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REPORT FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT AND THE COUNCIL

Updated analysis of the non-CO2 climate impacts of aviation and potential policy measures pursuant to EU Emissions Trading System Directive Article 30(4)

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UPDATED ANALYSIS OF THE NON-CO_2 CLIMATE IMPACTS OF AVIATION AND POTENTIAL POLICY MEASURES PURSUANT TO EU EMISSIONS TRADING SYSTEM DIRECTIVE ARTICLE 30(4)

1. Introduction

As part of the 2017-revision of the EU Emissions Trading System (ETS) regarding aviation, the co-legislators tasked the European Commission with presenting "an updated analysis of the non-CO_2 effects of aviation, accompanied, where appropriate, by a proposal on how best to address those effects", as per Article 30(4) of Directive 2003/87/EC.

Previous analyses date back to the 2006 Impact Assessment for the inclusion of aviation in the EU ETS that examined the possibility of regulating oxides of nitrogen (NOx),[1] and the 2008 study 'Lower NOx at Higher Altitudes: Policies to Reduce the Climate Impact of Aviation NOx Emission'.[2] At the time of those analyses, the scientific understanding was not considered sufficiently mature to propose policies to address these impacts. Instead, since 2012, the EU ETS as the cornerstone of the EU's climate policy regulates solely carbon dioxide (CO_2) emissions from covered flights, which, in contrast to non-CO_2 impacts, directly correlate with the amount of fuel burned.

To fulfil the requirement of Article 30(4) of the EU ETS Directive, a report was commissioned by the European Commission to the European Union Aviation Safety Agency (EASA). The report captures the much-evolved scientific understanding, presenting an updated analysis of the main climate impacts associated with air traffic, besides CO_2 emissions. EASA conducted the work through a project team comprising renowned experts in this field from the EU, Norway and UK, covering the whole spectrum of different schools of thought in the climate science domain. This allowed for open-minded discussions and the consideration of diverging opinions in the analysis of all issues identified. Combined with the validation of this work through two peer reviews, this ensured the scientific rigour of the provided analyses.

The following guiding research questions structured the work of the experts:

- What is the most recent knowledge on the climate change effects of non-CO_2 emissions from aviation activities?
- What factors/variables have had an impact on these effects - e.g. technology/design, operations, fuel, market-based measures? What is the level of that impact? Do these factors/variables exhibit trade-offs or interdependencies between different impacts?
- What research has been undertaken on potential policy action to reduce non-CO_2 climate impacts? What are the pros and cons of policy options in terms of implementation? What knowledge gaps still exist?

The non-CO_2 impacts assessed by the experts arise namely from emissions by aircraft of oxides of nitrogen (NOx), soot particles, oxidised sulphur species, and water vapour. Their net impact is a warming effect on the climate, although there are a number of individual

[1] https://ec.europa.eu/clima/sites/clima/files/transport/aviation/docs/sec_2006_1684_en.pdf

[2] https://ec.europa.eu/transport/sites/transport/files/modes/air/studies/doc/environment/oct_2008_nox_final_report.pdf

warming and cooling effects from the respective aviation non-CO_2 emissions, with trade–offs and uncertainties of different degrees.

The authors note that the scientific understanding on the climate change effects of non-CO_2 emissions from aviation activities has advanced over the last ten years. With regard to these impacts, and how to assess them in terms of CO_2-equivalent emissions metrics, several uncertainties remain and new ones have emerged. The report identifies and evaluates a range of policy options as well as research areas to be tackled to address these uncertainties.

2. Summary of the report's findings on policies

The report acknowledges that there are already a number of measures in place that also contribute to reducing the climate impacts of aviation non-CO_2 emissions such as EASA environmental certification standards for aircraft engine emissions of NOx and non-volatile Particulate Matter (nvPM). Reductions in fuel burn, and thereby CO_2 emissions, from improvements in air traffic management through the Single European Sky will also generally reduce non-CO_2 emissions.

Possible additional policy options to address non-CO_2 climate impacts from aviation assessed in the report are divided into three categories: financial/market-related, fuel, and air traffic management (ATM), with two options under each of these. In principle, the options could co-exist with one another.

The two financial measures analysed consist in a **monetary charge levied on aircraft NOx emissions** on one side and/or the **inclusion of such emissions under the EU ETS** on the other side. These would further incentivise manufacturers and airlines to reduce these emissions and need to take account of the associated trade-offs. Outstanding research issues towards making any such policies implementable include the need to better understand the potential net cooling effect from aircraft NOx emissions under certain future scenarios of declining emissions of tropospheric ozone precursors from surface (non-aircraft) sources; the need for an accurate, internationally recognised methodology for estimating cruise NOx emissions; the need for an appropriate CO_2-equivalent emissions metric and time horizon for NOx emissions, taking into account the trade-off between NO_X and CO_2 emissions in engine design; as well as identifying an appropriate level of a charge. Given these outstanding research issues, the report estimates that these financial measures could potentially be implemented in the mid-term, i.e. in 5 to 8 years.

