CP/01

ABC IMPACTS - Results

Aviation and the Belgian Climate Policy : Analysis of Integration Options and Impacts

DURATION OF THE PROJECT
15/12/2005 - 31/07/2010

BUDGET
1.080.089€

KEYWORDS
Aviation ; Climate impacts ; Contrails ; Aviation induced cloudiness (AIC) ; Climate policy ; Mitigation ; Regional climate model ; Non-CO_2 climate effects.

CONTEXT

Since the publication of the Intergovernmental Panel on Climate Change (IPCC) Special Report on Aviation and the Global Atmosphere (SRAGA, 1999), the international scientific community has become aware of the importance of the impacts of emissions from the aviation sector on global warming. This report confirms that in addition to CO_2, condensation trails (contrails), induced cirrus cloud formation and NO_x emissions contribute significantly to climate change (IPCC, 1999; Sausen et al., 2005; IPCC, 2007; Lee et al., 2009). Yet, emissions from international air transport are not targeted by the Kyoto Protocol commitments but part of ongoing international negotiations at the United Nations Framework Convention on Climate Change (UNFCCC) is dedicated to accounting for emissions from international air and maritime transport (UNFCCC, 2009).

In November 2008, the European Union has officially published its Directive to include the aviation sector in the EU-ETS (EU, 2008). ICAO had already expressed its support to voluntary agreements and to the integration of the aviation sector in existing emission markets, but so far ICAO seems to be reluctant to accept the application of the EU Directive to non-EU carriers without bilateral agreements (ICAO, 2007) and IATA (International Air Transport Association) has intended a legal action at the European Court of Justice against it.

The current negotiations on the review of the existing EU-ETS at the European level and those on the post-2012 scheme and commitments at the UNFCCC level illustrate how climate impacts of the aviation sector have become a high-priority issue but also how complicated and interdependent policy options to include aviation in climate policy are.

Concerning scientific progress related to climate impacts of non-CO_2 emissions from the aviation sector, major scientific advances have been included in IPCC's Fourth Assessment Report (IPCC, 2007), resulting in particular from European projects such as TRADEOFF and QUANTIFY. Both projects estimates of the impact of NO_x and contrails have been lowered but the impact of cirrus cloud formation seems to be greater than was previously thought although there is still a large uncertainty. Overall, the total climate impact of aviation is dominated by the non-CO_2 impacts, particularly in the short term or in specific areas such as Belgium (cf. air traffic density).

Different options may thus be considered for the inclusion of aviation into climate policy. The analysis of these options is of particular interest for Belgium, given the value added multiplier effect of airport related activities in the local economy (Kupfer and Lagneaux, 2009), but also the impact of take-off noise and the intensity of airborne traffic above the Belgian territory with the related regional climate impacts.

OBJECTIVES

In this context, the *ABC impacts* project analyses the different climate policy options (as well as their consequences) and provides a wide study of the technical, economic and physico-chemical characteristics of the aviation sector, that are linked to climate change.

This research project serves two main objectives: 1- to inform political decision-makers about the environmental, political and socio-economic implications for Belgium of integrating the international aviation transport sector into climate policy; 2- to help with the preparation and assessment of Belgian climate policy, on the context of the negotiations concerning the expansion of the European Emission Trading Scheme (EU-ETS) and the post-2012 phase at the UNFCCC level.

The ABC Impacts project has been split into two phases. The report explaining more in details the work carried out during the first phase is available on Belspo's website: http://www.belspo.fgov.be/belspo/ssdh/science/Reports/ABC_IMPACT_FinalReport.def.pdf.

The whole project covers the evolution of the climate policy and the analysis of policy options to tackle aviation total climate impacts, the creation of an emission database for Belgium and a new emission calculator tool (Aviactor), a better understanding of non-CO2 aviation climate impacts and metrics through the integration of a specific module in the general climate model JCM5 and the use of regional climate modelling, a multi-criteria analysis (MCA) to synthesize several characteristics of selected policy options, as well as some considerations about total climate impacts from the international maritime transport.

