# AVIATION AND CLIMATE CHANGE

WAYPOINT 2050

*The air transport industry is a key driver of the global economy, supporting connectivity, a third of world trade and 65.5 million jobs. Like all other sectors, it has an impact on the environment and climate change.*

Like nearly all human activities, air transport produces carbon dioxide ($CO_2$) emissions as it uses fuel to power aircraft. The efficiency of aircraft has improved continuously and, in fact, a flight taken today will produce half the $CO_2$ that the same flight would have in 1990. However, the industry is also growing rapidly to meet the needs of citizens around the world who wish to travel. That growth is often faster than the efficiency improvements, leading to a rise in overall emissions.

## $CO_2$ emissions

Aviation produces around 2% of all human-induced $CO_2$ emissions: 915Mt of $CO_2$ in 2019. By comparison, this is less than the shipping sector and around the same as the servers and transmission cables of the internet (not including the computers and tablets accessing the internet)[1]. Bitcoin mining alone produced 69Mt of $CO_2$ in 2017[2].

↳ International aviation (which falls outside of national $CO_2$ accounting) is around 1.3% of total $CO_2$ emissions – the size of Indonesia or Canada. If aviation were a country, it would be the 11th or 12th largest emitter.

## Other emissions

Whilst carbon dioxide is the greenhouse gas that has the most long-term impact (and is the only so-called 'Kyoto gas' generated by aviation), there are other emissions from flight. The exhaust of a jet engine is made up of:

- 5% to 6% $CO_2$;
- 2% water vapour;
- around 0.03% nitrogen oxides, unburned hydrocarbons, carbon monoxide and sulphur oxides;
- traces of hydroxyl family and nitrogen compounds and small amounts of soot particles;
- between 91.5% and 92.5% of aircraft engine exhaust is normal atmospheric oxygen and nitrogen.

It is important to note that not all gasses have the same climate impacts. $CO_2$ is the most notable greenhouse gas because of its long life, whereas some other gases (such as methane from agriculture and waste) have a much stronger impact on climate change, but a very short life. Recent analysis has shown that the full impact of aviation may be around 3.5% of all anthropogenic climate impact.

## Emissions at altitude

Some people assume that aviation emissions have more of an impact because they are released at higher altitudes than emissions from ground-based sources. For $CO_2$ emissions, the impact is the same no matter which altitude it is released. Other gases, such as nitrogen oxides, do have a larger climate impact as they react to other gases in the upper atmostphere.

Aviation produces

**2.1%**

of global $CO_2$ emissions

**1.3%** international
**0.7%** domestic

**80%** of aviation emissions are from flights over 1,500km (without practical alternatives)

Total human $CO_2$* 2019:

**43.1Gt**

Total human GHG* 2018:

**53Gt**

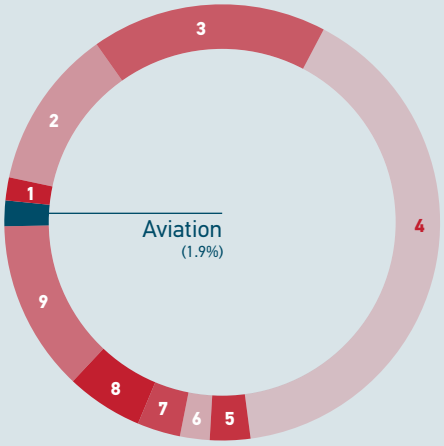
Total aviation $CO_2$ 2019:

**915Mt**

**80%** Today's aircraft are over 80% more efficient than the first jets from the 1950s.

## Counting $CO_2$

*Aviation makes up around 2% of global $CO_2$eq emissions. Figures from 2016[3]*




1. Shipping (1.7%)
2. Road transport (11.9%)
3. Energy use in buildings (17.5%)
4. Energy use in industry and other (40.2%)
5. Cement (3%)
6. Chemicals (2.2%)
7. Waste (3.2%)
8. Deforestation and crop burning (5.7%)
9. Other agriculture and land use (12.7%)

*Includes all greenhouse gas emissions (49.5 Gt $CO_2$eq in 2016), not only $CO_2$ emissions. Data released in 2020.*

## Contrails

One of the most visible signs of aircraft movements are the white trails left behind as flights move through some areas of the sky. These are called contrails and are made up of ice crystals from the condensation of water vapour (like naturally-occurring clouds) produced from the combustion process inside the engine.

