FAQ: Non-CO_2 mitigation measures in ReFuelEU and EU ETS

Why MRVs are key to tackling aviation non-CO_2 effects

October 2022

Summary

Non-CO_2 effects are estimated to account for two thirds of aviation's climate impact. These effects have been known for decades, but they have received little attention from industry and policymakers so far.

However, scientific research has made significant progress in recent years, and innovative companies are creating effective solutions to mitigate these effects. Moreover, **tackling non-CO_2 effects could be the fastest way to reduce aviation's climate impact**, as they are very short lived. The missing piece is an adequate policy framework to support the development and deployment of these solutions.

Fortunately, the the EU ETS revision and ReFuelEU initiative offer a great opportunity to start mitigating these effects by means of Monitoring, Reporting and Verification (MRV) schemes:

- EU ETS: an MRV pilot scheme to measure non-CO_2 effects for each flight, with binding policy proposals by 2026, including pricing incentives to support solutions.
- ReFuelEU: an MRV to monitor the level of aromatics, naphthalene and sulphur in jet fuel, and a European Commission report with mitigation measures and binding legislation if appropriate.

Both legislative files provide opportunities to develop mitigation pathways, which is why they are complementary and should be pursued in parallel. Guided by solid science and research, the EU can and must seize the opportunity to lead the fight against non-CO_2 effects. The proposed measures have minimal impact on airlines, and are a necessary first step to create policies that will support the development of quick and effective solutions against aviation's biggest climate issue.

1. What are non-CO_2 effects?

On top of CO_2, aircraft engines emit other gases (NO_x, SO_2 and H_2O) and particulate matter (soot). When emitted at high altitudes, these emissions affect atmospheric physical and chemical properties, resulting in an increase in climate warming through greenhouse gases creation and the formation of persistent contrail cirrus. **The consequence is a net warming, twice as big as the warming caused by aviation's CO_2 emissions**.

Persistent contrail cirrus are particularly important, as they account for more than half of aviation's effective radiative forcing (ERF). Contrails form when the water vapour in the atmosphere and engine exhaust condensates around the soot particles emitted by aircraft engines. They usually dissipate within seconds or minutes and have a negligible warming effect. However, if they are formed in very cold and humid areas of the atmosphere, known as ice supersaturated regions (ISSRs), they can develop into persistent contrail cirrus, lasting for hours and having an important warming effect .

Nevertheless, non-CO_2 effects are very short lived compared to the impact of carbon dioxide, meaning that acting against them would quickly reduce aviation's climate warming.

2. EU ETS: understanding non-CO_2 effects and setting incentives

The EU ETS is a market based measure (MBM) which incentivises the decarbonisation of the sector by putting a price tag on aviation CO_2 emissions. Although non-CO_2 effects are not part of this regulation today, the EU ETS can be used to monitor these effects per flight, like airlines monitor CO_2 emissions, and eventually set pricing incentives if required to drive the mitigation of the biggest component of aviation's climate impact.

2.1. Why is a non-CO_2 MRV pilot scheme needed in the EU ETS?

The climate impact of CO_2 emissions is independent of the location of those emissions, as they stay in the atmosphere for centuries. **Non-CO_2 effects of aviation**, on the other hand, **depend on aircraft emissions and their location**, and not all flights generate significant non-CO_2 effects. For example, an estimated 80% of contrail cirrus warming is created by less than 15% of flights.

A non-CO_2 MRV pilot scheme in the EU ETS is an opportunity to gather data quantifying aviation non-CO_2 effects per flight. It will provide a more precise estimate of EU aviation's climate impact, and the type of flights that generate the most non-CO_2 effects, including the influence of flight location, time of day, season or weather conditions. By better understanding the problem, European regulators will then have the opportunity to develop policies to incentivise solutions such as avoidance of ISSRs, or replacement of current jet fuel with SAF or hydrotreated fuels.

Having an MRV in the EU ETS would also provide a common framework to calculate non-CO_2 effects, avoiding the risk of multiple individual initiatives running in parallel with different methods and results.

2.2. What data needs to be monitored, and what is the impact on operators?

Depending on the models used, the MRV scheme may require, among others, the following data:

- Aircraft trajectories: 3D position (longitude, latitude, altitude) or 4D position (3D position + time)
- Fuel flow: amount of fuel burnt at each stage of the flight
- Ambient temperature: retrieved from aircraft sensors
- Ambient humidity and aircraft mass (optional)

The impact on aircraft operators is minimal, as the above data is already monitored by aircraft systems, and gathered by airlines during regular operations. The MRV pilot scheme would only require feeding this data to a model, and reporting the data and the model results to verifying authorities, something which is already done for CO_2 emissions in EU ETS. An MRV pilot scheme has been trialled by the DLR in real aircraft operations, proving the feasibility of such a scheme.

The non-CO_2 model should be provided by the European Commission, and could be based on some of the models which currently exist. These models quantify the climate impact of non-CO_2 effects based on the reported aircraft data, and on data integrated in the model, such as engine emissions, and either climate data (simpler models which provide good average results) or weather data (accurate models for each individual flight, more complex).

INFO BOX: example of a non-CO_2 MRV pilot scheme step by step

1. Aircraft operators monitor the required set of aircraft data.
2. Aircraft data is fed into the model, which performs the following steps:
    a. Calculates engine emissions at each stage of the flight based on the reported data.
    b. Combines the emissions results with the climate/weather data, which provides the average/actual atmospheric conditions at each point of the flight route.
    c. Based on the interaction between the emissions and atmospheric conditions, the model calculates the amount and impact of NO_x emissions and the likelihood of persistent contrail cirrus formation for each point of the flight.
    d. The model then sums the results at each point of the trajectory to calculate the total climate impact of each flight, measured in tonnes of CO_2 equivalent (t CO_2e).
3. The aircraft data and the calculated climate impact of non-CO_2 effects are reported to verifying authorities, who also have the same model and can verify the results if needed.

