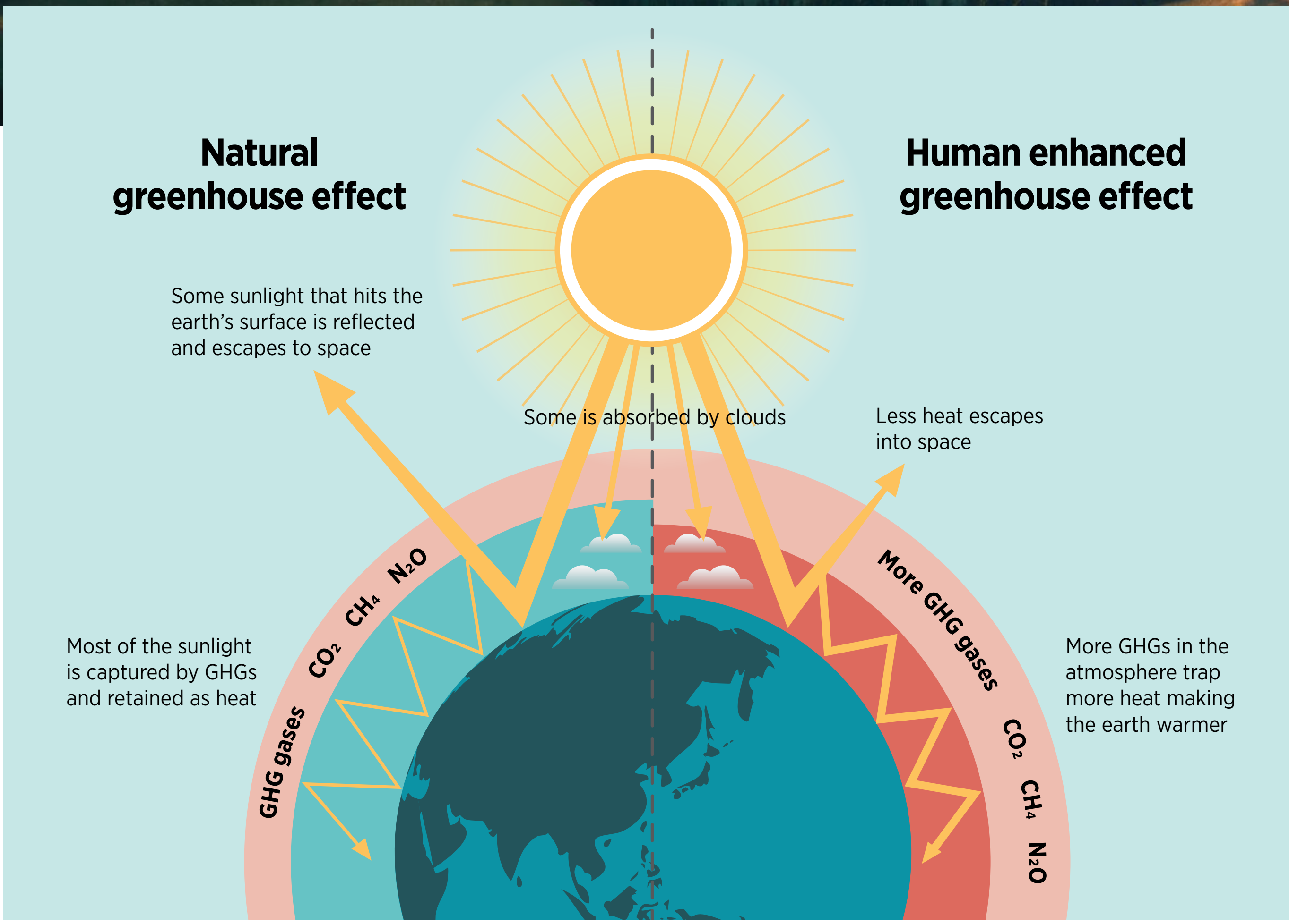
FACTSHEET

# The Greenhouse effect, including long and short-lived gases

*September 2021*




The Earth's atmosphere is made up of naturally occurring greenhouse gases (GHGs), the largest of which is water vapor ($H_2O$), but also includes carbon dioxide ($CO_2$) mainly from the decay of plant matter, methane ($CH_4$) mainly from wetlands, nitrous oxide ($N_2O$) mainly from soils and oceans, and ozone ($O_3$), which is produced and destroyed by chemical reactions in the atmosphere.

Solar radiation from the sun enters the Earth's atmosphere. Some is absorbed by the Earth's surface and then a proportion of this is re-radiated as heat back out into the atmosphere. Some escapes through the layer of GHGs and is lost to outer space, while the rest is trapped by the layer of GHGs that creates a warming effect. This process ensures that Earth is kept at an average temperature of 15˚C and without those naturally occurring GHGs trapping heat the average temperature at Earth's surface would be -18˚C.

