

## What Is Methane?

- Methane is an odorless, colorless, tasteless gas that is lighter than air.
- It is the main component in natural gas and is also present in many coal formations. When methane burns it produces a great amount of heat, which makes it very useful as a fuel source.
- In sufficient amounts of oxygen, methane burns to give off carbon dioxide and water.

**Methane's ability to trap heat is 28 times greater than carbon dioxide**

## Methane As A Greenhouse Gas

Atmospheric methane is an important greenhouse gas, with an ability to trap heat that is 28 times greater than carbon dioxide.

- Since the Industrial Revolution, the amount of methane in the atmosphere has more than doubled.
- Methane is responsible for about 20 percent of the Greenhouse warming.

(See Fact Sheets on Greenhouse Effect and Climate Change.)

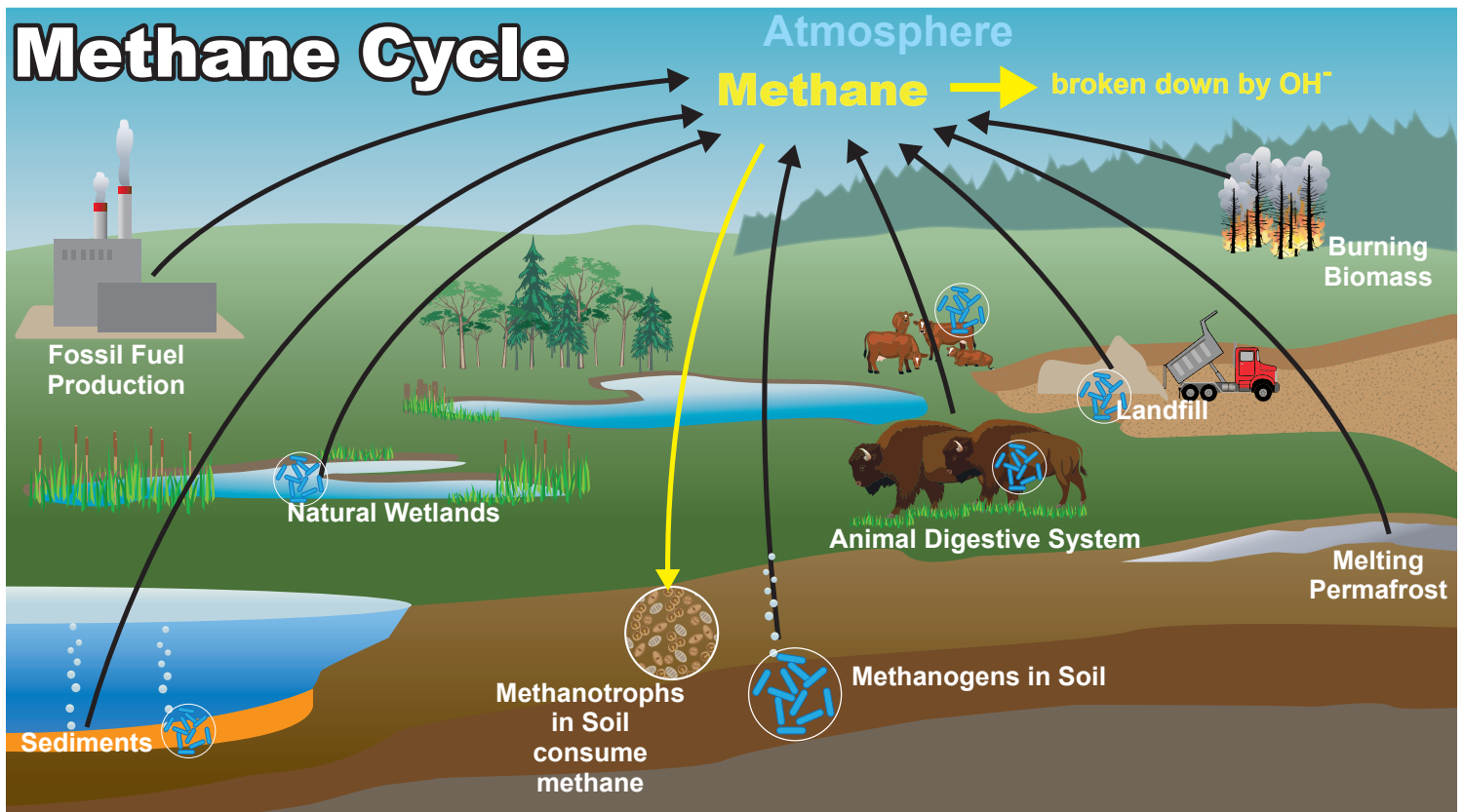
## How Is Methane Produced?

