OPPORTUNITY GREEN

Factsheet: How EU policy measures against the science of aviation non-CO_2 impacts

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Summary

All flights departing Europe emitted 140m tonnes of CO_2 in 2023, roughly the same as all greenhouse gases (GHGs) emitted by the Netherlands in the same year. But these planet-warming CO_2 emissions are only part of the sector's total climate impact. Flying also causes **non-CO_2 climate impacts**, including from contrails and nitrogen oxide (NO_x) emissions, which could be twice as damaging as CO_2 on short timescales.

The EU ETS covers CO_2 emissions from flights within Europe, but non-CO_2 impacts are not priced by the EU ETS or addressed by wider European climate policy. Some within the industry continue to claim that science is too uncertain to address these, but while this may have been true 20 years ago, **we now know enough that not acting would be irresponsible in light of the climate crisis**.

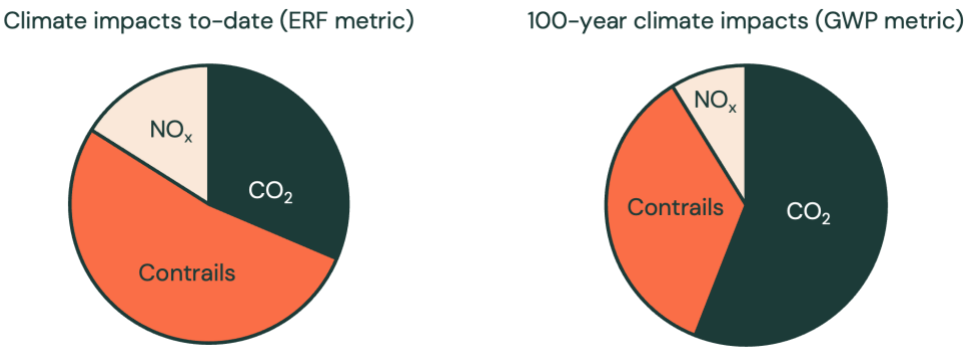
The **2026 EU ETS revision is a key moment** to develop policy for aviation's full climate impact. This factsheet summarises how EU policy stacks up against current scientific understanding of aviation's non-CO_2 impacts, marking the first in a series of pieces which will outline how EU policy must tackle aviation's full climate impact.

Aviation's total climate footprint

Aviation's climate footprint comes from CO_2 emissions and non-CO_2 impacts.

	CO_2	Contrails[1]	NO_x[1]
Explainer	Formed when carbon-based fuels (e.g., fossil fuels) are burned in plane engines.	In cold and humid regions of the atmosphere, ice crystals form around soot and other particles emitted fro m plane engines. The resulting clouds – which can be seen as white streaks in the sky - are called contrails.	Produced by the reaction of nitrogen and oxygen due to high temperatures in plane engines.
Climate impact	**Overall warming.** CO_2 in the atmosphere traps heat, warming the planet.	**Overall warming.** Contrail clouds cause warming by trapping heat, and cooling by reflecting incoming solar radiation. Overall, the warming effect is larger.	**Overall warming.** NO_x causes chemical reactions in the atmosphere which lead to increased ozone production (warming) and increased methane oxidation (cooling). Overall, the warming effect today is larger. However, this may change in the future due to changes in atmospheric composition.
Timescale of impacts	Centuries to millennia	Hours	Months (ozone) to decades (methane)

If aviation's climate impacts were eliminated tomorrow, the CO_2 emitted by planes today would continue to heat the planet for hundreds or even thousands of years, while the contrails from those flights would be gone in a few hours. Aviation's CO_2 and non-CO_2 climate impacts therefore operate on different timescales, and there is debate over how best to compare these. Contrails have contributed most to the sector's warming impacts to-date, while the sector's CO_2 emissions have larger long-term climate impacts:[2]



[1]Contrails and NO_x are the main components which currently contribute to aviation's non-CO_2 climate impacts. Sulphur oxides, water vapour and particulate matter also play a role.
[2] Charts based on Lee et al. (2021). Contributions to impacts to-date are based on the Effective Radiative Forcing (ERF) metric from 1940–2018, while long-term impacts are based on the 100-year Global Warming Potential (GWP) metric applied to annual emissions from the year 2018.

What do we know about non-CO_2 impacts?

Aviation's non-CO_2 climate impacts are more uncertain than the impact of the sector's CO_2 emissions. Research has arrived at different estimates of aviation's non-CO_2 climate impacts, some of which suggest larger impacts than others. Some within the aviation industry have exploited this uncertainty to claim that we do not have enough confidence about non-CO_2 climate impacts to be able to take concrete action on these.

However, while there are undoubtedly gaps in our knowledge, **we know that aviation's non-CO_2 climate impacts are significant, and we know enough that not taking effective action would be irresponsible**. What's more, industry has a key role to play in improving our knowledge through data collection and sharing – **yet some airlines have been consistently reluctant to do so.**

We know that:

- Contrails warm the planet, and account for a large share of aviation's total climate impact.

We are confident that:

- **Contrail avoidance** targeting the most warming flights is a no-regret path to reduce the sector's climate impact. This involves small adjustments to flight paths to avoid the cold, humid areas of the atmosphere in which contrails form. Furthermore, meaningful action can be made at a cost of only €4 per ticket, and 60% of contrails could be reduced by rerouting just 1.7% of flights.

