high emission rates, such as gas pipeline leaks, can provide greater reductions in atmospheric methane than targeting diffuse sources such as wetlands (Saunois et al., 2025).

To illustrate this, livestock accounts for approximately 37% of anthropogenic methane emissions, but methane production from an individual cow occurs at a low rate (~200 pounds per year) (U.S. EPA, 2020). By contrast, individual pipeline leaks tend to emit methane at much higher rates, but occur less frequently. In turn, addressing these concentrated sources can provide greater mitigation results. This targeted action is contingent on reliable methods for estimating the overall quantity of methane produced by a leak or emission source, and consistency in how the estimates are derived. However, to a significant degree, the reliability and consistency of methane measurements remains insufficient (Saunois et al., 2025).

I. Emission Quantification Discrepancies

There are a wide variety of approaches for quantifying emissions. These approaches can be separated into two main categories: “bottom-up” (BU) and “top-down” (TD). Bottom-up approaches use source-specific factors to estimate emission quantities, while top-down approaches use atmospheric concentrations. Historically, BU approaches have been the standard in methane emissions quantification, and calculate total emissions based on the rate of activity of a given source and its emission factor, according to the following relationship (Trace, n.d.):

$$\sum Emissions \;=\; Activity\ Rate\ x\ Emission\ Factor$$

Emission factors are coefficients used to estimate emissions produced by a given source, and activity rates describe the relative frequency of emissions caused by a source (Trace, n.d.). These factors are based on averages of source samples from measurement studies.

Modern quantification methods have introduced top-down quantification approaches. By measuring methane concentrations and fluxes within atmospheric columns and spatially extrapolating these within the identified methane plume region, estimates of methane quantities within a plume can be made (Jacob et al., 2022; Saunois et al., 2020). However, TD quantification techniques vary substantially (Varon et al., 2018).

The remote sensing spectroscopy techniques described in Chapter 4.1 are used not only in the detection of methane, but also the estimation of methane concentrations as used in top-down measurements. Spectroscopic absorption patterns identify the gas' presence, and the magnitude of these patterns is indicative of concentration, as higher concentrations result in greater absorbance of EM radiation. Retrieval algorithms are used to estimate methane concentrations and mixing ratios using these measured absorption patterns along with atmospheric background information (Jacob et al., 2022).

Using these mixing ratios, TD approaches first calculated methane enhancement (ΔX), which is the increase in methane mixing ratio (the proportion of atmospheric molecules that are methane) relative to the local atmospheric background in a column of the atmosphere:

$$\Delta X = X - X_b$$

Here, X is the average methane concentration in the column (retrieved by the instrument) and Xb is the local background methane concentration, determined separately prior to atmospheric measurement (Varon et al., 2018). This is then converted to mass enhancement (the methane mass increase within an atmospheric column):

$$\Delta\Omega = \frac{M_{CH_4}}{M_a}\Omega_a \Delta X$$

Where ΔΩ is the mass enhancement or increase in methane mass in the atmospheric column, a is the mass per unit area of dry air in the column, and MCH4 and Ma are the molar masses of methane and dry air respectively (Varon et al., 2018).

These column mass enhancement estimates represent the increase in methane in an individual atmospheric column, and can be extrapolated throughout a plume's area through a number of mathematical techniques, including Gaussian plume inversion, integrated mass enhancement, or cross-section flux methods (Varon et al., 2018). Each of these techniques results in different estimates for the overall quantity of methane generated by a source, reflecting methodological uncertainty internal to top-down techniques.

