Doc 10018

Report of the Assessment of Market-based Measures

Approved by the Secretary General
and published under his authority

First Edition — 2013

International Civil Aviation Organization

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Acknowledgement

The quantitative and qualitative assessment of a global market-based measure (MBM) scheme, as contained in this report, would not have been possible without the significant levels of support and engagement of the MBM experts, nominated by States and international organizations. The ICAO Secretariat wishes to thank the experts who have shared their knowledge and devoted their time by participating in numerous meetings and conference calls and providing substantial inputs. We are truly grateful for their collective insight, which helped undertake this research on the potential global MBM scheme options for international aviation, in responding to the requests of the 37th Session of the ICAO Assembly and the ICAO Council. We believe this report will assist in decision-making and further work on MBMs towards defining global solutions for a sustainable aviation future.

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EXECUTIVE SUMMARY

Market-based measures (MBMs), as a potential means for limiting or reducing CO_2 emissions from international aviation, have been under consideration by the International Civil Aviation Organization (ICAO) for the last decade. With a view to better understanding such measures, ICAO has undertaken a number of studies since 2001 which resulted in the preparation of guidance material on MBMs. Under the policy framework adopted by the 37th Session of the Assembly in 2010, as contained in Assembly Resolution A37-19: *Consolidated statement of continuing ICAO policies and practices related to environmental protection — Climate change*, MBMs became a part of a basket of measures that States can use to address CO_2 emissions from international aviation, and further work in this area was requested.

In particular, the Assembly requested "the Council, with the support of member States and international organizations, to continue to explore the feasibility of a global MBM scheme by undertaking further studies on the technical aspects, environmental benefits, economic impacts and the modalities of such a scheme, taking into account the outcome of the negotiations under the UNFCCC and other international developments, as appropriate, and report the progress for consideration by the 38th Session of the ICAO Assembly" (paragraph 18 of Resolution A37-19).

In early 2012, six potential options for a global MBM scheme were identified, and the criteria by which they would be evaluated were elaborated on, building upon the MBM guiding principles (Annex to A37-19). In June 2012, the ICAO Council, at its seventh meeting of the 196th Session, narrowed the MBM options to three (global mandatory offsetting, global mandatory offsetting with revenue, and global emissions trading) and requested further quantitative and qualitative assessment of these options be undertaken.

This report provides an overview of the results of the quantitative and qualitative assessment of the options for a global MBM scheme, undertaken during 2012 and 2013 by the ICAO Secretariat with the support of MBM experts nominated by Member States and international organizations.

Quantitative assessment

The quantitative assessment in 2012, which is referred to as the "core study" in this report, was supplemented by a quantitative assessment in 2013 (referred to as the "supplementary study"). The supplementary study used the updated traffic forecasts and emissions trends prepared in 2013 by the ICAO Council's Committee on Aviation Environmental Protection (CAEP) to further assess the global impacts of MBMs on international aviation.

In the core study undertaken in 2012, the cost of introducing an MBM scheme was found to be relatively small. Under a scenario of keeping net carbon emissions from 2020 at the same level, MBMs would need to reduce or offset 464 Mt of CO_2 in 2036, as a result of the emissions increase from 2020 to 2036. In the case where 100 per cent of the costs of an MBM scheme would be passed on to customers through increases in the price of tickets, the quantitative assessment showed that:

— *Traffic impact:* While an MBM scheme provides the environmental benefit of offsetting 464 Mt of CO_2 in 2036, international aviation traffic under a scheme would grow 107 per cent from 2020 to 2036; however, without the scheme the traffic level would have grown 110 per cent;

— *Profit impact:* Profits for the international aviation sector in 2036 would be $33.3 billion[1] under the scenario with an MBM scheme which would be $0.4 billion lower than the profit level without the scheme; and

— *Cost impact:* The cost of an MBM scheme in 2036 would be approximately $10 per seat for a flight of 10 000 to 12 000 kilometres and $1.5 per seat on a flight of 900 to 1 900 kilometres.