The impact of contrails (and the hazy cirrus clouds they sometimes generate as they dissipate) on climate change is complex and still includes large uncertainties, despite advancement in research. Some recent studies have shown that contrail-induced cirrus could help cool the planet during the day, but warm it at night, similar to ordinary clouds.

It is actually possible to avoid creating contrails, either by flying around the areas of super-saturated cold air in which they form, or flying at a different altitude. However, this brings with it some downsides, as airlines use more fuel (and therefore emit more $CO_2$) to avoid these areas.

A number of airlines and aviation experts are engaged with research teams to investigate the impacts further.

## A multiplier?

Given the fact that air transport does not just produce $CO_2$ but also other gases, some climate researchers like to multiply the $CO_2$ emissions by a factor to account for the extra warming generated by these other emissions. However, it should be remembered that most other sources of $CO_2$ also generate other greenhouse gases, these are often not included in sectoral accounting. Due to the uncertainty surrounding this multiplier (and the fact that it would differ depending on routes, times of year and even day or night operations), it is inappropriate for determining individual flight $CO_2$ emissions. The industry supports more research to understand the impact of other gases and to identify potential mitigation opportunities. Also, if it is to be applied to aviation, then a multiplier should also be applied to other sectors.

## An energy transition

Until 2011, there was no certified alternative to traditional fossil fuel for air transport. However, airlines are now able to tap in to new sources of energy through sustainable aviation fuels produced from a variety of feedstocks – including waste by-products, non-food crops and potentially synthetic fuels. These currently cost significantly more than fossil jet fuel, but as production ramps up and supply increases, we expect sustainable aviation fuel to become more cost-competitive.

Eventually, there may be an option for electric or hybrid-electric aircraft to be used on short-haul flights. This is an area of increasing reseach in the aerospace industry.

## Historical and future comparisons

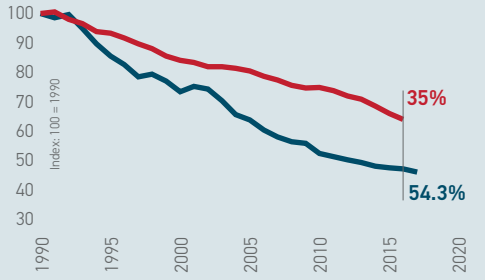
Aviation's $CO_2$ emissions have remained at around 2% of total global emissions since at least as far back as 1992[4]. Despite the growth in traffic of aviation, the industry's efforts to improve efficiency have ensured that the $CO_2$ growth has at least not outgrown the growth of emissions from the rest of the economy.

However, as all parts of the economy wake up to the need to cut emissions (and as other sectors already have access to low- or zero-carbon energy options), emissions from air transport are likely to become a larger proportion of total $CO_2$.

On this basis, the air transport industry came together in 2009 to launch a climate action plan – one of the first for any global transport network. You can read more about the industry plan on www.enviro.aero. At its heart is the need to balance the growth in connectivity and economic activity supported by air transport, with the need to react to climate change concerns. The industry is focused on cutting $CO_2$ emissions whilst retaining the benefits of air transport in the long-term.

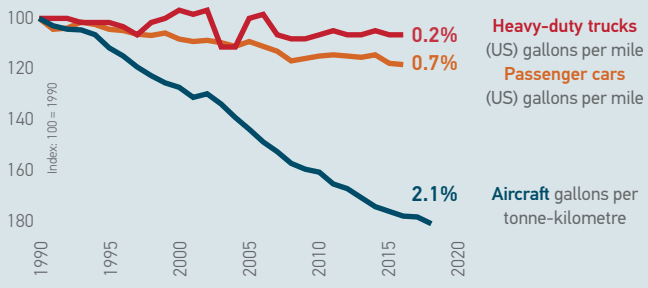
### Improving efficiency faster than **global economy**

*$CO_2$ emissions per unit of productivity*




### Improving efficiency faster than **road vehicles**

*Average fuel efficiency improvement per year since 1990*




* $CO_2$ emissions includes $CO_2$ from forestry. GHG: including $CO_2$-eq from other GHG emissions covered by UNFCCC· Global Carbon Project December *Global Carbon Budget 2019*

[1] University of Hawai'i study published in Nature Climate Change *Bitcoin emissions alone could push global warming above 2°C*, 2018

[2] Climate Watch and World Resources Institute, 2020

[3] Science Magazine, *Net-zero emissions energy systems*, June 2018

[4] IPCC *Special Report on Aviation and the Global Atmosphere*, 1999