THE ROLE OF GAS IN THE ENERGY TRANSITION

Using data and markets to curb methane emissions

insight brief

March 2020

Authors
Cate Hight
chight@rmi.org

Laura Hutchinson
lhutchinson@rmi.org

Raghav Muralidharan
rmuralidharan@rmi.org

Taku Ide
tide@rmi.org

KEY INSIGHTS

- Natural gas will play an important but declining role in the energy transition. There is a growing consensus that most, if not all, of the gas currently used in buildings and power plants can and must be replaced with readily available clean energy and clean electricity options. The timeline for phasing out gas in the industrial sector remains uncertain, as efforts globally work to scale a range of potential alternatives to both coal and gas, the key thermal energy inputs in heavy manufacturing.

- As we phase out gas, we have a much higher likelihood of meeting our climate goals if we are also minimizing methane emissions, both intentional and accidental,[i] from the gas value chain. Methane emissions from oil and gas production, processing, transmission, and distribution total **over 6.7 billion tons CO_2e**[ii] each year, equal to 16 percent of all human-made CO_2 emissions.

- Investors, regulators, and consumers are applying increasing pressure on the global gas industry to curb its methane emissions and do so quickly.

- The current patchwork of voluntary and regulatory actions is failing to drive methane reductions at the scale and speed necessary for climate alignment.

- Despite greenhouse gas reduction commitments by several companies, there is a lack of transparency into whether a company's claimed methane emissions reductions are actually occurring in practice.

- Two things are essential to curbing methane emissions from the oil and gas industry:

  1. Global adoption of a methane emissions standard for gas that clearly defines the rules industry must comply with during this transition.

  2. A trusted source of transparent and accessible data, coupled with creative analytical approaches, that can translate data into methane abatement action by operators, investors, consumers, and regulators.

[i] Methane emissions from natural gas come from two main sources: venting (deliberate emissions as part of operations) and leaks (accidental emissions). There are also methane emissions associated with operating (gas used to power facilities), flaring (burning of waste gas), and end use (gas combustion for end use); however, carbon dioxide comprises the majority of GHG emissions from these sources.

[ii] Carbon dioxide equivalent of methane is calculated using the 20-year global warming potential (GWP) of 84, as articulated in the Intergovernmental Panel on Climate Change's Fifth Assessment Report (AR5).

THE ROLE OF GAS

To avoid 1.5 degrees of warming, we need to dramatically reduce global greenhouse gas emissions over the next two to three decades, including reducing CO_2 emissions by at least 45 percent over the next ten years, and **completely eliminating CO_2 emissions by 2050**.[iii] This requires phasing out the vast majority if not all coal, oil, and gas by 2050. Most experts agree that phasing out coal can and should happen first, **followed closely by oil and gas**.

When considering what a global energy system on a 1.5°C pathway will look like by 2050, natural gas will play an important and ever-diminishing role. We have existing and cost-effective technologies like wind, solar, and batteries to **replace gas use in the power sector**, as well as electric heat pumps to **replace gas use in buildings**. Scaling these existing technologies will require a concerted effort to overcome the inertia of the status quo.

In the industrial sector, alternatives to fossil fuel are not so readily available. There remain a lot of questions about the role of gas, and where it will be key to replacing coal in the near-term. How long gas plays a role in industry will depend in large part on the cost and application of carbon capture, utilization, and storage, as well as the availability of alternatives like green hydrogen and ammonia to **displace natural gas entirely**.

Whether we can avoid exceeding 1.5 degrees of warming depends in part on a willingness to solve the most important problem the gas industry has on its hands today: emissions of the extremely potent greenhouse gas methane, the primary component of natural gas. Gas is often presented as a “clean transition fuel” because it burns more cleanly than coal. Though burning natural gas does indeed emit less carbon dioxide (CO_2) and particulate matter than coal to produce the same amount of energy, the “clean” label for gas ignores the methane released into the atmosphere when gas is extracted, moved through pipelines, and distributed into homes and businesses. Worldwide, the oil and gas industry emits **80 million tons of methane pollution each year**, equivalent in short-term warming potential to 16 percent of all human-made CO_2 emissions.[v]