The supplementary study in 2013 confirmed the results of the core study: an MBM scheme could achieve the environmental target of stabilizing CO_2 emissions at a relatively low economic cost. In the supplementary study, the traffic level in 2036 under an MBM scheme would be up to 1 per cent lower than the traffic level without the scheme; and the cost of an MBM scheme as a proportion of total revenue would be up to 1 per cent, in the worst-case scenario studied.

The core study in 2012 also assessed the impacts of MBMs, taking into account the additional evaluation criterion "Ability to accommodate the special circumstances and respective capabilities [SCRC] of developing countries", as requested by the Council at its 196th Session[2]. Three different approaches were used to assess impacts on developing countries: evaluation of six geographic regions; differences between least developed countries (LDCs) and non-LDCs; and using two parameters defining level of development: per capita income and international aviation activity in terms of available seat kilometre (ASK) by departing flights from individual countries.

The assessment demonstrated that the differences between MBM impacts by regions or groups of States were marginal. For example, the MBM impacts on traffic demand in the six regions, were generally consistent with the global average of a 1.2 per cent reduction. The change in operating result (profit) brought about by an MBM scheme was relatively consistent between regions, varying from 1.0 per cent to 1.3 per cent; this was generally consistent with the global average of 1.1 per cent. The comparison of LDCs and non-LDCs showed a similar pattern to that of the six regions in terms of the consistency with the global results. However, LDCs were not as affected as non-LDCs by MBMs. Impacts on traffic levels and profits were smaller in LDCs, although reductions in CO_2 were also smaller. No differences between groups using development parameters were noted.

Qualitative assessment

The qualitative assessment focused on the design features of the three options for a global MBM scheme, by identifying and elaborating on the implications of different design choices. Any MBM scheme is designed to achieve a clear **environmental objective**, which can be established with a baseline or cap on emissions levels. The **distribution of the environmental objective** among participants establishes individual obligations, which collectively respect the environmental objective. Both Member States and aircraft operators would have important roles to play in a global MBM scheme. It will be important to distinguish between the compliance obligations placed on the **participants** of a scheme and on implementation responsibilities, such as administration and enforcement at national or international levels.

Compliance obligations could generally be tracked through a registry, which at a minimum, records the environmental objective of a scheme, the emissions of each participant, the obligation of each participant to surrender **emissions units** and the tracking of emissions units to ensure participants' obligations are respected. A robust **monitoring, reporting and verification (MRV)** system is key to any MBM scheme, as it ensures that one unit of emissions emitted and recorded in one jurisdiction is directly comparable to a unit in another jurisdiction; this also protects fair market competition and avoids market distortion.

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1. All dollar values in the core study use 2006 USD.
2. Council Decision 196/7.

The three main differences in the design features of the options for a global MBM scheme (offsetting and emissions trading) were identified: use of different emissions units; differences in the allocation of obligations to individual participants; and different accounting requirements to ensure compliance.

These design differences were translated into different administrative steps, impacting the complexity for implementing the three options. A global mandatory offsetting could be less complex since existing emissions units can be used and tracked through a simple registry. A global mandatory offsetting complemented by a revenue generation mechanism could be more complex due to the need to determine how revenue will be collected and used. A global emissions trading scheme could increase complexity and have higher upfront costs due to the need to administer specific aviation allowances. However, it should offer more flexibility for participants due to the creation of emissions units, which can be traded in the marketplace.

Feasibility of a global MBM scheme

The overall results of the qualitative and quantitative assessment of the three options for a global MBM scheme demonstrated that they were technically feasible and have the capacity to contribute to achieving ICAO's environmental goals.

GLOSSARY

AERO-MS. Aviation Emissions and evaluation of Reduction Options — Modelling System. The model was developed by the Netherlands government as a policy testing tool for quantifying the environmental and economic consequences of a wide range of measures to reduce global aircraft engine emissions, including regulatory, financial and operational measures.

