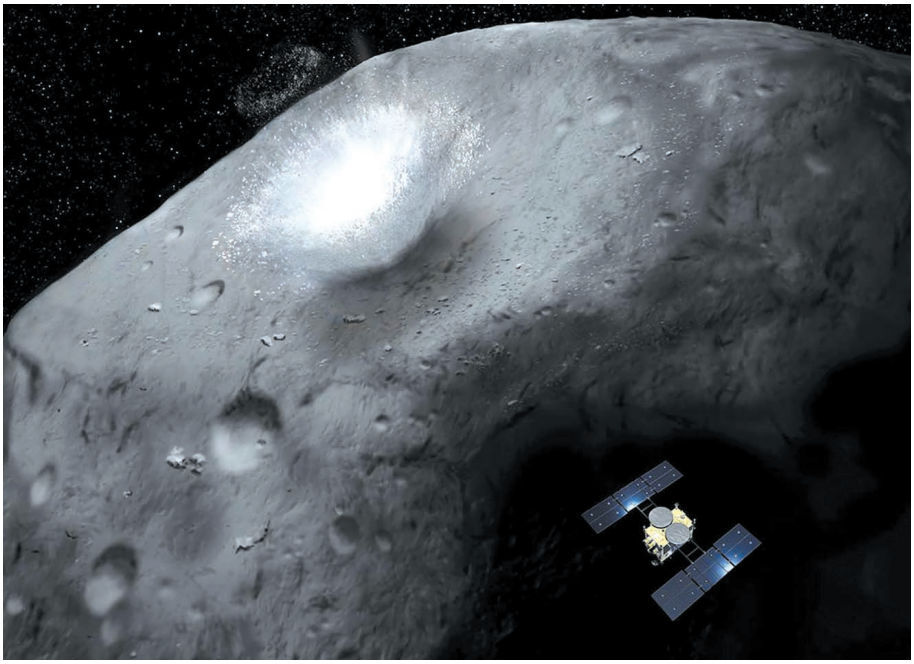

JAXA

An artist's impression of Hayabusa-2.

axis, which is about 7.5 hours. This is good news, because a much faster rotation could have made it harder to approach the surface, says mission manager Makoto Yoshikawa of JAXA's Institute of Space and Astronautical Science in Sagamihara. But its shape was surprising, he says, because it has a bulge around the equator, something that is usually associated with much faster-spinning objects, Yoshikawa adds.

Hayabusa-2's most important task right now is to pinpoint its own position using laser ranging so that it can manoeuvre accordingly. "We want to know the exact distance of the spacecraft to the asteroid," Yoshikawa says. Also crucial is to map the asteroid surface using its on-board camera and infrared spectrometer. Temperature variations will hint at the composition of the surface. All of these data will be crucial for deciding where to release MASCOT, the shoebox-sized lander that will probe the asteroid, and the three other small probes carried by the mothership.

"We will use the information we get from the mother spacecraft to do landing-site selection," says MASCOT payload manager Stephan Ulamec of the German Aerospace Center in Cologne. Ulamec was also project manager for Philae, a probe that Rosetta released onto the surface of 67P/Churyumov–Gerasimenko. That approach took several hours because Rosetta was orbiting the comet and Philae had to spiral down to its surface.

Hayabusa-2 will simply hover over Ryugu — using its own gentle ion engines to counteract the asteroid's gravitational attraction — and release MASCOT straight down. Some time in October, the lander will make a soft touchdown. After MASCOT settles on the surface, an internal mechanism will straighten the lander up so it can use its on-board instruments and communicate with Hayabusa-2.

MASCOT carries no solar panels and its batteries are expected to last only a few hours. The team will meet in Toulouse, France, in mid-August to make the final selection for the landing site of MASCOT and its companions.

Meanwhile, Hayabusa-2 will make its own, brief soft landings to collect samples of the asteroid's surface. Then, in late 2019, it will head back to Earth, a journey expected to last a year. Compared to the more daring manoeuvres to reach the asteroid's surface, the current part of the mission is relatively low risk, says Yoshikawa. But as the craft approaches Ryugu, his team has already kicked into high gear, he adds: "I do not have much time for sleep." ■

CLIMATE CHANGE

Methane leaks from US gas fields dwarf official estimates

Latest study suggests that emissions could be coming from faulty equipment.

BY GIORGIA GUGLIELMI

Methane leaks from the US oil and gas industry are 60% greater than official estimates, according to an analysis of previously reported data and new airborne measurements.

Because methane is a potent greenhouse gas, scientists say that the unaccounted-for emissions could have significant impacts on the climate.

The analysis[1], published on 21 June in *Science*, is one of the most comprehensive looks yet at methane output from US oil and gas production, and reinforces previous studies that suggested emissions outpaced government estimates. That research prompted the government to develop regulations that would restrict methane emissions from oil and gas production — rules that US President Donald Trump is now attempting to roll back.

The latest study shows that the US oil and gas supply chain emits about 13 million tonnes of methane, the main component of natural gas, every year. That's much higher than the US Environmental Protection Agency (EPA) estimate of about 8 million tonnes.

This discrepancy probably stems from the fact that the EPA's emissions surveys miss potential sources of methane leaks, such as faulty equipment at oil and gas facilities, says study leader Ramón Alvarez, an atmospheric chemist at the Environmental Defense Fund, a non-profit group in Austin, Texas.