THE BASICS OF GAS IN THE GLOBAL ENERGY ECONOMY

Natural gas is burned to generate electricity, to heat our homes and workplaces, to fuel heavy manufacturing, and to power vehicles. Currently, natural gas supplies **22 percent of the world’s energy**.[vi] In the United States, natural gas comprises an even larger share: **33 percent of all energy produced**, and 31 percent of all energy consumed. Gas has an increasingly global reach, with several new gas transmission pipelines under construction around the world, and continued growth in shipping of liquified natural gas (LNG) to countries not connected by pipelines to a gas supply.

[iii] The IPCC *Special Report on Global Warming of 1.5°C* emissions pathways analysis is limited to projected CO_2 emissions reductions under different transition scenarios, and does not consider changes in emissions of other greenhouse gases like methane.

[iv] Green hydrogen is produced using renewable electricity through a process called electrolysis.

[v] In terms of CO_2 equivalent, referencing IPCC AR5 statistics with 20-yr GWP. Uses 80 MT of methane from the oil and gas industry, and 75 GT CO_2e for all anthropogenic greenhouse gas emissions (which includes CO_2, CH_4, and N_2O).

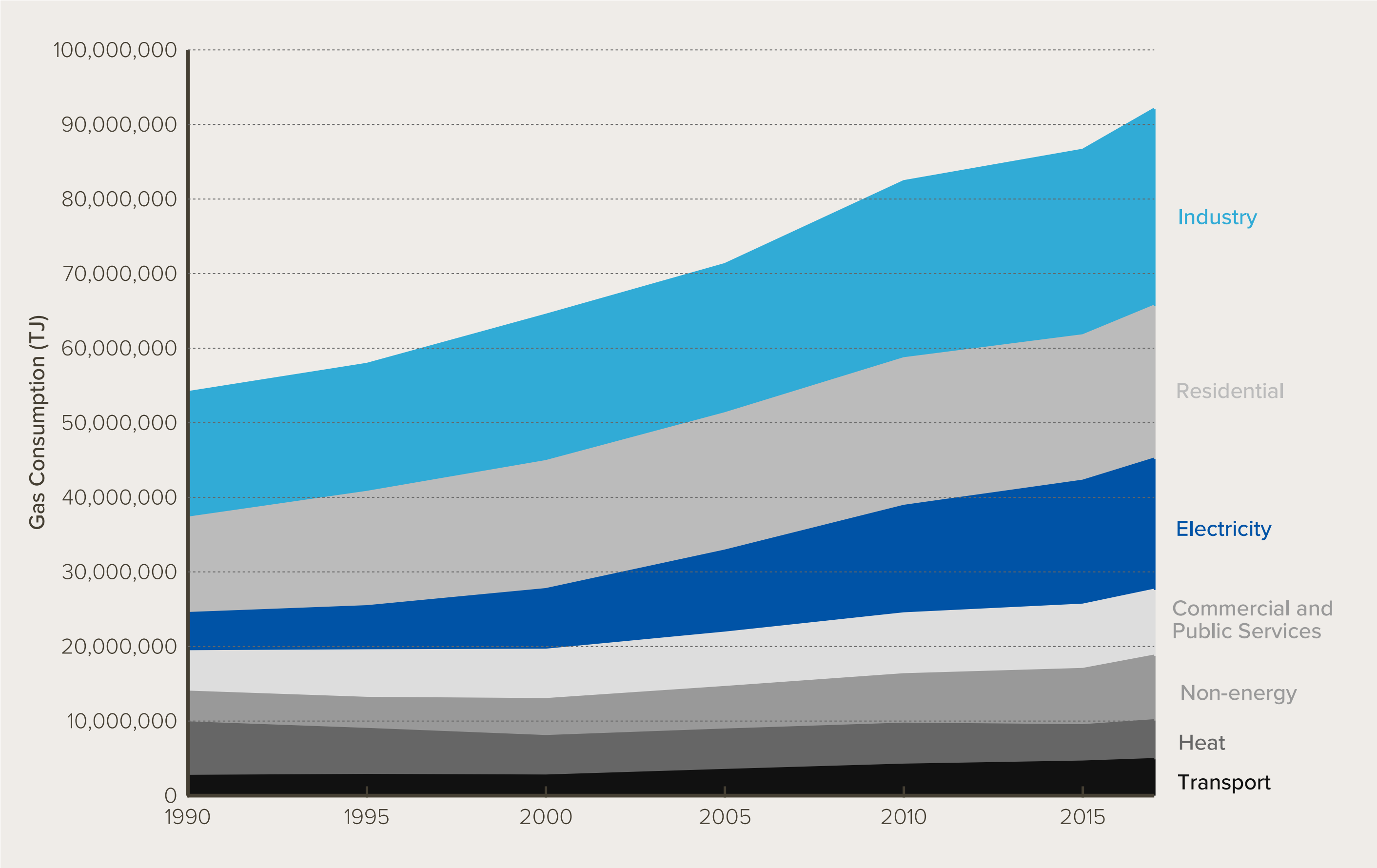
[vi] According to the IEA, gas was the third-largest energy source in the world after oil and coal, respectively, in 2017 in terms of total primary energy supply (TPES).

