METHANE – RECENT DEVELOPMENTS

By Gary Antonides

Right now, our knowledge of how much methane is entering the atmosphere, as well as its effects, is changing as scientists conduct more studies. At the same time, regulations are being rolled back, and, in large part, don't reflect what we're learning.

https://www.popularmechanics.com/science/environment/a28858699/what-is-methane/, By Jennifer Leman, Aug 29, 2019, tells us that methane is a colorless, odorless, and highly flammable gas, and is the main component in natural gas, which is used to generate electricity and heat homes around the world, as well as other industrial uses. Methane (CH4) is composed of one carbon atom and four hydrogen atoms. It can be produced naturally and synthetically, and when burned in the presence of oxygen, it produces carbon dioxide (CO_2) and water vapor. Methane accounted for roughly 10 percent of all human-driven greenhouse gas emissions in the U.S. in 2017, according to the EPA. While it isn't the most abundant greenhouse gas in the atmosphere, it is among the most powerful. About a quarter of man-made global warming is thought to be caused by methane.

This issue is important right now because the EPA is trying to roll back Obama-era regulations on methane gas. Under the current rules, oil and gas operations are required to install controls that keep methane gas from leaking out of their equipment. But the Trump administration argues that the EPA does not have the authority to regulate methane gas under the Clean Air Act.

Sources of Methane

There are two main ways that methane can be *naturally* produced. First, methane can be produced as organic matter is decomposed at shallow depths in low-oxygen environments, such as swamps and bogs. As plants die and sink to the bottom of these watery environments, bacteria starts to break them down. According to a study in the *Proceedings of the National Academy of Sciences*, wetlands are the single largest natural contributor to methane emissions. Second, a form of methane mixed with ice, called methane gas hydrates, can be found trapped in layers of sediment on the ocean floor and beneath permafrost and frozen lakes in the Arctic. These solid, ice-like deposits have been touted as a potential energy source, but there is concern that they may release large concentrated amounts of methane into the atmosphere.

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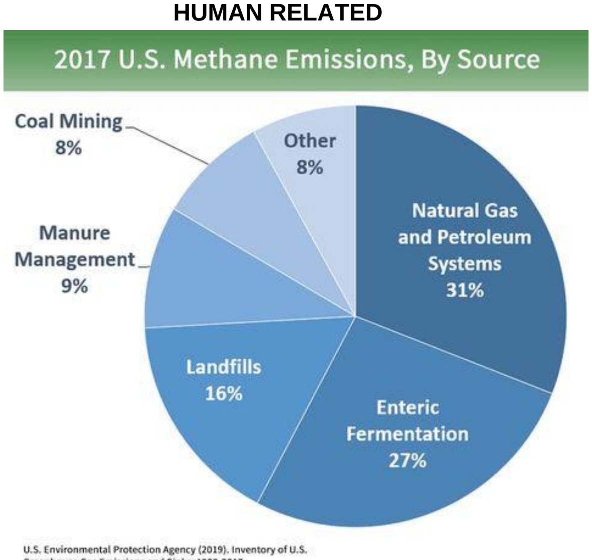

However, according to the EPA, roughly 50 to 65 percent of U.S. methane emissions are related to human activity. Around 30 percent of human-related methane emissions are released by the natural gas and petroleum industry. About 27 percent of methane emissions are generated through enteric fermentation—cows burping and farting while they digest their food, and 16 percent of global methane emissions are generated by organic waste decomposing in landfills. Methane can be also be released through the storage and use of manure for fuel (9 percent) and through coal mining (8 percent).

As for the belching cows, a recent study published in *Science Advances* identified groups of microbes in cows' guts that cause enteric fermentation and suggested that selectively breeding cows to produce less gas might lower emissions. Also, a Yale study found that supplementing cow's diets with a certain kind of seaweed can reduce their methane production by about half.

Methane is one of the most potent greenhouse gases because it can efficiently absorb heat in Earth's atmosphere. However, methane lasts for maybe a decade in the atmosphere before it begins to react with a free radical called hydroxyl and turns into CO_2, which can last for centuries.