Most of Earth's methane is produced by living organisms.

- Methane is produced by single celled organisms, which are similar to bacteria. Since they produce methane, they are called methanogens.
- Methanogens produce energy for living without oxygen. This process produces the methane.
- Methanogens live in many places, from wetlands, to sediments below the seafloor, and to the digestive tracts of cattle, termites and some people. They avoid places that have oxygen.

## The Methane Cycle

- There are many sources that release methane into the atmosphere. There are also sinks, or ways that methane is stored or destroyed.
- In an ideal world, methane sources would be balanced with methane sinks, however, the amount of methane is rising due to human activities.
- About 60% of the current methane released from land to the atmosphere is the result of human activities
- Methane concentrations have more than doubled over the past 200 years.



## Natural Sources – Where Methanogens Live

### Wetlands

- Natural wetlands are responsible for approximately 80% of global methane emissions from natural sources.
- Bogs, marshes, fens and permafrost provide the perfect place for methanogens - environments with little oxygen and lots of organic matter for them to break down.

### Other Natural Sources

All other natural sources only make up about 20% of natural global emissions

#### Soil

- Methanogens in the deeper soil where there is little or no oxygen, produce methane that bubbles up to the surface and is released into the atmosphere.

#### Digestive Tracts of Animals

Methanogens live in the guts of various animals and produce methane as part of normal digestion, including;

- Ruminants - mammals that have specialized stomachs to break down plant material. This group includes cattle, bison, caribou, deer, elk, goats, moose, sheep, and antelopes.
- Humans - occurs only in some humans, resulting in flatulence
- Termites - methane from termites are estimated to be about 9% of the global emissions from natural sources

Methanogens have been found in other animals including rats, rabbits, horses, pigs, monkeys, baboons, rhinoceroses, hippopotamuses, giant pandas, geese, turkeys and chickens.

#### Oceans & Lakes

- Methanogens in oceans and lakes contribute about 7% of the global methane emissions from natural sources.
- Digestion in marine animals and methane produced in sediments are the main sources.

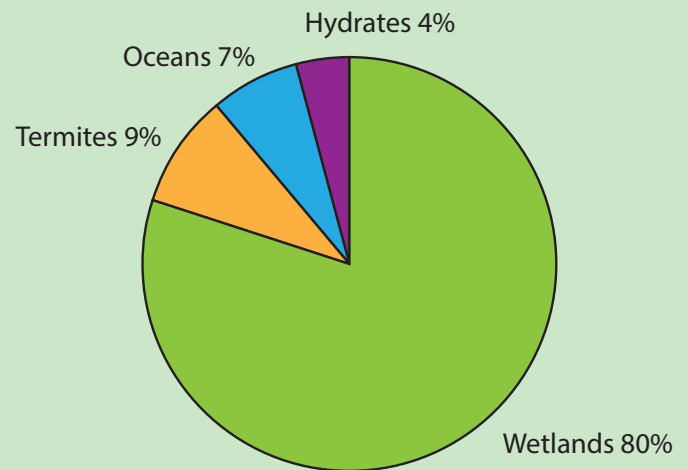


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### Frozen Methane (Clathrates)

- Methane produced by methanogens that is frozen into ice crystals is called clathrates.
- They form in cold, oxygen-poor undersea sediments. Clathrates are also trapped in permafrost, the permanently frozen soil in the arctic and subarctic.
- As global warming causes melting, this frozen methane is released and adds approximately 4% to the emissions.

### Natural Sources of Methane by %



Based on information from: [https://www.esrl.noaa.gov/gmd/education/info\\_activities/pdfs/CTA\\_the\\_methane\\_cycle.pdf](https://www.esrl.noaa.gov/gmd/education/info_activities/pdfs/CTA_the_methane_cycle.pdf)

## Human Sources

Today, about 60 percent of the methane in the atmosphere comes from sources scientists think of as human caused.

### Landfills

- Methane is generated in landfills as waste is broken down by methanogens, where there is no oxygen.
- Globally, trash releases over 10 percent of all methane generated by humans
- Landfill methane can be decreased by reducing the methane-generating materials going into landfills.
  - reducing food waste
  - turning the remaining food and yard waste into compost, rather than sending it to landfills

### Fossil Fuels

- Fossil fuels were formed by the breakdown of buried dead organisms from long ago.
- Methane is the main part of natural gas. Methane is

released when it is made, stored, and shipped.