But natural gas has not always been so ubiquitous in the United States, let alone in the world. Gas' share of the world's energy supply has grown by more than 3 percent since 1990, outpacing all other primary energy sources. This growth has largely been driven by gas' seemingly endless supply and associated low cost today, thanks to new drilling techniques like fracking that enabled the shale gas boom. One of the most notable shifts in global gas use has been in the electricity sector, which is the third-largest consumer of natural gas, after industry and residential use (see Figure 1).

In the global electricity sector, gas-fired power plants are slowly but surely replacing coal-fired generation. Between 2005 and 2017, the share of global electricity generation from gas-fired power plants **rose by 2.7 percent**, while coal plants' share decreased by 1.5 percent. This trend is even more pronounced in the United States, where gas-fired power plants' share **grew by 13 percent and coal plants' share dropped by 20 percent** in the same timeframe. The **decrease in carbon intensity** of the global, and certainly the United States', electricity supply is attributable to this shift from coal to natural gas-fired generation, coupled with a **large increase in renewable electricity generation**.

FIGURE 1

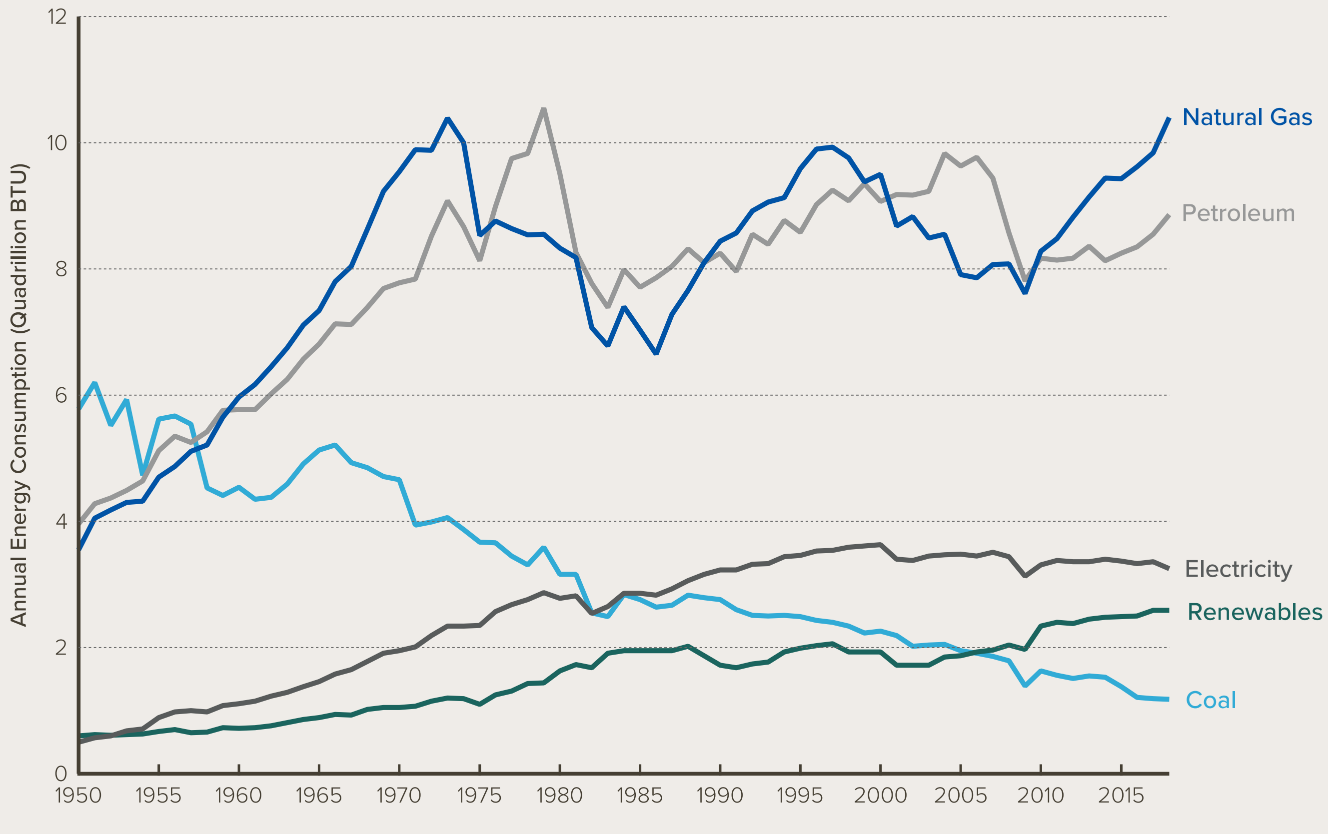
Global natural gas consumption by sector[vii]