More broadly, the mathematical and methodological differences between bottom-up and top-down quantification methods result in significant discrepancies in calculated emissions estimates. Generally, BU measurements tend to underestimate methane emissions, which is indicated by the fact that TD measurements consistently exceed them (Vaughn et al., 2018; Zavala-Araiza et al., 2015). These discrepancies arise as a result of various uncertainties and differences between measurement approaches, including:

- Variations in spatial and temporal resolution between different detection and measurement systems, and subsequent uncertainties in spatiotemporal patterns
- Uncertainties or inaccuracies in emission factors (Vaughn et al., 2018)
- Uncertainties in atmospheric transport modeling used to infer emission dispersion (Saunois et al., 2020)
- Uncertainties associated with different atmospheric conditions
- Differences in measurement sensitivity (detection limit) across platforms (Duren et al., 2025)

The lack of agreement between results from BU and TD measurements, and uncertainties within each of these approaches, exemplify how methane measurements and quantification protocols remain largely unstandardized. This lack of standardization poses significant challenges for accurately estimating emission quantities, calibrating measurements across detection platforms, and characterizing and predicting methane emissions variations under different atmospheric conditions, among other important components of modern LDAR techniques.

Mitigating methane emissions in the presence of these challenges is possible, but will remain economically and operationally inefficient. There are, however, clear opportunities to minimize these measurement uncertainties and discrepancies through R&D. Reducing these discrepancies would directly improve LDAR and mitigation efforts across all source types.

II. Standardization Solutions in H.R. 752

Each of the R&D programs proposed by H.R. 752 address this standardization problem in different ways. The Mitigation Research Consortium facilitates data sharing between private sector, public sector, and nongovernmental entities. This data sharing benefits a number of purposes, including the improvement of emissions measurement capabilities, specifically for "assessing multi-tiered atmospheric measurements" (i.e. emissions estimates based on measurements from multiple technologies or detection platforms) and "improving the understanding of methane quantification data analysis and machine learning platforms, including for calibration of measurements" (H.R. 752, 2025, § 969E(b)). In turn, the Consortium can direct research efforts to reduce the main uncertainties that prevent cohesion between BU and TD measurements listed above.

The Technical Assistance provision of the bill establishes cooperative agreements that facilitate the demonstration and research of technologies and methods to detect, quantify, and mitigate methane emissions. The program prioritizes research on characterizing temporal patterns in emissions across multi-tiered systems, improving data analytics and machine learning platforms, and improving high-resolution spectroscopic databases of methane (H.R. 752, 2025, § 969E(a)). This research establishes standardization of measurements across measurement and detection platforms, data processing and calibration methods, and databases used to characterize methane's absorption of light frequencies. In turn, this program supports greater consistency in methane quantification and reduces discrepancies between BU and TD measurement protocols.

Finally, the National Facilities for Testing and Intercalibration Program's primary purpose is to advance methane measurement methodologies and solidify their standardization. This program provides high-resolution spectroscopic reference data, including measurements of background methane concentrations, to advance the accuracy of remote sensing techniques. It also seeks to "develop methods relating methane concentration observations to associated emission fluxes", helping to address discrepancies between TD measurement approaches. Finally, it facilitates testing of new and existing measurement technologies to reduce uncertainties associated with various factors, including geographic diversity, temporal characteristics, sizes and extents of emission sources, and diversity of observing platforms (H.R. 752, 2025, § 2(c)). Across all three programs, there is a comprehensive and multifaceted research strategy for improving methane emissions quantification and measurement.



Photo: Pointner (2022)

4.3 Stream III: Methane Mitigation

While technological advances in detection and measurement strengthen mitigation response, different emissions sources require different mitigation strategies, of which there are a wide variety. Moreover, some emissions sources can be addressed using multiple mitigation techniques, and it can be unclear which is best. Alongside its robust framework for developing and standardizing detection and measurement applications, H.R. 752 seeks to strengthen methane mitigation by identifying optimal mitigation techniques for different emissions sources, and providing best-practice resources.

Proactive and Retroactive Mitigation Techniques

Mitigation approaches can prevent emissions either retroactively or proactively. Retroactive mitigation address leaks identified in detection protocols. Methane leakage frequently occurs due to improper pressure regulation, valve failures, worn seals, or the gradual deterioration of pipeline components across the full lifecycle from wellhead processing through to distribution. This can lead to point-source emissions that can be addressed by sealing, repairing, or upgrading damaged pipelines or infrastructure.