When people talk about the impact of human activity on the GHG effect they are referring to an increase in GHG emissions that creates more GHGs in the atmosphere, so less re-radiated heat is able to escape to outer space and thus the average temperature at Earth's surface is increased. Since humans started using fossil fuels the average temperature at Earth's surface has increased by 1˚C. In 2015, New Zealand signed the Paris Agreement, which has the purpose of keeping the global average temperature well below 2˚C above pre-industrial levels while aiming to limit the temperature increase to 1.5˚C.

Under this agreement New Zealand's specific commitments are to reduce our carbon dioxide equivalent emissions to 30% below 2005 levels (or 11% below 1990 levels) by 2030. New Zealand's domestic targets were passed into law in 2019. These are:

- Carbon dioxide and nitrous oxide (long-lived gases) to reduce to net zero by 2050
- Methane emissions (a short-lived gas) to be reduced to 10% below 2017 levels by 2030 and between 24 and 47% below 2017 levels by 2050.

For more detail, see the 'Responding to a changing climate' chapter in B+LNZ's Farm Plan: Environment Module.

## What are 'Global Warming Potentials' and '$CO_2$ equivalent emissions'?

The current metric used globally to compare the warming impact of the various gases is GWP100, which compares the impact of the gases on warming over a 100-year period.

This metric is accurate for measuring the impact of carbon dioxide and nitrous oxide on warming. It is relatively accurate for measuring the impact of increases in methane over a 100-year period, but it is inaccurate if methane is stable or decreasing.

If methane is increasing, over a hundred-year period one additional tonne of methane has the warming potential of approximately 25-30 tonnes of carbon dioxide, which is consistent with GWP100.

If, however, methane is reducing by 0.3% a year then it is not adding additional warming and has the same effect as net zero for carbon dioxide; and if methane is reducing by more than 0.3% it is reversing previous warming (ie cooling).

The current Government approach uses GWP100, but B+LNZ and other industry groups are advocating for the government to use GWP* to report national emissions, which more accurately reflects the warming impact of methane, particularly if it is stable or decreasing. B+LNZ want the government to start to report on the warming caused by the gases each year in the national accounts, and for GWP* to be used to determine the methane reduction targets in the Zero Carbon Bill. (Note that GWP* isn't practical or necessary at a farm level. However, if your stock numbers aren't increasing then your farm isnt really adding additional methane emissions to the atmosphere.)

## What does 'net' mean?

'Net emissions' is the result of the gross emissions minus the offset occurring from carbon sinks (primarily forestry). The amount of carbon dioxide that must be removed per unit of GHG emitted varies depending on the gas. Currently, the government does not allow the removal of carbon dioxide from the atmosphere to be used to off-set methane. Also, currently, the government only allows for sequestration by trees to be used to off-set carbon dioxide emissions.

## How can $CO_2$ be removed from the atmosphere?

Currently the only readily available and reliable way of removing or sequestering $CO_2$ is by growing trees.

Trees store carbon as they grow. Once they stop growing, they stop adding carbon. When trees die they start to break down and decay and release the carbon back into the atmosphere as $CO_2$. Trees can be used as timber for building and making things, but once it starts to decay, it releases the $CO_2$ back into the atmosphere as well.

There is a lot of research into other ways to remove $CO_2$ from the atmosphere.

## What about soil carbon?

Soil can store quite a lot of carbon, but

- It is really hard to measure at farm scale:
  - Soil samples only measure a small part of the soil and it is too expensive to take enough samples over a whole farm. Scientists are working on new tools
  - There are still big gaps in knowledge about how soil carbon behaves.
- It can be lost very quickly for reasons beyond a farmer's control such as during a drought.
- There are lots of things that affect soil carbon such as underlying soil types.
- New Zealand soils are very young and most still have very high soil carbon levels, with the exception of repeatedly cultivated soils. Other countries that have been cultivating their soils for hundreds of years may have very low soil carbon levels, and can add more carbon to the soil.

There are things that can be done to protect soils and soil carbon as much as possible as well as helping to build soil carbon. Carbon is added through photosynthesis so avoiding bare soil and having growing plants on soil as much as possible is the way to avoid soil carbon loss.

- No-till cultivation and other carbon building actions.
- Avoiding compaction and soil damage through pugging wet soils or heavy machinery.
- Avoiding soil losses through erosion, keeping soils in place.