[vii] Data adapted from IEA total final gas consumption and electricity and heat analyses. Non-energy use is primarily consumption of natural gas for fertilizer production. Heat refers to natural gas used in central heating plants and combined heat and power (CHP) plants.

FIGURE 2

United States industrial energy use by source[viii]



Note: Includes energy sources used as feedstocks in manufacturing products. Electricity includes purchased electricity and excludes associated electric system energy losses. Renewables are mainly biomass.

Source: **U.S. Energy Information Administration**

The United States industrial sector is seeing a similar shift. Natural gas has been the single-largest energy input to industry since 2010, and coal use is rapidly declining (see Figure 2).

But the industrial sector is not as easily converted to renewable electricity. Electricity consumption in US industry has made up a consistent **13 to 14 percent of the sector's energy use** since 1985. The share of non-electricity renewable inputs—like biomass and biofuels—has grown over time, but is equivalent to only a quarter of natural gas' contribution today. Industry is a fundamentally challenging sector to decarbonize, because many manufacturing processes require thermal energy inputs, as well as feedstocks like natural gas, to function. While gas has ready and reliable alternatives for power generation and heating buildings, it will be key to displacing coal in the industrial sector until thermal alternatives that can be made with renewable energy, such as hydrogen and ammonia, are more widely available.

[viii] In this Energy Information Administration (EIA) dataset, electricity is defined as purchased electricity (which can include renewable electricity), and renewables are mostly biomass and biofuels.

In the United States, the coal to gas switch for power generation and industry, coupled with a large increase in renewable electricity and continued increases in efficiency, coincides with an overall decrease in reported CO_2 emissions. At the same time, the rate of reduction in reported methane emissions has been much slower. And numerous studies show that emissions from the oil and gas industry are much higher than reporting suggests, both in the United States and globally. Some scientists suggest that the US EPA Greenhouse Gas Inventory estimate for US oil and gas supply chain methane emissions **underestimates the sector's annual methane emissions by 60 percent**. Others show that this chronic underestimation is a global phenomenon—and that global inventories **underestimate the oil and gas industry's annual methane emissions by up to 40 percent**.