Proactive mitigation reduces future emissions through improved equipment design, more efficient operational practices, or capture and recovery of methane emissions. For this approach, there are a wide range of technologies and methods that can be best applied for different types of emissions sources. To illustrate these differences, a number of proactive mitigation techniques include:

- **High Efficiency Flaring:** Plant operators routinely combust excess or uneconomic gas through flaring rather than releasing it directly into the atmosphere. Flaring is a standard practice across the industry because by converting methane to carbon dioxide (a less potent greenhouse gas), the plant operator minimizes methane leakages. However, conventional flares are unreliable combustion devices, especially during adverse ambient weather conditions, resulting in incomplete combustion that releases methane. High-efficiency enclosed flares maintain stable combustion across a wider range of operating conditions. These flares are calibrated to achieve nearly 99% complete combustion of released gas.

- **Zero Non-Emergency Flaring:** Often, flaring happens when plant operators anticipate its needs rather than when a problem arises that requires flaring. By mandating a policy of avoiding flaring during these non-emergency events and instead implementing better gas recycling, even when it is uneconomical, methane leaks can be minimized.

- **Compressed Air Controllers:** Many oil and gas facilities use natural gas as the pneumatic power source for instrument controllers. These controllers regulate valves and manage pressure. These pneumatic controllers release small but continuous streams of natural gas as a byproduct of their normal operation. Replacing gas-powered pneumatic controllers with compressed air or instrument air equivalents eliminates this venting entirely at the source.

- **Vapor Recovery Systems:** Storage tanks at production facilities release methane and other vapors and gases through pressure-relief mechanisms. Vapor recovery systems capture these emissions at the tank vent before they reach the atmosphere, routing the recovered gas back into the sales line or using it as onsite fuel.

Mitigation Technique Selection and Best Practices

These technologies address leaks across the fossil-fuel life cycle, including fossil fuel extraction, processing, and distribution. Vapor recovery systems can collect methane leakage from processing plants or pipeline infrastructure, while compressed air controllers replace use of methane gas itself for pressure control in the pipeline, which reduces leakage throughout the network. Retroactive repair fixes faulty pipes and valves; eliminating non-emergency flaring and using high-efficiency flares eliminates the risk of methane leakage from pipelines across its entire footprint. These retroactive and proactive mitigation technologies may be used in combination to address the same and different sources of methane leaks. However, deciding which techniques to use creates operational inefficiency in mitigation and the overall LDAR process.

Under the bill's Technical Assistance program, the Department of Energy, through cross-sector coordination and support from other federal agencies, will develop standard protocols and publicly accessible best-practice guidelines to streamline LDAR and mitigation. These best practices provide guidance on the design of, maintenance, and response to leaks in vulnerable infrastructure throughout the oil and gas industry, including pipelines, production wells, and storage facilities (H.R. 752, 2025, § 2(a)). In addition, they seek to strengthen the incorporation of mitigation technologies by providing performance metrics and "principles for selection and integration of emission reduction technologies that are best suited for the project or entity concerned" (H.R. 752, 2025, § 2(a)). In turn, the technical assistance program supports federal management of methane emissions by streamlining decision making in the LDAR process, informing appropriate mitigation responses for different leaks.



Photo: Lansdown (2026)