CONCLUSIONS

Technical and management potential emission reductions

Through important innovative adaptations, the aviation sector succeeded in implementing significant reductions of the emissions (CO_2, H_2O, Soot, CO, SO_x, NO_x, etc.) and fuel consumption of individual aircrafts. In the future, several evolutions (implementation of synthetic fuels or agro-fuels, aircraft design and engine improvements, etc.) as well as potentially some radical changes in the long-term perspectives (like the use of hydrogen as a fuel for aircraft) can be expected. Moreover, some specific management changes (improved air traffic flow management, Reduced Vertical Separation Minimum, Continuous Descent Approach, etc.) might reduce the impact of aviation on climate by more than 10% compared to the BAU scenario without the need for new technologies to be implemented on board.

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However, these evolutions alone do not appear sufficient to reduce climate impacts from the aviation sector enough to be consistent with scenarios avoiding global warming of more than 2°C above pre-industrialisation levels. These efficiency improvements (fuel consumption decreases by 0,5%-2% per year) are in fact smaller than the long-term high growth rate of the sector (average of 6,4% per year between 1991 and 2005 and growth in demand likely to recover to rates similar to the pre-economic crisis long-term forecast). Therefore, complementary climate policy measures are necessary to mitigate future aviation climate impacting emissions.

Modelling aviation climate impacts

Aviation impacts on climate may be much more significant at the local/regional scale than on global average due to short term non-CO2 effects and concentration of the air traffic above specific regions of the globe. As an illustration, the radiative forcing due to aviation is estimated to 78 mW/m2 on global average (for the year 2005), to 400 mW/m2 over Europe (in 2002), and to 1 W/m2 over Belgium. The largest impact of aviation on climate, outside that from CO2 in the long term, is likely to be that from induced cirrus clouds.

Test simulations were first made by assuming a homogeneous spatial distribution of flights, providing results that appear coherent with other studies. The potential AIC cover is larger in winter than in summer, resulting from the colder temperatures and the more frequent occurrence of super-saturation in winter. A simulation has been done with an actual flight distribution over Europe, based on the AERO2k database (Eyers et al., 2004). The initial comparison with satellite data is promising. Other satellite data are used for validating the temperature and humidity variables of the model prior and suggest a very good agreement..

Non-CO_2 aviation climate impacts

Our research confirms that impacts on climate from causes other than carbon dioxide, and specifically those from aircraft induced cloudiness, are non-negligible and likely to be substantial. Therefore, these need to be taken into account in mitigation objectives and related legislation, which is currently not the case. We included aviation impacts on climate and reference future scenarios in an interactive global climate model, and made it available on the internet (www.climate.be/jcm), enabling users to experiment with hypotheses regarding scenarios, uncertain climate parameters, and choices such as time-horizon. Our own analysis with this tool shows that to achieve a relatively ambitious mitigation target (such as limiting temperature increase compared to pre-industrial times to 2°C), it is very likely that the net emissions and climate impact from aviation will need to be much lower than in BAU scenarios. In the absence of efforts in the aviation sector, other sectors would need to reduce their emissions a lot more.

Non-CO2 effects must also be taken into account to reflect the effective climate impact of aviation transport when comparing or adding it to the impacts from other sectors, such as in the EU-ETS. Failing to do so would result in emission units from aviation that would represent a higher effect on climate than units from another sector, so that trading emission reductions may result in reduced climate benefit. This aspect should also be taken into account when trying to inform the general public about aviation and climate change. Therefore, it is essential to include it in offset calculators for example.

Metrics of impact on climate and inclusion of aviation in cap-and-trade systems

The difficulties associated with attributing a weight to non-CO_2 impact from aviation, i.e. defining a metric for these effects, may have given the impression that uncertainties are so large that no reliable numbers can be provided to policymakers. However, we conclude that current knowledge is sufficient to provide estimates of aviation impacts on climate in spite of remaining uncertainties, with the caveat that metrics of non-CO_2 impacts have a fundamental limitation that will probably always require a compromise: a choice regarding the relative weight of short and long term effects (from days to centuries) must be done. In line with the recent expert meeting of the IPCC on metrics (IPCC, 2009), we currently recommend the use of Greenhouse Warming Potentials (GWP) to express the climate impacts of aviation in terms of CO_2 amounts having a comparable effect on climate, with a 100-years time horizon to match the choice made in the Kyoto Protocol.