The fuel-related measures comprise the **reduction of *aromatics*** within fuel (leading to cleaner fuel burn and reduced nvPM emissions) and the **mandatory use of Sustainable Aviation Fuels** (SAF). Both measures target emissions of soot particulates and contrail cirrus clouds. Reducing aromatics content would require fuel producers to adapt their production processes and a system to monitor the aromatics content of fuels. Given a set of research issues that would need to be addressed according to the experts and the preference for an international standard, this measure could potentially be introduced in the mid- (i.e. 5 to 8 years) to long-term (i.e. 8+ years). The mandatory use of SAFs could be implemented through an EU blending mandate specifying that a certain gradually increasing percentage of the total jet fuel sold over a set time period would have to be SAF. If well designed, this should lead to simultaneous reductions in nvPM and sulphur emissions (though not NOx

emissions) and CO_2 emissions. The experts consider that this measure could potentially be implemented in the short- (i.e. 2 to 5 years) to mid-term (i.e. 5 to 8 years).

The measures in the ATM category are **avoidance of ice-supersaturated areas** and a **"climate charge".** While optimizing the flight trajectory to avoid ice-supersaturated areas and other regions considered climate-sensitive, would reduce the formation of contrail-cirrus clouds, a climate charge would address all non-CO_2 effects (NOx, water vapour, soot, sulphates, contrails).[3] As a series of research issues that would first need to be addressed, the measure to avoid ice-supersaturated areas could potentially be introduced in the midterm, i.e. 5 to 8 years, according to the experts. Regarding a climate charge, the experts deem that given the broader nature of the measure and the associated "significant" research needed, it could potentially be implemented in the long-term, i.e. 8+ years.

3. Towards policies targeting aviation's full climate impacts

The significance of non-CO_2 climate impacts from aviation activities, previously estimated to be at least as important in total as those of CO_2 alone is fully confirmed by the report. This results in a need to consider how to best to address them further to contribute to the EU's climate objectives and the Paris Agreement, complementary to climate action already being taken. This would allow moving towards policies targeting aviation's full climate impacts. This would also result in co-benefits regarding local air quality.

However, the complexity of non-CO_2 climate impacts relative to CO_2 ones and the trade-offs between various impacts, poses a challenge to the policy measures analysed in the report and summarised above. This report is an important step towards better knowledge, both on the science and on policy measures and the Commission will further examine the measures suggested by the experts, each with its associated advantages and drawbacks. The specific issues identified in the report need to be addressed in order to take these potential measures forward at EU level. Without necessarily being exhaustive, three main dimensions for further work could be envisaged:

First, the scientific consensus indicates that – from measurements at ground and altitude – the use of sustainable aviation fuels – be it advanced biofuels or power-to-liquid fuels – reduce soot particulate emissions. The ReFuelEU Aviation initiative, already announced under the European Green Deal, aims to provide climate benefits through both lower life-cycle CO_2 emissions and lower nvPM emissions. In addition, Commission services could further explore the possibility to make the current global standard for maximum aromatics content in aviation fuels more stringent.

Secondly, there is a clear need for additional research, to increase knowledge and certainty of the various non-CO_2 impacts and trade-offs between them. This requires measuring emissions at the different stages of flights and related to different types of fuels. Related and of crucial importance are accurate factors that compare the climate change impact of non-CO_2 emissions to CO_2 emissions, due to the different timescales on which these pollutants operate. Further research on metrics and time horizons could be used to assess the impact of potential

[3] The concept of a climate charge is to levy a charge on the full climate impact of each individual flight (separate from the EU ETS). This makes it the measure with the broadest coverage.

policy measures. Horizon Europe provides a suitable platform at EU level for supporting such research.

Thirdly, increasing the efficiency of operational measures, in particular Air Traffic Management is key and needs European coordination. For instance, a potential first step towards full optimisation of flight profiles for lower climate impacts could focus on ways to avoid ice-supersaturated areas and the formation of persistent contrails over the Atlantic airspace, in order to complement the work carried out since 2013 in this area.[4] An enhanced capability to predict accurately the formation of persistent contrails would be needed to support the implementation of this policy option.

In conclusion, the Commission takes note of the findings of the report consolidating the state of the art of the climate science on the subject, as well as identifying potential measures to address these. The Commission commends the enclosed EASA report as an updated analysis of the non-CO_2 effects of aviation under Article 30(4) of Directive 2003/87/EC, and will further examine the measures suggested therein.

[4] See, for instance, the project ATM4E at: https://www.atm4e.eu