5. Implementation Challenges and Controversies

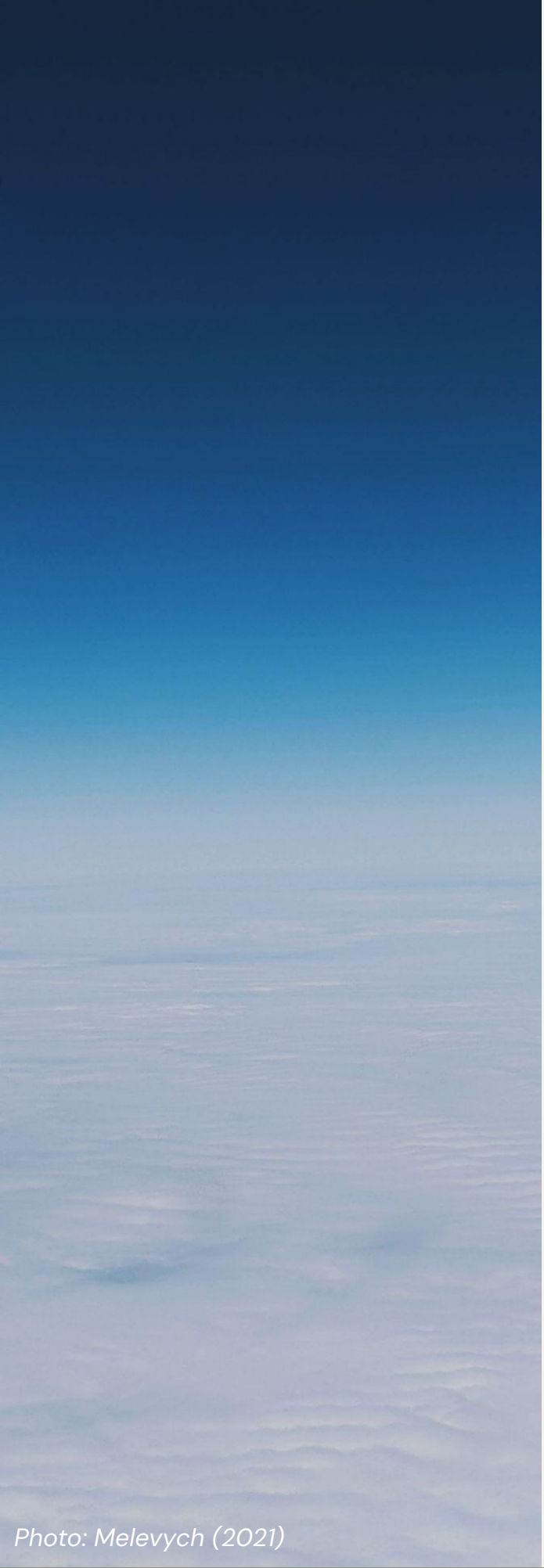


Photo: Melevych (2021)

There is strong scientific consensus that methane is a potent greenhouse gas, and that its emissions are a key contributor to climate change (IPCC, 2021). There is also extensive evidence documenting the global rise in methane emissions: the International Energy Agency reported that, in 2025 alone, the energy sectors of the 10 countries with the most methane emissions contributed approximately 85 million metric tons of methane (IEA, 2026). Nevertheless, political controversy concerning climate change persists. A 2025 analysis by the Center for American Progress identified 119 out of 541 members of the 119th Congress as rejecting or questioning the scientific consensus of human-caused climate change (So, 2025). Political denial of the environmental problem H.R. 752 seeks to address creates substantial challenges for its implementation.

Beyond this political backdrop, there is additional controversy surrounding H.R. 752's proposed strategies for addressing methane emissions, and the effectiveness of its strategies are contingent on several key uncertainties. These uncertainties give rise to a range of technical, economic, and policy debates that may further hinder the bill's approval by Congress, and that are examined in the following section.

Investment Tradeoffs

Detection technologies vary significantly in their capabilities, applications, and research and development costs. Ground-based detection systems can provide high resolution measurements but cover limited areas. Aerial detection systems can survey larger regions but typically only collect data intermittently and are affected by weather conditions. Satellites provide the broadest geographic coverage and are useful for regional or global scans, but they have lower spatial resolution and can also be limited by cloud cover. The costs associated with each of these technologies vary substantially but generally increase with technical complexity. Satellites, for instance, have significant costs associated with launch, operation, and maintenance. Failure or underperformance of these systems can therefore have more significant consequences for the allocation of federal funds.

The fundamental challenge is determining how to balance accuracy, coverage, frequency, and cost to create a reliable national methane monitoring system. While the bill's proposed Research Consortium is intended to provide guidance on prioritizing research and allocating funding, addressing this challenge ultimately depends on the Consortium's efficacy in evaluating these competing factors.