RISKY BUSINESS

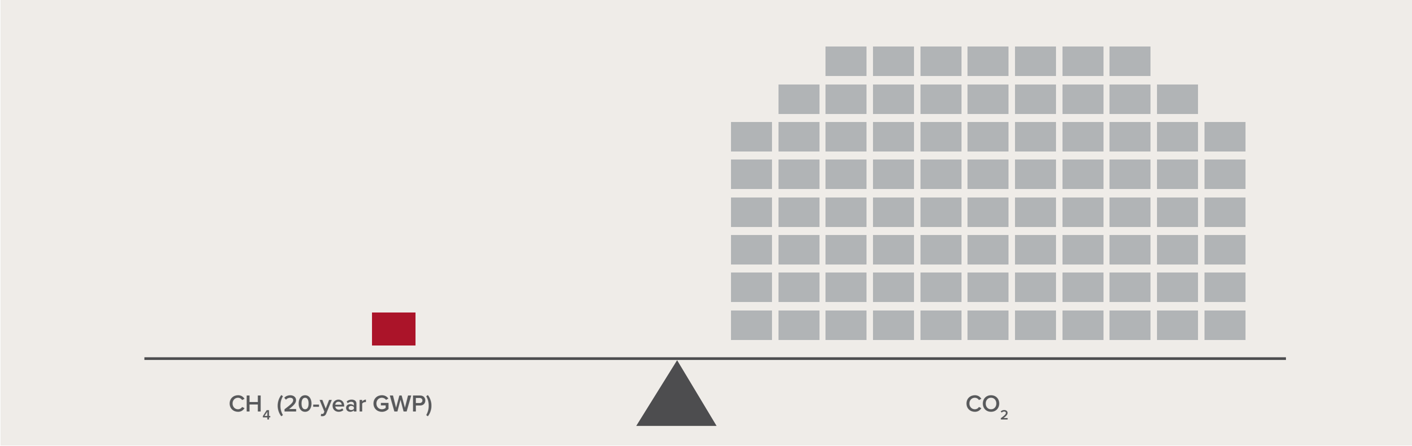
Whether the world is able to meet its commitments under the Paris Agreement to avoid 1.5 degrees of warming may well hinge not only on how quickly we phase out gas, but also on how quickly the gas industry curbs its methane emissions. Methane is critical to address because it is such a powerful climate pollutant, with 84 times the global warming potential of carbon dioxide over 20 years.[ix] The methane emitted by the oil and gas supply chain each year has the same short-term warming impact as double the annual CO_2 emissions of the entire European continent. Investors, regulators, and consumers are applying increasing pressure on the global gas industry to curb its methane emissions, and to do so quickly.

Globally, human-made methane emissions increased by 1.3 percent every year for the last decade, and by **1.7 percent in 2018 alone**.

The oil and gas industry is not the sole source of methane emissions, but it is **the second-largest human-made source** after the agriculture industry and is the most poised and practical to change.