2.3. How can non-CO_2 effects be priced?

The primary goal of the non-CO_2 MRV pilot scheme is to test how non-CO_2 effects can be monitored and quantified in daily aircraft operations, to improve our understanding of these effects, and to explore the best policy pathways to mitigate them. **Pricing non-CO_2 effects in EU ETS would provide a really strong incentive to develop and deploy the solutions to mitigate these effects.** Solutions exist already, such as smart flight planning tools to reduce non-CO_2 effects and to avoid contrail formation. The right policy support or market incentives, such as a phased-in non-CO_2 pricing, would allow them to quickly scale up.

However, pricing non-CO_2 effects under the EU ETS might not be the only policy option, and a combination of policy and operational measures may be envisaged. For this reason, **we recommend that the European regulators follow the non-CO_2 MRV pilot scheme with a report by 2026** that includes binding policy proposals to accelerate the use of mitigation solutions.

3. ReFuelEU: acting on fuel composition

The ReFuelEU regulation intends to reduce the climate impact of aviation, primarily by mandating the use of sustainable aviation fuels (SAFs). But modifying the fuel composition of current fossil jet fuel can also have a significant positive impact on non-CO_2 effects.

3.1. Why is it important to tackle non-CO_2 effects in ReFuelEU?

Persistent contrail cirrus are the biggest driver of aviation-caused warming. They form when water vapour condensates around soot particles emitted by aircraft in the upper atmosphere, especially in ISSRs. Scientific research shows that **reducing soot by 80% can cut contrail cirrus warming by 50%**. Soot emissions are linked to the concentration of some hydrocarbon molecules present in fossil jet fuels (aromatics and naphthalene), and to the amount of sulphur. **Reducing the content of aromatics, naphthalene and sulphur in jet fuel would therefore reduce the warming effects of contrail cirrus**.

Fossil jet fuel composition varies significantly from batch to batch, with typical concentrations ranging from 12 to 25% for aromatic compounds, 1 to 3% for naphthalene and 300 to 600 ppm for sulphur.

An MRV in ReFuelEU is a necessary first step to reduce non-CO_2 effects through regulating jet fuel quality, as it would provide the current composition of the jet fuel supplied to European aircraft. This would allow European regulators to adopt informed binding legislation to reduce the level of aromatics, naphthalene and sulphur, which would lower soot formation and mitigate contrail warming.

3.2. How would the fuel composition be reported?

Jet fuel suppliers already track the composition of jet fuel, including the level of aromatics, naphthalene and sulphur of every single batch of fuel supplied. The MRV would simply require them to share this information with the European Union Aviation Safety Agency (EASA).

3.3. How can we optimise jet fuel composition?

The reduction of aromatics, naphthalene and sulphur in fossil jet fuel can be achieved through hydrotreatment, a set of refining processes that use hydrogen and a catalyst to change the chemical composition of hydrocarbons in fossil fuels. This process is well-known by the oil refining industry, and has been used for decades to produce ultra-low sulphur diesel and gasoline for the road transport sector.

Sustainable Aviation Fuels (SAFs) contain no or very low levels of aromatics, naphthalene and sulphur, due to the feedstocks they are made from and their production processes. Promoting SAF uptake is a key measure to reduce both CO_2 and non-CO_2 emissions, but SAF production the scale-up will take time, making this a mid/long-term solution to non-CO_2 effects. The bulk of aviation jet fuel will continue to be fossil in the foreseeable future - more than 50% by 2040 as per the ReFuelEU proposed targets. Acting on the composition of fossil jet fuel is therefore essential to mitigate non-CO_2 effects in the short term.

Hydrotreated jet fuel can bring significant climate benefits with no compromise on safety. Current aircraft can safely fly with Jet A fuel containing only 8% aromatics and no naphthalene or sulphur, which leaves a lot of room for the reduction of those components. Aircraft and engine manufacturers are also working to certify the use of jet fuel with no aromatics in the coming years.

3.4. Are there any other benefits from jet fuel optimisation?

By reducing particulate matter emissions, hydrotreated jet fuel can also create significant benefits to local air quality, with a positive health impact on the population living around airports.

Moreover, hydrotreated jet fuel has a higher energy density, which could reduce fuel consumption and subsequent carbon emissions by approximately 1%, and may even reduce engine maintenance costs due to cleaner burning, bringing important operational benefits to aircraft operators as well.

3.5. How much would jet fuel optimisation cost?

The estimated costs are less than 0.05€/liter of jet fuel. This is a very reduced cost when considering the positive effects on climate - cutting contrail warming by up to 50% - and the associated benefits on health of the population living near airports, and on aircraft operators.

4. Policy recommendations

T&E recommends the following policy measures proposed by the European Parliament in EU ETS and ReFuelEU:

- EU ETS: a non-CO_2 MRV pilot scheme, followed by a report in 2026 to analyse the results and to provide binding policy proposals.
- ReFuelEU: an MRV to monitor the level of aromatics, naphthalene and sulphur in jet fuel, followed by a report with possible measures to optimise those levels and with binding legislation if appropriate.

Further information

Carlos López de la Osa
Aviation Technical Manager
Transport & Environment
carlos.lopez@transportenvironment.org
Mobile: +34 626053843