Competing Incentives Between Stakeholders

The Methane Measurement and Mitigation Research Consortium brings together diverse cross-sector entities as a model for identifying research priorities and facilitating cross-sector data sharing. While this collaboration offers significant advantages, it may introduce challenges balancing the interests of its diverse stakeholders. Industry operators may prioritize affordability and profitability, scientists may emphasize measurement accuracy and scientific rigor, governments and federal agencies may focus on cost-effectiveness, non-governmental organizations may advocate for stronger environmental protections, and community groups may prioritize local environmental concerns. While these interests overlap, they may diverge in important ways requiring tradeoffs for reconciliation which, if not managed effectively, could create difficulties in identifying research priorities that most effectively address broader methane mitigation objectives.

Industry Compliance

Ultimately, effective mitigation depends on industry action, which is made uncertain because regulatory requirements and economic incentives vary significantly between states and regions. In many cases the cost of repairing a leak may exceed the market value of the methane that would be recovered, or possible financial penalties. The economic feasibility of mitigation also depends heavily on natural gas prices, detection costs, and repair costs (Hegemony, 2025). When prices are low, operators have little financial incentive to act even when the climate benefit of a repair is substantial.

The complexity of methane extraction, delivery, and storage infrastructure presents a further obstacle. Reducing emissions across these nationwide systems often requires substantial capital investment, particularly for older facilities and equipment that were not designed to prevent unintended emissions. Such upgrades can be expensive and slow to implement, limiting how quickly improvements in detection and measurement can translate into actual emissions reductions.

Societal Considerations: Surveillance, Privacy, and Environmental Tradeoffs

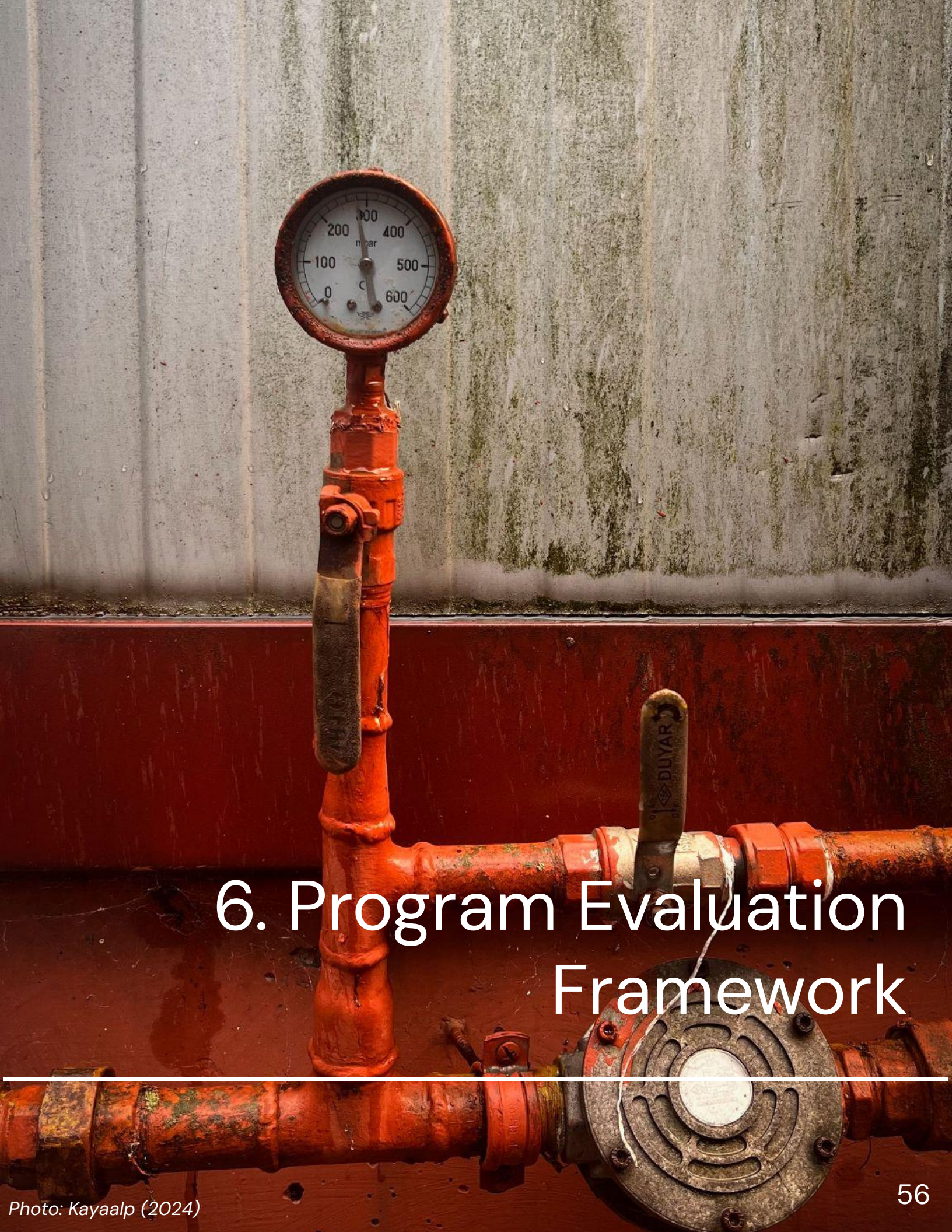
While the solutions presented in H.R. 752 are designed solely to target methane emissions, broader questions surrounding international surveillance and data governance are raised by the deployment of satellites that continuously collect spatial data across national borders. The United Nations Principles Relating to Remote Sensing of the Earth from Outer Space recognizes freedom to conduct remote sensing from space but requires that this activity is conducted on the basis of "respect for the principle of full and permanent sovereignty of all States and peoples over their own wealth and natural resources" and "shall not be conducted in a manner detrimental to the legitimate rights and interests of the sensed State" (United Nations General Assembly, 1986). Thus, while satellite remote sensing is permitted by international law, emissions data revealing the performance of specific regions or facilities may carry economic or geopolitical significance. Whether the collection, dissemination, or use of such data could conflict with the legitimate rights and interests of sensed States is unclear.