FIGURE 3

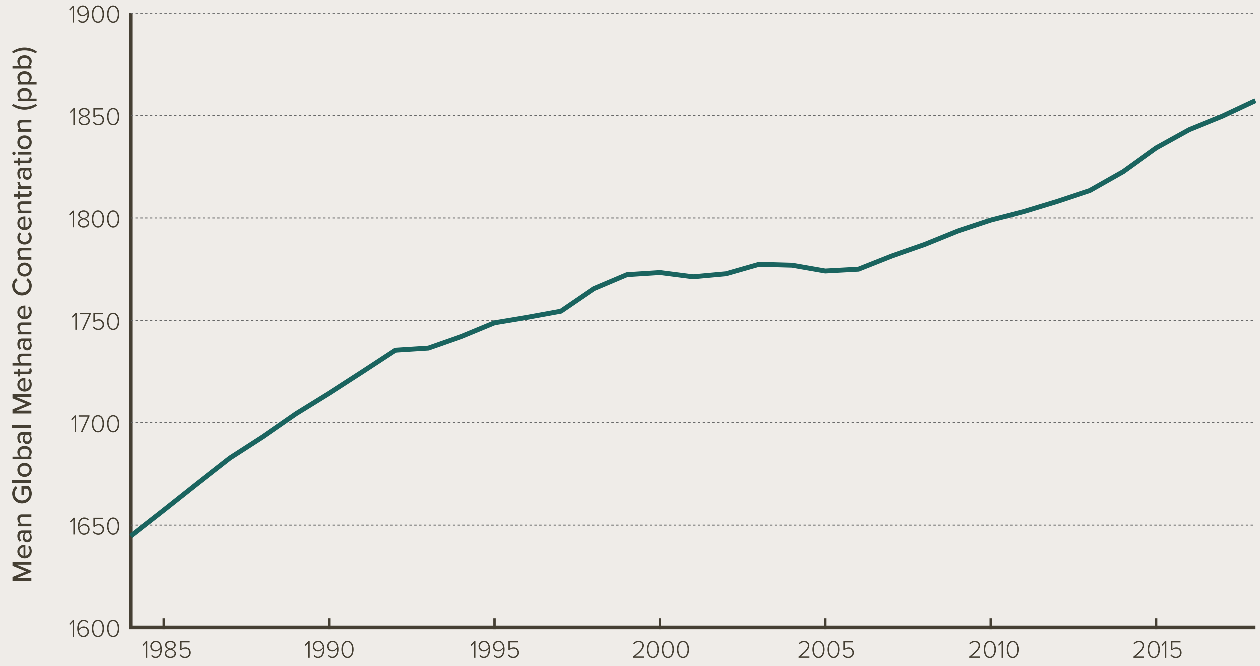
Global warming potential of methane, as compared to CO_2



[ix] The most commonly cited methane 20-year GWP is 84—from IPCC AR5—which does not include climate-carbon feedbacks (cc fb). With cc fb, IPCC states 86. Fossil methane is characterized as 85 without cc fb.

FIGURE 4

Global methane concentrations have increased every year since 2005



Source: **NOAA**

THE METHANE OPPORTUNITY

The good news is that the global oil and gas industry has the tools to curb most of its methane emissions. Understanding around technological and operational best practices is improving, mitigation technologies are cost-effective and widely available, and the landscape of commercially available emissions monitoring technologies continues to expand.

In recent years, several companies have taken on voluntary methane abatement commitments through membership in methane-focused coalitions, both in the United States (**ONE Future**, **the Environmental Partnership**, **US EPA Methane Challenge**) and internationally (**Global Methane Initiative**, **Oil and Gas Methane Partnership**, **Methane Guiding Principles**, and **Climate and Clean Air Coalition's Oil and Gas Climate Initiative**).

Additionally, the regulatory landscape is changing, as states and countries recognize the scale of the methane problem. While the United States' federal methane regulations are currently being rolled back, other countries, including Canada, Mexico, and several European countries, are actively considering or enacting regulation. States are leading the way in the United States, with methane-focused regulations in place or under development in Colorado, California, Wyoming, Ohio, Pennsylvania, and New Mexico. And some of these efforts are leveraging a growing suite of "next generation" methane detection technologies that enable operators to take swifter, more comprehensive methane abatement action.[x]

[x] See discussion in "*Making Emissions Actionable*" section of this insight brief.

Despite these voluntary and regulatory programs, oil and gas methane emissions are not yet declining at the scale and speed necessary for climate alignment. It is clear that there is a need for stronger regulatory and market drivers. Furthermore, it is difficult for the public to verify a company's stated success in reducing methane leaks. Lastly, there are no consequences for a company failing to meet its voluntary commitments.

Addressing these three problems is a primary focus of RMI's Industry Program. We are working to define a standard for gas produced with minimal methane emissions, and to leverage publicly available and operator-specific data to reveal methane emissions from specific assets. This information can be used to assess which gas producers might qualify for such a standard, as well as to identify opportunities for additional methane emissions abatement. This, in turn, can be used to design a system of fair and meaningful consequences for industry actors based on their actual success in curbing methane emissions.

DEFINING A METHANE EMISSIONS STANDARD

Defining a standard for gas is key to being able to compare the emissions from different oil and gas operations in a transparent and replicable way. A standard will also enable climate-conscious producers, regulators, and end users to credibly demonstrate methane abatement to consumers and investors.