APMT-Economics. Aviation Portfolio Management Tool — Economics. A software tool developed by the United States Federal Aviation Administration, in collaboration with Transport Canada and the United States National Aeronautics and Space Administration (NASA). It has been developed as a part of the Aviation Environmental Tools Suite to allow for thorough assessment of the environmental effects and impacts of aviation.

Allocation. The initial distribution of allowances to accountable entities for a compliance period. This allocation could, for example, be based on historical emissions or a performance standard and level of production; it could be made for free or through an auctioning process or both.

Allowances. An allowance is a tradable emission permit that can be used for compliance purposes in an emission trading system (ETS). Each allowance represents the emission of pollution once.

Auctioning. Method for distribution of obligations under an MBM scheme. In the context of an MBM scheme, it applies to emission trading where allowances below the cap are fully or partly auctioned rather than provided to participants for free.

Available tonne kilometres (ATK). Available (offered) capacity for passengers and cargo expressed in metric tonnes, multiplied by the distance flown.

Benchmarking. Method for distribution of obligations under an MBM scheme. It establishes a reference level based on efficiency such as emissions per unit of output, e.g. CO_2/RTK.

CAEP. Committee on Aviation Environmental Protection.

Certified emission reductions (CERs). A Kyoto Protocol unit equal to one metric tonne of CO_2 equivalent. CERs are issued for emission reductions from clean development mechanism (CDM) project activities.

CO_2. Carbon dioxide, a naturally occurring gas that is also a by-product of burning fossil fuels and biomass, and other industrial processes. Carbon dioxide is the reference gas against which the global warming potential of other greenhouse gases is measured.

Emissions unit. For the purposes of this report, the compliance instruments, otherwise referred to as “credit”, “offset credit”, “offset” or “allowance” are called emissions units. One emissions unit equals one tonne of CO_2.

Flat percentage of emissions. Method for distribution of obligations under an MBM scheme. Under this method, all participants reduce emissions by a fixed percentage of their individual totals, e.g. 15 per cent below 2013 total emissions. This approach requires percentages to be continuously calibrated to meet the environmental objective.

Grandfathering. Method for distribution of obligations under an MBM scheme, in which allowances are allocated to participants based on historical emissions.

Greenhouse gases (GHGs). The atmospheric gases responsible for causing global warming and climate change. The major GHGs are carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). Less prevalent, but very powerful GHGs are hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF6).

Market-based measures. Sometimes referred to as market instruments, MBMs provide financial incentives and disincentives to regulated entities towards desired behaviour, e.g. lowering emissions. These measures can be implemented to reduce damage to the environment.

Open emissions trading. An emissions trading system where allowances can be traded in and outside the given scheme or sector. For example, within an emissions trading scheme for aviation, participants would be allowed to buy allowances from sectors outside the aviation emissions trading scheme.

Operating costs. The operating costs in the models used for this study include labour costs, landing fees, financing costs, fuel and maintenance costs.

Revenue tonne kilometres (RTK). Utilized (sold) capacity for passengers and cargo expressed in metric tonnes, multiplied by the distance flown.

Scenario A (low aircraft technology and moderate operational improvement). In addition to including the improvements associated with the migration to the latest operational initiatives, e.g. those planned in NextGen and SESAR, this scenario includes fuel burn improvements of 0.96 per cent per annum for all aircraft entering the fleet after 2010 and prior to 2015, and 0.57 per cent per annum for all aircraft entering the fleet beginning in 2015 and prior to 2050. It also includes additional fleet-wide moderate operational improvements by region.

Scenario B (optimistic aircraft technology and operational improvement). In addition to including the improvements associated with the migration to the latest operational initiatives, e.g. those planned in NextGen and SESAR, this scenario includes an optimistic fuel burn improvement of 1.5 per cent per annum for all aircraft entering the fleet after 2010 out to 2050. It also includes additional fleet-wide independent experts' (IE) operational improvements by route group. This scenario goes beyond the improvements based on industry-based recommendations.