Greenhouse gases are rated according to their Global Warming Potential (GWP). Studies have shown that, over a 20-year period, methane warms the planet over 80 times more than the same weight of CO_2. But the most common figures rate the gases for 100 years, in which case the GWP of methane is over 30 times as potent as CO_2.

We often hear that carbon dioxide heats Earth's atmosphere and oceans, causing them to expand, but "short-lived" greenhouse gases like methane and CFCs (gases that contain chlorine or fluorine) also spur thermal expansion. In 2017, scientists ran computer simulations that showed thermal expansion caused by methane continues for centuries even after the gas has dissipated from the atmosphere.

Also, there are health problems with methane. It can lead to higher levels of ozone in the atmosphere. Ozone can cause a number of health problems such as shortness of breath and aggravate lung conditions like asthma, emphysema, and chronic bronchitis, according to the EPA.

Using Satellites to Detect Methane

People have been measuring methane in the atmosphere with aircraft and ground instruments for a long time. Now, scientists are beginning to use satellites.

The Economist, in https://www.economist.com/science-and-technology/2020/01/30/using-satellites-to-spot-industrys-methane-leaks?cid1=cust/dailypicks1/n/bl/n/2020023n/owned/n/n/dailypicks1/n/n/NA/393509/n, Jan 30th 2020, reports on advances in using satellites for methane detection.

When scanning for emissions in western Turkmenistan in January 2019, a satellite called *Claire* came across three large plumes of methane that appeared to originate from a gas pipeline and a compressor station. The company operating the satellite, *ghgsat,* based in Montreal, informed officials in Turkmenistan, and after a few months the leaks stopped. This incident illustrates two things: satellites can play an important role in spotting leaks of greenhouse gases and, unfortunately, the extent of such leaks is often greatly underestimated.

To see how big the leak in Turkmenistan had been, Daniel Jacob of Harvard University and his colleagues studied the images obtained by this satellite along with observations made by the Tropospheric Monitoring Instrument (*tropomi*), which is carried by a satellite operated by the European Space Agency. The results, published in *Geophysical Research Letters* in November 2019, concluded that during an eleven month period, the three leaks would have released far more than that discharged over four months by a notorious blowout at a natural-gas storage facility in Aliso Canyon, California, in 2015, which is thought to be the worst natural-gas leak yet recorded in America.

There have been other big leaks. In 2018, a group of researchers at the Netherlands Institute for Space Research studied *tropomi* images of a blowout at a natural-gas well in Belmont county, Ohio that took three weeks to control. In a paper published in the *Proceedings of the National Academy of Sciences* in December 2019, the researchers calculated from the images that the blowout was responsible for the equivalent of a quarter of the annual oil and gas industry's methane emissions in the entire state of Ohio.

Methane can be detected spectroscopically. Like other gases, it absorbs light at characteristic frequencies. With a spectrometer mounted on a satellite it is possible to analyze light reflected from Earth for signs of the gas. As with the satellites that carry them, spectrometers come in many shapes and sizes. *tropomi* can detect other polluting gases, such as nitrogen dioxide, sulphur dioxide and carbon monoxide. It rides in a large satellite weighing about 2200 pounds. The detector has an extensive view, looking at a strip of Earth about 1,600 miles wide with a resolution that means a single pixel in the image represents an area 4.4 by 2.2 miles.

Observing things more closely is the specialty of *Claire*. This 33 pound "nanosat", about the size of a microwave oven, was launched in June 2016 to measure carbon dioxide and methane emissions. With a field of view 7.5 miles wide and a resolution better than 165 by 165 feet, *Claire* can spot leaks from individual industrial plants. *ghgsat* aims to launch two more methane-hunting nanosats later this year.

Claire surveys industrial facilities on behalf of firms that want to monitor their emissions. *ghgsat's* chief executive, Stephane Germain, says employing satellites to do this is more reliable than using terrestrial methods. By the end of the year he plans to roll out a new service. This will provide a digital image of Earth which users will be able to zoom in on to explore continually updated patterns and hotspots of methane emissions. The map will have an average resolution of 1.25 by 1.25 miles.