Recent research has also investigated:

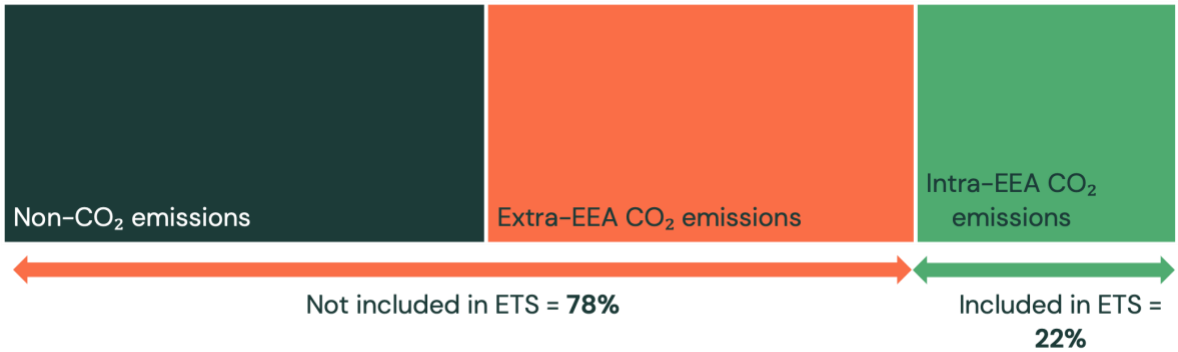
- The extent to which **hydrotreating fuel** to reduce its aromatic, naphthalene and sulphur content, and therefore reduce soot emissions and contrail formation, can lead to significant overall climate benefits.
- The extent to which **Sustainable Aviation Fuel (SAF)** use can reduce contrail climate impacts.
- Whether **optimising engine conditions,** like temperature, to reduce NO_x formation can lead to overall climate benefits. The overall benefits vary because measures to reduce NO_x emissions may reduce engine efficiency, causing additional CO_2 emissions.

Industry claims about uncertainty **should not be allowed to prevent action**. Three of the most common claims are outlined in the table below, and we recommend this fact-check for a full overview.

Claim	Reality
Contrail avoidance increases CO_2 emissions, so are we sure about the overall climate benefit?	Contrail avoidance can cause additional CO_2 emissions due to planes flying further and burning more fuel. However, the risk of this cancelling out climate benefits is "almost non-existent" for the 5% of flights responsible for 80% of contrail warming, and recent research on a global scale modelled climate benefits from contrail avoidance which were 300 times larger than the climate costs from increased fuel burn.
Predicting the formation, lifetime and climate impacts of individual contrails is hard, hindering avoidance.	Research shows that when targeting the most warming flights, even if 60% of contrail avoidance manoeuvres are unsuccessful, the climate benefits still far outweigh the climate costs of additional fuel burn. What's more, airlines must play a role in addressing uncertainty by collecting and sharing data and information, which could come from operational experience and trials.
We need to know more about impacts from contrails and NO_x before taking action.	While some strategies like contrail avoidance on the most warming flights are no-regret actions, it's true that others need more research. Some airlines are collaborating with scientists and taking part in trials at scale, helping close this evidence gap – but many are not. Parts of industry argue against action on the basis that we lack information, and then are slow to help acquire that same knowledge.

How are EU aviation's climate impacts currently regulated?

The EU ETS currently covers CO_2 emissions from flights within Europe, resulting in two glaring oversights in EU policy. First, the climate impacts of flights between European and non-European airports are not accounted for in the EU ETS, resulting in over 1bn tCO_2 going unregulated between 2012–2023 to the tune of €26bn in lost revenues. Second, other than the recently implemented monitoring, reporting and verification (MRV) directive, non-CO_2 aviation impacts are missing from EU policy.[3]



In addition, the non-CO_2 MRV requirement currently only applies to flights between European countries. Flights to and from destinations outside of Europe account for 67% of the total contrail climate impact of flights departing or arriving at European airports, underscoring the importance of expanding the non-CO_2

[3] Figure shows proportion of aviation climate impacts priced in the EU ETS, based on Opportunity Green calculations for 2012-2023 (see link for methods).

MRV requirement to include these as planned. More broadly, that some airlines now have to monitor their non-CO_2 impacts is an important step, but they still **do not pay for them, and are not incentivised to reduce them**.

Uncertainty in non-CO_2 impacts shouldn't prevent action

Recently, Opportunity Green showed that countries are legally required to include aviation's non-CO_2 impacts in their climate plans, and research shows that mitigating non-CO_2 impacts is essential to align the sector with the goals of the Paris Agreement. Reducing aviation's CO_2 emissions, which every day lock the planet into centuries of heating, is of utmost priority. Therefore, efforts to tackle the sector's non-CO_2 impacts must be **additional to, and not weaken or replace**, efforts to reduce CO_2 emissions.

Upcoming revisions of the EU ETS are an opportunity to kickstart these efforts, creating the conditions for airlines to reduce their non-CO_2 impacts and contribute to closing the gaps in scientific understanding. For too long, the industry has used uncertainty as an excuse for inaction, and it is by now clear airlines will not act unless policymakers step up. **The EU ETS revision in 2026 is a key moment to ensure that aviation's full climate impact is regulated.**

Recommendations

The current non-CO_2 MRV requirement in the EU ETS is expanded to all arriving and departing flights from 2027 as planned.

- MRV data will be crucial for further policy development.
- Flights to or from non-European countries account for a large share of contrail impacts, and cannot be exempted from MRV requirements.

New policy is introduced to encourage airlines to reduce their non-CO_2 climate impacts, and:

- Set targets for reducing their non-CO_2 climate impacts which align with the objectives of the Paris Agreement.
- Take part in large-scale contrail avoidance efforts.
- Engage in other trials focusing on, for example, fuel hydrotreating and NO_x reduction.

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Further information

Dr James Kershaw
Scientific Officer
Opportunity Green
james.k@opportunitygreen.org