

# Science for Environment Policy

## How best to address aviation's full climate impact?

**International regulation does not address non-CO<sub>2</sub> emissions from aviation, despite their climate-warming effects.** This study reports the findings of the AviClim research project, which investigated the feasibility of including CO<sub>2</sub> and non-CO<sub>2</sub> species in international protocols. Of several trading scenarios assessed, the authors found that a global emissions trading scheme for both kinds of emissions would be desirable in both environmental and economic terms.

**Aviation is a rapidly growing source of greenhouse gas (GHG) emissions.** In addition to the long-lasting effects on climate caused by CO<sub>2</sub>, aviation generates other pollutants, including water vapour and nitrogen oxides (NO<sub>x</sub> = NO and NO<sub>2</sub>), which have more temporary yet still serious effects on climate. NO<sub>x</sub> is a key air pollutant which has a net warming effect on the atmosphere, and water vapour generates high altitude clouds which also warm the atmosphere.

Although aviation's CO<sub>2</sub> emissions are regulated in several countries, the majority of its non-CO<sub>2</sub> emissions with [climate](#) effects are not. The EU [Emissions Trading System](#) currently covers emissions from all flights between European Economic Area (EEA) airports. Figures show emission reductions of around 32 million tonnes in 2013 and in 2014<sup>1</sup>. Aviation is also covered in the emission trading systems of South Korea, New Zealand and Shanghai.

To support the development of international protocols that consider aviation's full impact on climate, the Aviation in International Protocols for Climate Protection (AviClim) research project was initiated. The project focused on market-based measures, which include emissions trading schemes and emission-related charges and taxes and are a cost-effective approach to controlling emissions.

To understand how climate impacts could best be regulated under different conditions, the researchers designed four different geopolitical scenarios with differing levels of international support for climate protecting measures. The first scenario 'Greater EU' represents current geopolitical support for an emissions trading scheme that limits CO<sub>2</sub> emissions. The second scenario 'Great Aviation Countries' assumes the key actors in aviation support a market-based measure to address emissions, while 'Annex-I Countries' hypothesises that the countries that supported the Kyoto protocol (plus Brazil, China, India and Russia) would introduce a market-based measure. Finally, in the 'World' scenario, global support for the climate protecting measure is assumed. This would be the ideal solution from an environmental perspective, though historical negotiations indicate that a solution of this kind may be difficult to reach.

The CO<sub>2</sub> emissions of aviation between 2010 and 2030, differentiated by the different geopolitical scenarios and years, were calculated using the 'VarMission' tool created by the [German Aerospace Center](#) (DLR).

Every scenario was compared with a 'business-as-usual' case, which assumes the maintenance of existing climate policies. The scenarios were also combined with three different market-based measures: an emissions trading scheme for all climate-relevant emissions; a climate tax on emissions; and a NO<sub>x</sub> emission airline charge combined with a CO<sub>2</sub> trading scheme and operational measures<sup>2</sup>.

*Continued on next page.*



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1. Report on the functioning of the European Carbon Market, COM(2015)576.

2. Operational measures assume that half of all flights operated between 30°N and 60°N and at an altitude between 28 000 and 38 000 feet will fly 2 000 feet lower to reduce contrails (water vapour trails).

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*(continued)*

The environmental and economic impacts of each combination were assessed by a model. The model analysed three different 'price paths', which describe the potential costs of complying with the market-based measures, based on the prices (per tonne) for CO<sub>2</sub> equivalents emitted on flights under the different measures. Costs for complying with the measures were calculated by multiplying the amount of CO<sub>2</sub> equivalent (subject to the regulation scheme) by assumed prices for CO<sub>2</sub> equivalent, differentiated by these price paths.

These CO<sub>2</sub> charges would lead to a production cost increase for the airlines. Assuming airlines try to pass on the full cost increase to customers, prices for air services will increase. To assess how demand for air services will react to this price hike, the researchers assessed three 'demand reaction cases' (created using empirical data on the price elasticities of demand for air services). The most likely response is a reduction of demand, slightly sub-proportional to the price increase by the airlines.

Overall, the results suggest that a global emissions trading scheme for the regulation of both CO<sub>2</sub> and non-CO<sub>2</sub> emissions would be desirable both environmentally and economically. The costs and effects on competition and employment are moderate, while the environmental benefits are considerable. For example, under the 'High Price Path' (a price increase from US \$10 per tonne of CO<sub>2</sub> equivalents in 2010 to \$80 tCO<sub>2</sub>eq in 2030), the temperature change caused by aviation could be reduced by up to 70% in 2100, compared to business-as-usual. As the proposed trading scheme would include NO<sub>x</sub> emissions (which are released into the atmosphere during landing and take-off), it would have air quality benefits, as well as being the most effective for climate change.

However, a more realistic solution, say the authors, is represented by the 'Great Aviation Countries' and 'Annex-I Countries' scenarios, which generated environmental and climate benefits almost equivalent to a global solution (over 90% of global flights were regulated by a climate protecting measure) but may be easier to achieve.

This study may facilitate progress towards a measure that addresses the full climate impacts of aviation. The [International Civil Aviation Organization](#) (ICAO) is currently discussing offsetting schemes for CO<sub>2</sub> emissions, to be implemented by 2020. If ICAO is successful, the results of this research project could be used to expand the CO<sub>2</sub> offsetting scheme to other climate relevant species.



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