Other methane-hunting satellites are coming. These include one due for launch in 2022 by *Methanesat*, an affiliate of the Environmental Defense Fund, an American non-profit organization. The 770 pound satellite will scan an area of land 125 miles wide with a resolution of 0.6 by 0.6 miles. According to *Methanesa*t, it will be the most sensitive to emission levels yet, and data collected by the satellite will be publicly available.

These satellites will give us a much better idea of how much methane is being emitted, and who is emitting it. It will also make it easier to figure out reasonable measures to manage (and regulate) methane.

Studying Ice Cores for Methane

Thawing permafrost Is unlikely to increase global warming according to the study described in https://www.forbes.com/sites/trevornace/2020/02/25/thawing-permafrost-is-unlikely-to-increase-global-warming-scientists-find/#4cd389cc666e Feb 25, 2020. Many scientists believed that, as Earth continues to warm, the melting permafrost would release methane gas into the atmosphere, furthering greenhouse gas warming. However, this study suggests that melting permafrost may not have a significant impact on increasing temperatures. The study focused on two types of permafrost, frozen soil and frozen methane hydrates in the soil underneath the oceans.

Permafrost on land is predominantly found in Siberia, Alaska, and Northern Canada. As plants, algae, and animals die, significant amounts of the carbon are not decomposed but buried in frozen soil. This "locks away" this organic matter. As temperatures warm, the soil begins to melt, introducing liquid water and oxygen to the organic matter, thus allowing bacteria to break it down and potentially release methane into the atmosphere.

Methane hydrates, the other main concern for permafrost melting, are a combination of water ice and methane trapped in frozen ocean sediment below the ocean floor. As oceans begin to warm these hydrates will begin to melt and release both water and methane. In both scenarios, the concern is that a warming planet will cause a sudden release of significant amounts of methane into the atmosphere, thus causing positive feedback and warming the planet more.

Louis Sass, U.S. Geological Survey, GETTY IMAGES

This research, published in the journal *Science*, involved looking at small trapped gas bubbles in ice cores to see what the atmosphere looked like on Earth for the past 15,000 years. By analyzing the gas bubbles, which were sequentially trapped through time and represent past atmospheric conditions, the team believes methane release from permafrost did not play a significant role in warming during past warming events. They studied cores from the last glacial period to modern times, analyzing how permafrost impacted a warming planet. The team found that signatures of methane gas were small during these past warming periods and that methane release from permafrost likely did not cause a large warming event.

In the case of land permafrost, in most scenarios the bacteria decomposed the organic matter through organic respiration, releasing CO_2 as opposed to methane. While the

CO_2 released does add to warming, as we stated earlier, each molecule of CO_2 is less potent than a molecule of methane (CH4).

When looking at methane hydrates in the ocean sediment, the team found that a significant amount of the methane released never makes it to the ocean surface. It simply dissolves into the ocean water as trapped gas or is oxidized by microbes.

While it is good news that permafrost appears to play a smaller than anticipated role in potential warming, that doesn't mean we shouldn't be concerned with methane as a greenhouse gas. The existing methane came from somewhere, and the results imply that scientists and governments have been undercounting the amount of methane spewing from oil and gas operations, which could be 25 to 40 percent higher than previously thought.

Regulation

Federal efforts to address methane emissions did not begin in earnest until 2014, when the Obama Administration proposed an initial set of regulatory measures to control methane emissions from oil and gas production, coal mining, and landfills. Notably, this did not provide for regulation of agricultural methane emissions, presumably because Congress has prohibited such regulation in each annual appropriations act passed since 2009. In 2016, EPA adopted three sets of methane-related regulations under the Clean Air Act (CAA) to control methane emissions.

Large landfills had to install gas collection systems once their emissions exceeded certain limits. Oil and gas facilities were restricted on gas venting and flaring at new oil wells and required enhanced leak detection and repair at wells and processing facilities. At the time, EPA was fully committed to addressing emissions from existing facilities but, the agency's position changed markedly following President Trump's inauguration.