Methane warms the planet 80 times as much as carbon dioxide does over the first 20 years after it is released. And atmospheric methane contributes to about 25% of global warming, Alvarez says. "That's a significant amount."

If left unchecked, he says, methane emissions from the oil and gas industry could erode the potential climate benefits of using natural gas, which releases much less CO_2 and other toxic pollutants than coal does when it is burned.

The latest study comes one year after the EPA announced a delay of the rule that would restrict methane emissions produced by oil and gas drilling operations. The policy,

introduced under former president Barack Obama, will not take effect until 2019.

Before 2012, published estimates of the US methane leakage rate ranged from 1% to about 8%, Alvarez says, and the lack of consensus pushed scientists to improve measurements of those rates in subsequent years. Alvarez and his team pooled data from some of these studies — many of which quantified emissions at individual facilities — and validated the measurements using aircraft surveys. The team covered regions accounting for about 30% of US gas production.

The researchers then extrapolated the figures to estimate methane leaks at the national level. The team found a leakage rate of 2.3% in 2015, compared with the 1.4% estimate from the EPA. The gas is escaping through holes in the production system, and it adds up to a lot of emissions, says Alvarez.

The findings reduce the uncertainty around the magnitude of US methane emissions, says Daniel Zimmerle, an energy researcher at Colorado State University in Fort Collins. "But I would be surprised if this would be the final word on the topic."

Because of methane's warming potential, a leak rate of 2.3% is concerning, says Robert Howarth, an Earth-systems scientist at Cornell University in Ithaca, New York. But he cautions that the study might have underestimated the actual leak rate of methane. Howarth notes that the measurements scientists used include some obtained with an instrument that — according to the device's inventor — produces systematically low numbers[2].

What's more, Howarth says, the researchers didn't look at the emissions from systems that distribute gas to urban areas, which studies suggest are considerable[3].

But Alvarez looks on the bright side. Because a substantial proportion of these leaks is probably due to faulty equipment, he sees a "tremendous opportunity" to reduce methane emissions by developing systems to quickly detect malfunctions at oil and gas facilities, and by identifying overlooked ways in which the greenhouse gas escapes into the atmosphere. ■

1. Alvarez, R. *et al. Science* https://doi.org/10.1126/science.aar7204 (2018).
2. Howard, T. *Environ. Sci. Technol.* **49**, 3981–3982 (2015).
3. McKain, K. *et al. Proc. Natl Acad. Sci. USA* **112**, 1941–1946 (2015).

MICROBIOLOGY

Bacteria deliver gene therapies

Engineered strains of Escherichia coli *and other microbes are being tested in people as treatments for a slew of illnesses.*

BY SARA REARDON

People often take medicines to rid themselves of problem bacteria. Now, a counter-intuitive approach — turning genetically modified bacteria into medicines — is gaining ground.

Several companies are testing whether engineered bacteria can treat conditions that affect the brain, liver and other organs — and even kill other, harmful microbes. But although US regulators have approved trials of several types of engineered bacterium as a form of gene therapy, questions remain about whether microbes' ability to share DNA with one another will create long-term safety risks.

The idea of using bacteria to deliver gene therapies first surfaced in the 1990s, but early clinical trials met with mixed results. Interest in the approach has increased in recent years amid mounting evidence that the bacteria that live in the body — the microbiome — can influence human health. Researchers are looking to treat disease by modifying microbes that are normally found in people or the foods they consume.

"The microbes are extremely smart and they know how to survive."

Matthew Chang, a synthetic biologist at the National University of Singapore, says that genetically modified bacteria have the potential to treat many diseases. His group is engineering the gut bacteria *Escherichia coli* and *Lactobacillus* to recognize and destroy harmful microbes[1]. "It's a rapidly growing area," says Chang, who adds that he is in talks with regulators in Singapore about starting clinical trials.

One strain of research is aimed at treating the genetic disorder phenylketonuria. People with the condition are deficient in an enzyme that breaks down the amino acid phenylalanine, which causes neurological damage if it builds up in the body. At the American Society for Microbiology's annual meeting in Atlanta, Georgia, earlier this month, researchers from the biotechnology firm Synlogic in Cambridge, Massachusetts, reported that *E. coli* modified to produce an enzyme that degrades phenylalanine, and a protein that moves it from blood to cells, reduced levels of the amino acid in monkeys' blood by more than half compared with animals in a control group. The company started clinical trials in healthy human volunteers in April, and will begin testing the bacteria in people with phenylketonuria as soon as it concludes that the therapy is safe.

Another firm, Intrexon of Germantown, Maryland, has altered *Lactococcus lactis*, a bacterium used in cheese production, to make a protein that protects skin's outer layers. One clinical trial that has enrolled about 200 people with cancer is testing whether an *L. lactis* mouthwash can prevent oral sores that are a side effect of chemotherapy. In July, the company will begin dosing people who have diabetes with a different form of *L. lactis* that produces both the precursor to human insulin and an immune protein that enhances cells' ability to respond to insulin.

Both Intrexon and Synlogic have engineered their bacteria to reduce their likelihood of establishing colonies in the body — which means that patients would have to take the microbes regularly. But other companies are pursuing treatments that would create colonies of transgenic bacteria in the body.

The biotechnology firm Osel in Mountain View, California, plans to seek US ▶

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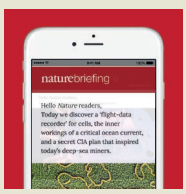

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