Once GWP is selected as a climate impact metric, a remaining issue is that the uncertainty is still significant (roughly a factor of 2 or 3 between the low and high end of the 90% confidence interval). However, in the specific case of a trading system, we suggest that there is a rationale to simply select the best-guess value, as selecting the high estimate would not represent a more cautious approach – it would be more likely to overestimate the “climate value” of reduction units in the aviation sector as compared to other sectors. Based on the current literature, the simplest solution that we may advise is to use a multiplier of CO_2 emissions (based on GWP) equal to or slightly above 2 (cf. conclusions of the ABC Impacts workshop on “Aviation and offset programmes”). Similar values have been proposed for a long time, and although this should remain revisable as research progresses, it is now more supported by research than it was before.

However, a fixed value for all flights is not fully satisfying, as the actual impact may differ for each flight and specific measures (e.g. flight management to mitigate persistent contrails) may reduce the non-CO_2 impacts but slightly increase fuel consumption (and thus CO_2 emissions). We discussed variable multipliers and similar measures in a note to policymakers (Ferrone and Marbaix, 2009). A complementary approach may be to have specific legislation for certain non-CO_2 impacts (as the EU is planning for NO_x). However, this does not eliminate the issue of trade-offs that may exist (e.g. techniques that reduce non-CO_2 impacts at the expense of more CO_2 emissions: in some cases, regulation outside the CO_2 cap-and-trade may also result in more CO_2 emissions).

Belgium and aviation climate impacts

The Belgian aviation market has a very specific position within Europe due to its geographical situation; in the middle of the so-called FLAP area which is delimited by four of the five main airport areas of Europe: Frankfurt, London, Amsterdam and Paris. This also implies that the number of overflights is already considerable through Belgian airspace and could become even more important due to the sector growth and potential route adaptations (according to Statfor-Eurocontrol, the adoption of shorter routes could increase overflights above the Belgian territory by 10%).

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The impacts of the Belgian aviation sector on global climate change is relatively small compared to other sectors or that of other countries, while regional climate impacts due to contrails, cirrus formation and change in the ozone concentration could have a large influence on the country because of the concentration of flights over the Belgian territory. A focus for Belgian policy makers could be to reduce the impacts from transit aviation, especially via operational measures targeting non-CO_2 effects.

CONTRIBUTION OF THE PROJECT TO A SUSTAINABLE DEVELOPMENT POLICY

The ABC Impacts project scientific contributions supporting a sustainable development policy have taken multiple forms.
Concerning Belgian stakeholders and more specifically Belgian administrations, researchers participated actively as experts to the meetings of the "Ad hoc committee on bunker fuels – aviation and EU-ETS" of the CCIEP (national Coordination Committee on International Environmental Policies) – Greenhouse Effect working group, where the Belgian as well as the Flemish point of view concerning the inclusion of the aviation into the EU-ETS was prepared.
The research consortium organised also thematic workshops on "Aviation and offset programmes", "Non-CO_2 aviation climate impacts" and "Aviation scenarios and climate impacts" to which Belgian stakeholders as well as representatives from international organisations or research centres took part. Several specific co-operation actions followed these meetings as well as dedicated notes that were presented to Belgian and ICAO representatives, and discussed in more detail with members of the EU Parliament and Commission. ABC Impacts researchers have frequently interacted with the IPCC, in particular through the review of the AR4 and participation to the Plenaries of the WGI, WGII, and IPCC in 2007, contributing to improve the wording on aircraft induced cloudiness in the summary for policy makers.

ABC Impacts researchers participated also to several round-tables and scientific popularisation actions.
The project website (www.climate.be/abci) makes an extended glossary, different synthetic documents on the issues related to aviation and climate change, project publications, interesting references and links at everyone's disposal.
Finally, in order to assess the effectiveness of the identified policy options to reduce the total aviation climate impact, it was decided to use a multi-criteria analysis (MCA). A combination of the PROMETHEE&GAIA methodology and the Analytic Hierarchy Process (AHP) was carried out. The performance of the policy groups-alternatives were evaluated in relation to several appropriate criteria. The resultant ranking of possible alternatives is not intended to categorize the best one but to recommend an appropriate platform for future policy options compromises.

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Website of the project:
http://dev.ulb.ac.be/ceese/
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