Surrendering. Submitting allowances for emissions by the accountable entity in order to fulfil the obligations under the emissions trading scheme.

Chapter 1

INTRODUCTION

1.1 PURPOSE OF REPORT

1.1.1 After the adoption of Assembly Resolution A37-19 "*Consolidated statement of continuing ICAO policies and practices related to environmental protection - Climate change*" [1] by the 37th Session of the Assembly in 2010, the International Civil Aviation Organization (ICAO) initiated work on tasks requested by the Assembly in order to address the effects of international aviation on climate change and continuously progress towards a sustainable aviation future.

1.1.2 In particular, the Assembly requested the ICAO Council: "with the support of member States and international organizations, to continue to explore the feasibility of a global MBM scheme by undertaking further studies on the technical aspects, environmental benefits, economic impacts and the modalities of such a scheme, taking into account the outcome of the negotiations under the UNFCCC and other international developments, as appropriate, and report the progress for consideration by the 38th Session of the ICAO Assembly".

1.1.3 This report provides an overview of the results of the quantitative and qualitative assessment related to the feasibility of a global MBM scheme, undertaken during 2012 and 2013 by the ICAO Secretariat with the support of the MBM experts nominated by Member States and international organizations. It is a technical assessment of the economic and CO_2 impacts of three options for a global MBM scheme (global mandatory offsetting, global mandatory offsetting with revenue, and global emissions trading). It also summarizes various design features for a global MBM scheme, which were qualitatively developed and assessed. It is intended to be informative and support broader policy decisions on a global MBM scheme to address mounting CO_2 emissions from international aviation.

1.1.4 The quantitative assessment used modelling tools while the qualitative assessment relied on extensive research and the knowledge and experience of MBM experts. To undertake a more detailed assessment of a global MBM scheme, greater definition of design features (e.g. participants, obligations, etc.) will be required.

1.2 BACKGROUND

1.2.1 The research into options for a global MBM scheme involving international aviation began in 2011, with an initial literature review of planned and existing MBMs, in particular those related to aviation. The primary focus of this research in 2011 was to "review the *de minimis* threshold to MBMs … taking into account specific circumstances of States and potential impacts on the aviation industry and markets, and with regard to the guiding principles listed in the Annex, by the end of 2011" as requested by the Assembly (paragraph 16 of A37-19).

1.2.2 Following the results of the *de minimis* study, the MBM experts nominated by Member States and international organizations, assisted the Secretariat in further identification of possible MBM options, as well as the elaboration of the criteria by which they would be evaluated, building upon the guiding principles adopted by the 37th Assembly (Annex to A37-19). As a result of this work, six options for a global MBM scheme were identified.

1. ICAO Assembly Resolution A37-19: Consolidated statement of continuing ICAO policies and practices related to environmental protection—Climate change (http://legacy.icao.int/env/A37_Res19_en.pdf).

1.2.3 In June 2012, the ICAO Council narrowed the MBM options to three (global mandatory offsetting; global mandatory offsetting with revenue; and global emissions trading) and further quantitative and qualitative assessment of these options was undertaken over the remainder of 2012 and in 2013.

1.2.4 The quantitative assessment was undertaken in 2012, using aviation-specific economic models. Two models accepted by ICAO's Committee on Aviation Environmental Protection (CAEP) were used in the evaluation: the Aviation Emissions and evaluation of Reduction Options — Modelling System (AERO-MS) developed in Europe; and the Aviation Portfolio Management Tool for Economics (APMT-Economics) developed in North America.

1.2.5 The quantitative assessment that was undertaken in 2012 is referred to as the "core study" in this report. A "supplementary study" was performed in 2013. It used updated CAEP traffic forecasts and emissions trends to further assess the global impacts of MBMs on international aviation. The supplementary study also used a modelling tool developed by the ICAO Secretariat in association with the MBM experts. In addition, different scenarios that account for different levels of emissions reductions from aircraft technology improvements and operational measures as well as alternative fuels were considered in the supplementary study.