A further societal concern is domestic privacy. Aerial detection using aircraft and drones can capture imagery of private property while surveying land for methane plumes. Although these operations generally require permits, public anxiety about observation and data collection persists, and the perception of intrusion can erode community trust even when monitoring is lawful. A final consideration is the environmental footprint of the monitoring itself. Aircraft flights and satellite launches generate greenhouse gas emissions, which creates a tradeoff between improving the accuracy of methane detection and minimizing the emissions produced by the LDAR process. These ethical and policy challenges associated with technological advancements in methane emissions monitoring require transparency and effective public communication.

International Coordination

Methane emissions are a global challenge. Once emitted into the atmosphere, methane emissions mix globally. Moreover, the climate effects produced by methane emissions are experienced globally, regardless of where they originated. Thus, while H.R. 752 strengthens methane mitigation research within the United States, its long-term success ultimately depends on international coordination and agreement with international standards. This need for international coordination is reflected in global initiatives such as the legally non-binding Global Methane Pledge, now endorsed by 159 countries and the European Union, as well as the UN International Methane Emissions Observatory and the Methane Alert and Response System, which provide standardized monitoring and rapid identification of major methane emissions. Without consistent reporting methods, emissions can be measured differently across countries, creating challenges for global comparisons and accountability.

By funding a Department of Energy research consortium and directing the National Institute of Standards and Technology to establish national facilities for testing and calibrating methane measurement, H.R. 752 targets the standardization gap that lies at the root of measurement discrepancies. As shared calibration standards and pooled data become available, the differing measurement approaches are expected to converge, strengthening scientific consensus nationally that facilitates easier integration with international data and standards (IEA, 2026).