Also, in 2016, BLM adopted the Methane Waste Prevention Rule to limit methane emissions from oil and gas production on public lands. They required 95 to 98 percent of the associated gas produced from oil wells to be captured, and imposed leak detection and repair requirements on oil and gas facilities.

Methane gas is flared near Carlsbad, New Mexico
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Shortly after taking office, President Trump signed an Executive Order directing federal agencies to review and, if appropriate, revise all existing regulations "that potentially burden the development or use of domestic energy resources, with particular attention to oil [and] gas." BLM and EPA commenced reviews of their requirements. BLM completed its review in September 2018 and rescinded key provisions of their rule. This was immediately challenged in court by California and New Mexico, as well as several environmental groups. EPA's review of its methane regulations is still going on.

The 2020 Democratic candidates are already pledging to reverse this action. The administration has argued that its rollbacks are justified, in part, by the fact that firms already have an incentive to reduce leaks since methane is itself valuable.

Admittedly, because of the fracking boom, the U.S. now produces a lot of gas, and that gas is valuable. The problem is that getting all of that methane from wellheads, to gathering systems, to transmission lines, to distribution lines, and finally to your stove requires a lot of pipe connections. And if those connections aren't made well and aren't maintained, they leak. Estimates of how much methane leaks, and how much is due to fracking, are still highly variable and controversial. One estimate is that oil and gas facilities' leaks are 2.3% of total U.S. gas production, while another estimates a leak rate of 3.5%.

The global warming caused by methane emissions (and other causes) involves a “Social Cost of Carbon” (SCC), which is the cost of damages to human health and productivity, the environment, etc. A recent paper talking about the SCC says these costs are normally ignored by industry and developers. The Obama Administration estimated that the SCC of leaked methane was $41 per ton of CO_2 equivalent. This is ten times the private commercial value of the gas.

Absent regulation, oil and gas firms only have an incentive to reduce leaks up to the point where the cost of fixing leaks balances out against the private commercial value of the gas. Economists’ usual solution of pricing emissions with a tax or a cap-and-trade program aren’t practical. To price emissions you have to measure them, and presently, at least, they’re hard to measure. The development of satellite measuring systems helps, but for now, the best regulatory tool is to routinely inspect oil and gas facilities and require fixes when leaks are detected. Unfortunately, the EPA is proposing to undo the Obama-era regulations that did just that.

The Washington Post, “The Energy 202”, 3/4/2020, says that ExxonMobil thinks there should be stricter methane regulations and outlined its own guidelines for reducing the methane released by its operations, suggesting the guide can be a model for companies and governments around the world, according to the AP. Some environmental advocates see Exxon's move as a rebuke of President Donald Trump's EPA trying to relax regulations on methane emissions.

While Exxon (and other large oil companies, including BP), don’t like EPA’s move to roll back these regulations, smaller “independent” firms are generally happy about it. Regulations usually make it easier for larger firms to compete. Large firms can invest in technology to identify and fix leaks at a cost less than that faced by the smaller independents. So, the big firms will have an advantage when competing for oil and gas leases. The fact that methane regulations are likely to disproportionally affect small firms means that we should help provide technology and expertise to smaller firms.

As described in “The Status of Methane Regulation in the U.S.,” January 31st, 2020, *By Romany M. Webb (*http://blogs.law.columbia.edu/climatechange/2020/01/31/the-status-of-methane-regulation-in-the-u-s/), House Democrats, to counter what the EPA is doing, on January 28, published a draft of the “CLEAN Future Act” which aims to “achieve net zero greenhouse gas pollution,” among other things. An important component of the plan is stricter regulation of methane. Along with the CLEAN Future Act, lawmakers are currently considering five other bills, aimed at preventing the Trump administration from rolling-back existing methane regulations. It is expected that these are likely to be staunchly opposed by the Trump administration. But their introduction is significant in itself, and suggests that methane regulation may soon be a federal priority again.