## What are some human-induced GHGs and their sources?

Anthropogenic or human-induced GHGs are:

1. Carbon dioxide ($CO_2$) from the burning of fossil fuels, deforestation and land use change (e.g. from a natural state to pasture);
2. Methane ($CH_4$) from farmed ruminants (such as cattle, sheep and deer), landfills, animal effluent storage and wastewater management;
3. Nitrous oxide ($N_2O$) from urine patches, soils, nitrogen fertilisers, animal effluent storage and wastewater management; and
4. Other synthetic gases like CFCs (chlorofluorocarbons) from industrial processes and refrigeration.

## Short-lived and long-lived gases

Methane is a short-lived gas meaning that it breaks down a lot faster than other gases but while it's in the atmosphere it has a big impact on warming – it is many times more potent than carbon dioxide and so has a greater immediate warming effect. A molecule of methane will be basically gone from the atmosphere within about 12 years compared to thousands of years for carbon dioxide. Averaged over 100 years, an <u>additional</u> one tonne of methane produced causes about 25-30 times the warming of one tonne of carbon dioxide.

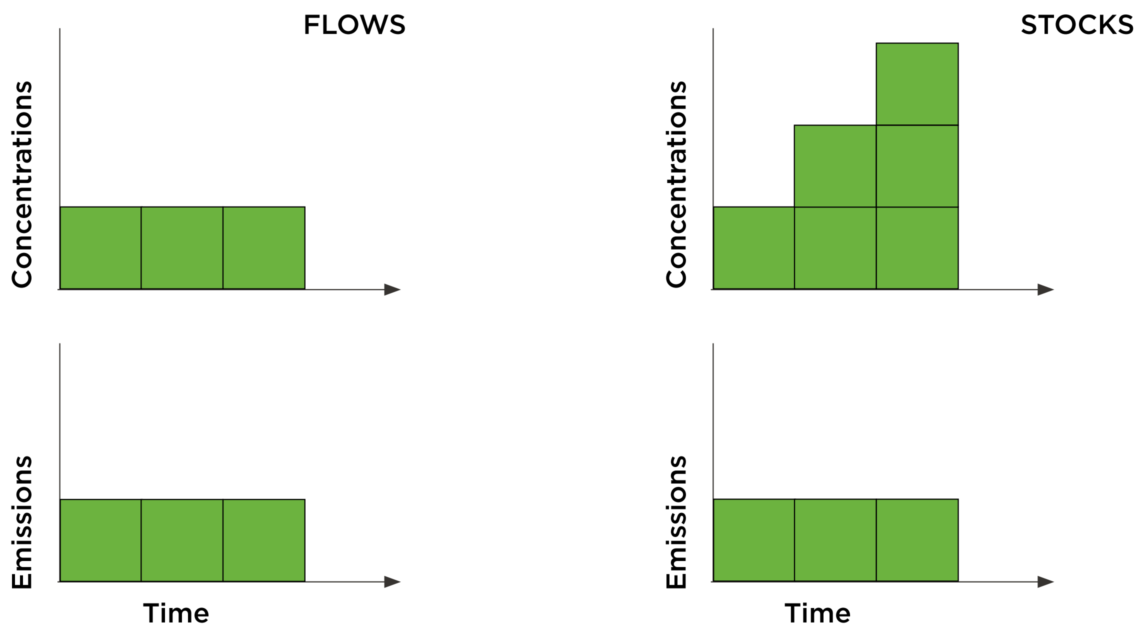
But if methane is reducing by only 0.3% per year it does not add any more additional warming (ie it is equivalent to net zero for carbon dioxide).

Using GWP100 methane accounted for around 42% of New Zealand's gross GHG emissions. But this does not provide an accurate picture of the additional warming methane contributed as methane has been stable.

Nitrous oxide is a long long-lived gas that stays in the atmosphere for over 100 years. It is around 300 times more potent than carbon dioxide over that 100-year period and its warming effect can continue for several centuries after it has disappeared. In 2019 nitrous oxide accounted for around 10% of New Zealand's gross GHG emissions.

Carbon dioxide is a long-lived gas that remains in the atmosphere for 100s to 1000s of years. Every unit of carbon dioxide emitted adds to warming.