6. Program Evaluation Framework

Photo: Kayaalp (2024)

Establishing a structured program evaluation framework is essential for determining whether public policies achieve their intended outcomes while ensuring accountability and governance. The success of H.R. 752 should not be evaluated using a single metric. Instead, it should be assessed holistically through three complementary dimensions: delivery of program outputs and milestones, achievement of robust scientific performance, and effective implementation across participating institutions.

At the highest level, the primary scientific measure of success for H.R. 752 is a measurable reduction in U.S. oil and gas industrial methane emissions. Methane is responsible for approximately 30% of observed global warming since the Industrial Revolution, and reducing emissions from the energy sector is one of the fastest opportunities to slow near-term climate change (IPCC, 2021; IEA, 2022–2025). Measuring methane emissions directly is therefore a more appropriate indicator of success than broader climate outcomes, such as changes in global temperature, which are influenced by numerous external factors.

From a societal perspective, success should also be reflected through improved air quality that contributes to better public health outcomes. Methane emissions are frequently released alongside volatile organic compounds (VOCs) and hazardous air pollutants, meaning reducing leaks can improve local air quality and reduce respiratory health risks in communities located near oil and gas infrastructure. Monitoring health outcomes including asthma prevalence and premature mortality, especially in communities living in proximity to oil and gas facilities, would be a direct and attributable indicator for evaluating the Bill's impacts.

Success Indicators for the Technical Assistance Program

The Technical Assistance Program establishes a national support network to assist stakeholders with methane measurement, detection, and mitigation. Success requires three principal outputs: (1) establishing a cooperative technical assistance network between the Department of Energy, industry, and other stakeholders, (2) developing publicly accessible technical guidance and best-practice resources, and (3) implementing demonstration projects that showcase methane technologies under real operating conditions. Key milestones include establishing the network within one year of enactment, publishing technical resources within approximately eighteen months, and submitting annual progress reports to Congress.

Success should also be assessed through scientific performance. For detection technologies, key indicators include sensitivity, accuracy, spatial resolution, and coverage, measured through metrics such as Minimum Detection Limit (MDL), Probability of Detection (POD), false-positive and false-negative rates, localization accuracy, and response time. The U.S. EPA, for example, requires advanced continuous monitoring technologies to demonstrate probabilities of detection approaching or exceeding 90% at specified leak rates under performance testing protocols (EPA, 2024). For measurement technologies, indicators should include accuracy, precision, repeatability, and cross-platform verification, including reconciliation between top-down measurements from satellites or aircraft and bottom-up facility inventories. The Oil and Gas Methane Partnership 2.0 Level 5 framework similarly requires operators to reconcile independently measured site-level emissions with facility source inventories to improve data integrity (UNEP, n.d.). For mitigation technologies, relevant indicators include abatement efficiency, operational responsiveness, reliability, and methane capture or destruction rates. Examples include capture efficiency for vapor recovery units, flare destruction efficiency, Mean Time to Repair (MTTR) under LDAR programs, equipment uptime, and uncombusted methane slip. Industry benchmarks generally target approximately 95–98% methane capture for vapor recovery units and 98–99% destruction efficiency for high-efficiency flares (EPA, 2011, 2018).

Implementation should additionally be evaluated based on stakeholder representation, cross-sector collaboration, and access to technical resources. The program will be most successful if it connects government, industry, academia, and community organizations and effectively transfers technical knowledge across sectors, enabling broader adoption of methane measurement and mitigation best practices.

Success Indicators for the Measurement & Mitigation Research Consortium

The Measurement & Mitigation Research Consortium focuses on coordinating methane research rather than directly deploying technologies. Its primary output is a national collaborative research network, with success measured through completion of required reporting milestones, including an initial report identifying available technologies, research priorities, and knowledge gaps, followed by annual progress reports and a formal five-year program review.