The first step in defining gas with minimal methane emissions is to define what it is not. At absolute minimum, gas must be better than coal—or have an **emissions intensity below 3.2 percent**. Methane emissions intensity is a commonly used metric to compare how much methane supply chains emit relative to how much gas they produce. But there is too much variation in how methane emissions intensity is defined for this metric to be tangibly useful.

Two of the voluntary initiatives listed above, the ONE Future coalition, and the Oil and Gas Climate Initiative, set methane intensity targets for their members—1 percent for the full supply chain, and 0.25 percent for upstream production, respectively—although they are not directly comparable. **The Natural Gas Sustainability Initiative** (NGSI) is working to address this problem by standardizing the industry's protocol for defining and reporting methane emissions intensity across the natural gas supply chain.

Even within a single methodology, the average methane emissions intensity of oil and gas operations ranges widely between reported data and other comprehensive studies.[xi] In the United States, the average EPA-reported intensity can be **as low as 1.2 percent**, while some nationwide studies suggest a much higher **average of 2.3 percent**, and regional case studies show average intensities **as high as 10 percent**.

While we can define the upper limit of an acceptable methane intensity at 3.2 percent, more investigation is needed to understand exactly what methane intensity top-performing operators can achieve, so a methane emissions standard can be used to fuel a race to the top. Additional analysis is underway at RMI to determine what top-level methane emissions performance

[xi] In the case of these studies, methane emissions intensity is defined as all supply chain methane emissions normalized by produced gas volume.

is, as well as what types of monitoring technologies might be deployed to ensure that this performance is maintained over time.

A certification standard can be applied in a voluntary market, or as part of a regulatory framework. In a voluntary market, an operator certified according to the standard may be able to demand a higher price for its product and use these proceeds to invest in additional methane abatement. In a regulatory market, the standard could serve as the minimum bar for performance, or alternatively as a bar for entry into a market.

In either case, the credibility of a standard lies in a combination of independence from and pragmatic compatibility with industry. Another essential component is review and certification by trustworthy and independent auditors. To build this credibility, initial transactions will likely be bilateral, so that both buyer and supplier can assess how the standard is being applied.

However, as confidence in the standard grows—and auditing becomes more streamlined—it is likely that the market for gas meeting the standard will evolve into a certificate-based market, in which the environmental attributes of the certified gas can be traded separately from the actual supply. This will be key to driving methane reductions at the necessary scale.

Models from other industries, such as markets for renewable energy credits (RECs), could provide useful templates. RECs are tradeable certificates that represent the environmental attributes of 1 MWh of renewable energy generation, and have helped drive **millions of megawatt-hours of clean energy onto the grid** in the United States and Canada.[xii]

These credits can be generated and traded at any scale, and bundled or unbundled with the electricity commodity itself. They are generated, bought, and sold in both voluntary markets and regulatory frameworks. RECs are most often used as the currency to substantiate alignment with corporate sustainability targets and utility compliance with state renewable portfolio standards. Renewable energy producers can also sell the RECs associated with the renewable energy they produce to earn additional income that can support further renewable energy deployment.

While RECs were an important part of the equation driving increased deployment of renewables throughout the United States and Canada, REC tracking and transfer proved challenging during the early days of the market, when transactions were not wholly secure and **some double counting of RECs occurred**. Digital ledgers have evolved significantly since these early days and now minimize that risk. The Energy Web Foundation (an RMI subsidiary), Xpansiv, and others are bringing unprecedented transparency and coordination to REC and other environmental attribute markets with distributed technologies like blockchain. It is essential that the certification standard, including an associated certificate market, be designed to minimize confusion and opportunities for fraud, and to maximize on-the-ground methane emissions abatement.

[xii] These credits have equivalents in other parts of the world, including Guarantees of Origin (GoOs) in Europe, Green Energy Certificates (GECs) in Japan, Small-scale Technology Certificates (STCs) and Large-scale Generation Certificates (LGCs) in Australia, and International RECs (I-RECs) and Tradeable Instruments for Global Renewables (TIGRs) in other regions.

