

What share of global CO₂ emissions come from aviation?

Aviation accounts for 2.5% of global CO₂ emissions. But it has contributed around 4% to global warming to date

DATA POINT

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Flying is one of the most carbon-intensive activities, yet it contributes just 2.5% of the world's carbon emissions. How does this add up? Well, nearly everyone in the world does not fly. Studies estimate that just 10% of the world flies in most years. But as incomes rise, this will change.

Increased demand and technological improvements have driven the change in aviation emissions over the last 50 years. Total CO₂ emissions are often explained through the "Kaya identity" – how many people there are, their income, the energy efficiency of economies, and the carbon intensity of energy. We can use a similar framework to understand the drivers of aviation emissions.

This article looks at historical changes in aviation demand, efficiency, and its contribution to climate change. Most of this work is based on an excellent paper by Candelaria Bergero and colleagues and another by David Lee and colleagues. To calculate carbon emissions from aviation, we need to know three metrics. Aviation demand: how many passenger and freight kilometers; energy efficiency: how much energy is used per km; carbon intensity: what fuel is being used, which tells us the carbon emitted per unit of energy. Multiply these metrics together, and we get CO₂ emissions.

Chart 1 shows trends in these relevant metrics since 1990. For now, let's ignore the period of the pandemic and focus on the trends up to 2019. Between 1990 and 2019, both passenger and freight demand approximately quadrupled. In 2019, passengers travelled more than 8 trillion km, which is about the same as a light year.

At the same time, flying has become more than twice as energy efficient. Travelling one passenger-km in 1990 used 2.9 megajoules

(MJ) of energy. By 2019, this had more than halved to 1.3 MJ. This efficiency has come from improved design and technology, larger planes that can carry more passengers, and a higher 'passenger load factor'. Empty seats are less common than in the past.

The carbon intensity of that fuel – how much CO₂ is emitted per unit – has not changed at all. We used standard jet fuel in 1990 and we are using the same today. It has not become any cleaner. Biofuels and other alternatives are just a tiny fraction of global demand.

If flying has become more than twice as energy efficient, and the carbon emitted per unit of energy has not changed, then it follows that the carbon efficiency of traveling one km is also more than twice as high. In 1990, one passenger-km would emit 357 grams of CO₂. By 2019, this had more than halved to 157 grams. How have the changes in demand and technology affected CO₂ emissions?

If demand has quadrupled, but aviation has become twice as efficient, then emissions will double. The gains in efficiency have partly counteracted the emissions from increased demand. In 1990, global aviation emitted around 0.5 billion tonnes. In 2019, that was around 1 billion as shown in Chart 1.

Global CO₂ emissions from aviation have quadrupled since the 1960s. To examine a longer-term perspective, the recent data was extended back to 1940 (**Chart 2**). Emissions have quadrupled since the mid-1960s.

Aviation's share in global emissions has been calculated using the time series above and total CO₂ emissions data using the Global Carbon Project. In 2019, aviation accounted for 2.5% of CO₂ emissions from fossil sources and land use. This share fluctuated from 2% to 2.5% since the mid-1990s but with a marked increase since 2010 (**Chart 3**).

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Polluted skies

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Chart 1: The charts show year-wise global aviation demand, energy efficiency and CO₂ emissions

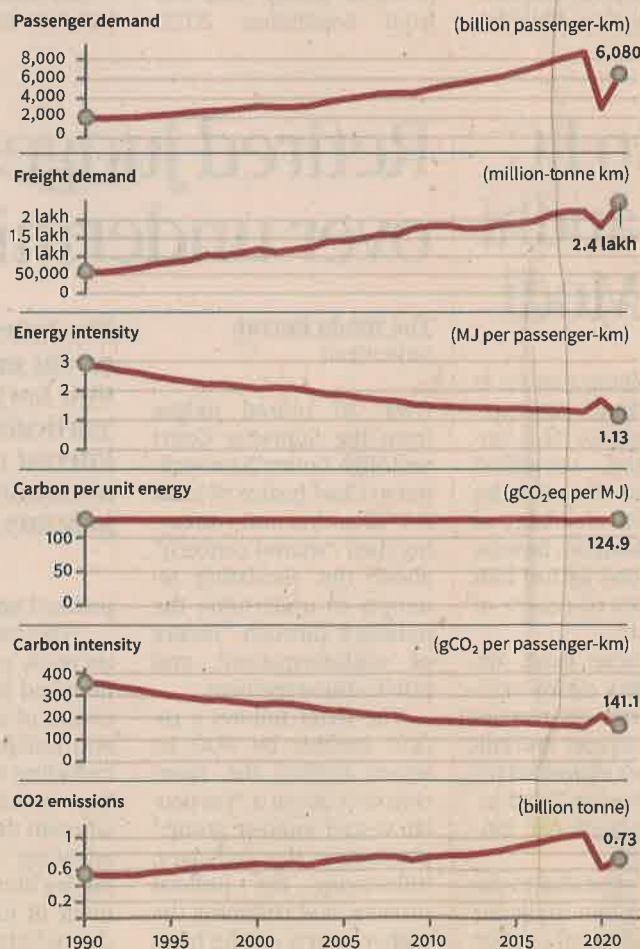


Chart 2: The chart shows global CO₂ emissions from aviation

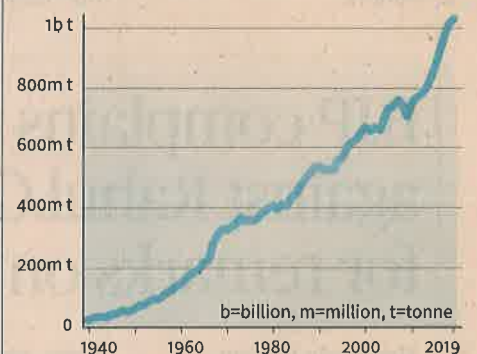


Chart 3: The chart shows aviation's share in global CO₂ emissions