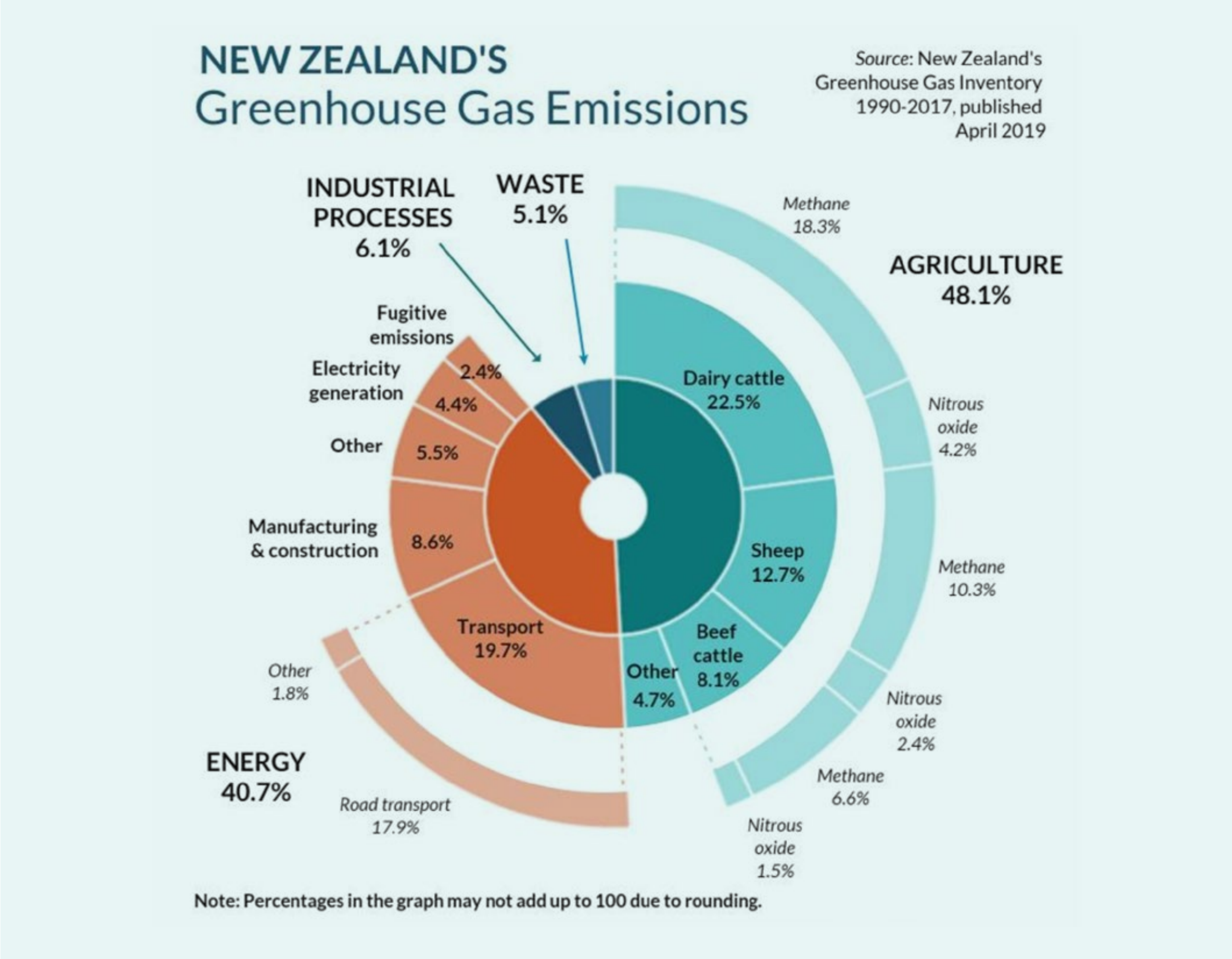
**Short-lived gases are 'Flows' while long-lived gases are 'Stocks'.**




Flows enter and leave the atmosphere after a relatively short period—for $CH_4$ they start to leave after about 12 years. If the amount of $CH_4$ being emitted to the atmosphere remains constant, then over an extended time the amount entering and the amount leaving will balance out.

Stocks are gases that accumulate over time, such as $CO_2$ and $N_2O$. Each addition of $CO_2$ or $N_2O$ adds to the total in the atmosphere.

**Below is a diagram of New Zealand's greenhouse gas emissions by sector and by gas**




## What does this all mean for sheep and beef farmers?

New Zealand's agricultural sector has a role to play to contribute to meeting specific greenhouse gas emission reduction targets, as part of international commitments on climate change and in the Zero Carbon Act.

Beef + Lamb New Zealand has put together resources for sheep and beef farmers to help you understand the issues and the options you have to measure and manage on-farm emissions so that you can meet regulatory requirements.

## Further information can be found here:

**B+LNZ Factsheets:** Find these Factsheets on the B+LNZ Knowledge Hub www.knowledgehub.co.nz

- Contributing to meeting our climate change commitments through He Waka Eke Noa
- Biogenic methane from ruminant animals and nitrous oxide from agricultural soils
- Greenhouse gas management and mitigation for sheep and beef farmers

**B+LNZ Farm Plan: Environment Module**

- You can download the Farm Plan, with the 'Responding to a changing climate' chapter at www.beeflambnz.com/farmplan

**Websites**

- www.agmatters.nz
- https://niwa.co.nz/our-science/climate/information-and-resources/clivar/greenhouse
- https://niwa.co.nz/education-and-training/schools/students/climate-change/climate-change-the-science