There is precedent and momentum for defining and trading differentiated gas. Several early-stage transactions for gas differentiated on the basis of environmental attributes have already taken place, including a **2018 "sustainable" gas transaction** between Southwestern Energy and New Jersey Resources, a 2019 transaction between Shell and Tokyo Gas for **"carbon-neutral" LNG** in June 2019; and a **"responsible" gas transaction** between Seven Generations Energy and Energir in February 2020.

While these deals have led the way, none have been focused exclusively on the methane problem, nor have they been transparently designed to push operators to improve their practices at the scale and pace necessary for the energy transition. Looking forward, a standard that "sets the bar" for acceptable methane emissions performance, backed by clear and credible information about which operators are meeting that bar, will be essential to transforming the global gas market.

MAKING EMISSIONS ACTIONABLE

For the past several decades, scientists and governments have grappled with how to estimate methane emissions from oil and gas supply chains and have developed inventories as well as company and facility-level reporting frameworks in response. Despite these rules, new measurements continue to prove that emissions inventories are consistently under-reporting, and global methane emissions continue to rise. Current reporting frameworks are not only proving to be an unreliable fact base but are also not inciting the action necessary to limit global warming to 1.5 degrees.

There has been a recent wave of technologies, services, and regulations pushing the momentum of emissions transparency. The methane monitoring space has grown rapidly and continues to do so, both in field level monitors and remote sensors. New satellite technology and image analysis from government satellites such as VIIRS and TROPOMI, and private companies like GHGSat, can visualize emissions globally. Academia and the nonprofit world play a key role in this world of transparency, too: for example, methane monitoring studies by the Environmental Defense Fund have been key in raising public awareness about the oil and gas industry's methane problem. Increasing public attention on methane is pushing oil and gas companies of all scales to deploy methane monitoring technologies.

Each of these technologies collects a different type of emissions data. Together, they contribute a more granular and comprehensive understanding of emissions sources, but this data alone is insufficient for meaningful emissions reductions. Efforts to date that simply visualize emissions data have been ineffective, primarily because emissions are not currently contextualized in line with operating and investment principles, or in terms of value and risk propositions.

In order to drive meaningful change at the scale needed over the next decade, this data must be translated into action. We need to be able to understand both "how much" and "why" emissions are happening, so we can stop emissions at their source. Fortunately, advances in data collection, distribution, and digitization at unprecedented scale now enable us to do this and offer the opportunity to drive methane abatement action in real time.

Companies like WattTime (an RMI subsidiary), which determines the emissions intensity of electricity supply in real time to enable smart devices to draw from the grid only when there is a surplus of renewable energy, are leading the way in translating emissions data into tangible emissions reductions. The oil and gas industry, and its regulators, investors, and gas buyers, need a similar set of solutions that enable data, coupled with creative analytical approaches, to be translated into methane abatement action.

Ultimately, we need to be able to forecast and act on emissions risk the same way that investors evaluate financial risk and operators evaluate asset risk. Emissions can and should be a part of every stakeholder's risk calculus, in the oil and gas industry and beyond.

This new wave of data and applied analytics also presents a significant opportunity for operators to differentiate themselves according to their methane emissions. For the laggards of the industry, high emissions mean increased exposure to investment, regulatory, and consumer risk. As market players choose to make decisions based on emissions and regulators have more visibility into the emissions picture, those not operating with best practices and infrastructure will have the market to answer to and nowhere to hide. But the opportunity is also there for operators to leverage the new data paradigm and proactively eliminate methane emissions risk from their assets.

CONCLUSION

Natural gas must eventually be phased out for the world to align with a 1.5°C pathway. But while the world still consumes gas, the natural gas supply chain can and must curb its methane emissions in order to substantiate its role in the industrial energy transition. The oil and gas industry has the technical tools it needs to substantially decrease its methane emissions today. But operators, investors, regulators, and buyers do not have adequate incentives or transparency into these emissions to drive action at the scale or pace necessary to mitigate the industry's climate impact. A certification standard and novel data-driven approaches to emissions visibility and prediction can enable the reductions we need in the next decade to meet our climate goals.