Because the Consortium primarily serves as a coordination mechanism, implementation indicators are particularly important. These include broad stakeholder representation, cross-sector collaboration, research coordination, and effective data and knowledge sharing among federal agencies, universities, industry, national laboratories, and other research organizations. Successful collaboration should reduce duplication of research, promote knowledge transfer, and accelerate technological innovation by integrating expertise across sectors. Ultimately, the Consortium should be assessed not simply on whether it produces research, but whether it creates a coordinated national research ecosystem that directs resources toward the most important methane measurement and mitigation gaps.

Success Indicators for the National Facilities for Testing & Intercalibration

The primary output of Program Three is the establishment of national methane measurement standards supported by dedicated testing and intercalibration facilities. Key milestones include establishing these facilities within one year of enactment and submitting a comprehensive progress report to Congress within two years. The principal scientific measure of success is standardization: ensuring methane measurements generated by different technologies use consistent methods, calibration procedures, and reporting formats. This can be evaluated through intercalibration, which tests whether ground-based sensors, aircraft, drones, and satellites produce comparable measurements when observing the same emission, as well as through alignment with internationally recognized measurement standards.

Implementation therefore depends heavily on cross-agency and international coordination. Domestically, collaboration among agencies such as the Department of Energy, EPA, and National Institute of Standards and Technology, alongside researchers, industry operators, and technology developers, is necessary to ensure standards are both scientifically rigorous and practical for regulatory and industry use. Without coordination, agencies and sectors may develop separate approaches that reduce comparability and confidence in methane data. International collaboration is similarly important because methane measurement standards are most valuable when data can be compared across countries. The United Nations Environment Programme's Oil and Gas Methane Partnership 2.0 provides a leading international framework for improving methane reporting by encouraging companies to move from estimated emissions toward direct measurement and reconciliation (UNEP, n.d.). Alignment between U.S. standards and frameworks would improve the international comparability and credibility of U.S. methane data. Similarly, the International Methane Emissions Observatory integrates satellite observations, scientific measurements, and industry reporting into a global methane monitoring system (UNEP, 2026). Therefore, success should be measured not only by whether the United States develops accurate and standardized methane measurements, but whether those standards are interoperable with international frameworks and contribute to a coordinated global methane monitoring system.



7. Findings, Analysis, and Recommendations

Photo: Chen (2025)



(Pabis, 2023)

Overall, this bill addresses the shortfall in methane research and development by targeting gaps in current research, development of leak detection and repair (LDAR) technologies, and capacity building across the energy sector. It does so by:

a. authorization of funds for research grants and initiating research consortiums with all stakeholders;
b. demonstration of current and promising technologies through testing facilities;
c. guidance on detection instrument calibration and measurement protocols.

This report identifies three streams of methane technologies that summarise the research and development activities within the scope of this bill: detection (through instruments like gas sensors and optical gas imaging cameras), measurement (through techniques like machine learning algorithms and computer vision technology), and mitigation (by fixing pipe-leaks and advanced technologies like vapor recovery systems). While this bill is effective at addressing these needs, there are ways of further strengthening its proposals.

Recommendations

1. **Establish a tiered framework for methane detection technology.** Clear guidance developed for when ground-based sensors, aerial, and satellites should be used based on their subjective accuracies, geographical coverages, and monitoring frequencies. Since no single technology is appropriate for every application; H.R. 752 should aim to implement an integrated monitoring system.

2. **Connect improved methane detection to mitigation incentives and implementation.** Detection alone will not result in methane reductions. Rather, research investments should be paired with technical and financial support that helps operators repair detected leaks and adopt methane control technologies.

3. **Establish transparent governance standards for the research consortium.** Meaningful representation within the consortium consists of defined decision making procedures, representation requirements, and conflict-of-interest safeguards to prevent a single stakeholder group from disproportionately shaping research priorities. With that, community organizations, researchers, government agencies, NGOs, and industry should have impactful representation within the consortium.

4. **Align U.S methane standards with international monitoring evaluations and efforts.** National measurements and calibration standards developed through H.R. 752 should be designed with compatibility and comparability with international monitoring frameworks. Greater standardization will ultimately improve cross-country comparisons, data transparency, and accountability for methane pollution across borders



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Photo: Rie (2020)

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