- Because natural gas is often found with oil and coal, it is also released when these are being produced.
- The energy sector contributes about a third of the annual methane budget.

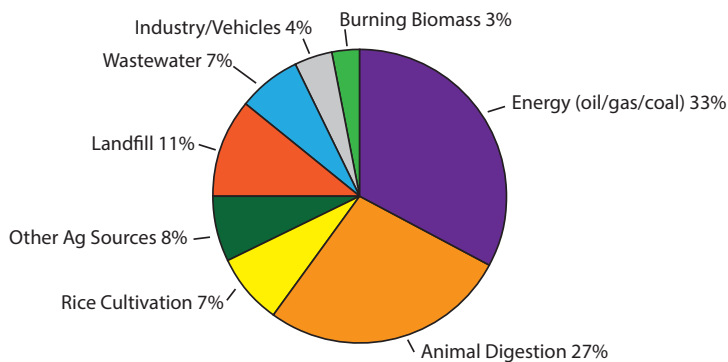
### Livestock

- Domesticated livestock produce large amounts of methane as part of their normal digestion.
- There are 1.4 billion cattle in the world, and that number is growing as demand for beef and dairy increases; together with other grazing animals, they contribute over a quarter of the annual methane budget.

### Wastewater Treatment

- When wastewater from sewage is treated to remove contaminants, methane can be produced if the wastewater is treated without oxygen (an ideal place for methanogens) and if the methane produced is released to the atmosphere.

## Human Sources of Methane by %



Based on information from: [https://www.esri.noaa.gov/gmd/education/info\\_activities/pdfs/CTA\\_the\\_methane\\_cycle.pdf](https://www.esri.noaa.gov/gmd/education/info_activities/pdfs/CTA_the_methane_cycle.pdf)

### Rice Cultivation

- Methane is produced during flooded rice cultivation by methanogens in the soil.

### Biomass Burning

- Methane is released during burning as a result of incomplete combustion and huge amounts can be produced during;
  - large scale burning of woodlands and grasslands for land clearing.
  - the burning of agricultural waste due to its generally high water content.
  - wood burning for domestic fuel and for charcoal production
- Biomass burning as an alternative to fossil fuels can be used effectively by avoiding incomplete combustion. It can have a much lower greenhouse gas impact compared to coal, oil and gas-fired power stations.



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## Natural Storage

Anything that absorbs more greenhouse gases than it gives off is called a sink. In a sense it stores the greenhouse gas.

### Atmosphere

- The main way that methane is removed from the atmosphere is when oxygen and hydrogen (OH<sup>-</sup>) naturally combine with methane and break it down to form water vapor and carbon dioxide. This is the main sink for methane.
- Methane remains in the atmosphere for about 8 years until it is cycled out by this process.

### Methanotrophs in soils

- Soil methane is also consumed by some microbes, called methanotrophs.
- They use methane as a source of energy, breaking it down with oxygen and giving off carbon dioxide and water.
- Forest soils act as good sinks for atmospheric methane because soils are moist, which is ideal for methanotrophs, and it is easy for them to absorb the methane directly from the air.
- Methanotrophs can also live in wetlands, marshes, rice paddies, landfills, lakes, oceans, and streams but they generally need oxygen to survive.

## More Resources

Methane, Explained - National Geographic

<https://www.nationalgeographic.com/environment/global-warming/methane/>

Municipal Solid Waste And Greenhouse Gases - Government of Canada

<https://www.canada.ca/en/environment-climate-change/services/managing-reducing-waste/municipal-solid-greenhouse-gases.html>

Compost Council of Canada

<http://www.compost.org/>

Methane, Climate Change and Waste Management in Canada - Canadian Institute for Environmental Law and Policy

<http://cielap.org/pdf/Methane.pdf>

Landfills Have A Huge Greenhouse Gas Problem - Ensia / University of Minnesota's Institute on the Environment

<https://ensia.com/features/methane-landfills/>

Global Methane Emissions and Mitigation Opportunities - Global Methane Initiative

<https://www.globalmethane.org/documents/gmi-mitigation-factsheet.pdf>

Food Waste Management + Climate Action - National Zero Waste Council of Canada

<http://www.nzwc.ca/focus/food/Documents/FoodWasteClimateChange-Report.pdf>