Chapter 2

MARKET-BASED MEASURES OPTIONS

The three global MBM options analysed in the core study were:

1) *Global mandatory offsetting.*
2) *Global mandatory offsetting with revenue.*
3) *Global emissions training.*

2.1 GLOBAL MANDATORY OFFSETTING

2.1.1 Greenhouse gases (GHG) can be offset through the reduction, removal or avoidance of emissions. An offset “cancels out” or “neutralizes” emissions from one sector through the reduction of emissions in a different sector or location. The standard measurement used is one tonne of CO_2, or CO_2 equivalent, which in this report is referred to as an "emissions unit". Offsetting operates through the creation of emissions units, which quantify the reductions achieved. These emissions units, which would generally be created outside the international aviation sector, can be bought, sold or traded.

2.1.2 A global mandatory offsetting scheme for international aviation would require participants to acquire emissions units to offset CO_2 above an agreed target. Emissions units would need to conform to agreed eligibility criteria to ensure adequacy of emissions reductions.

2.2 GLOBAL MANDATORY OFFSETTING WITH REVENUE

2.2.1 A global mandatory offsetting complemented by a revenue generation mechanism would generally function the same way as the mandatory offsetting scheme. A key difference would be that in addition to offsetting, revenue would be generated by applying a fee to each tonne of CO_2, for instance, through a transaction fee. The revenue would be used for agreed purposes, such as climate change mitigation or providing support to developing States to reduce GHG emissions.

2.3 GLOBAL EMISSIONS TRADING

2.3.1 A global emissions trading scheme would use a cap-and-trade approach, where total international aviation emissions are capped at an agreed level for a specified compliance period. Specific aviation allowances (one allowance is equivalent to one tonne of CO_2) would be created under this scheme for all the emissions under the cap within the international aviation sector. These allowances would then be distributed for free, or auctioned, to participants using an agreed method. Revenues can be generated by auctioning aviation allowances rather than providing them to participants free of charge.

2.3.2 At the end of each compliance period, participants would need to surrender allowances, or other emissions units, equal to the emissions they generated during that period. For participants with emissions above their initial allocation, allowances can be acquired from those who reduced emissions below their allocated amount and have surplus allowances available for sale or trade. Alternatively, other emissions units, such as offset credits can be used in combination with allowances. The participants' abilities to acquire and use these credits to meet their obligations under the scheme are established in the rules of the scheme.

Chapter 3

QUANTITATIVE ASSESSMENT — GLOBAL ANALYSIS

3.1 ASSUMPTIONS AND SCENARIOS

3.1.1 In order to assess the impact of an MBM scheme, it is necessary to assume a specific environmental objective that is expected to be achieved at a future point in time. In addition, it is necessary to forecast what the aviation sector may look like in the future without the MBM scheme — the "baseline", and then assess the impact of introducing the MBM scheme. Economic modelling provides a systematic means of doing this.

3.1.2 In order to undertake economic modelling that considers future conditions, it is necessary to develop assumptions that are consistent for the whole analysis over time. To measure the impacts of MBM scenarios against a future baseline, the following key assumptions were made in both the core and supplementary studies:

— the environmental objective of an MBM scheme would be keeping net CO_2 emissions from international aviation from 2020 at the same level (carbon neutral growth from 2020);

— impacts would be assessed from 2020 to 2036;

— the future per tonne prices of CO_2 (emissions units) (2010 USD) would be $30 in 2020, $40 in 2030, $45 in 2035;[1]

— the future prices of fuel based on a crude oil per barrel (2010 USD) would be $109 in 2020, $117 in 2030 and $120 in 2035;[2]

— the costs resulting from MBMs (costs of purchasing emissions units) would be passed through to ticket prices (i.e. 100 per cent cost-pass-through);

— a sensitivity analysis was conducted, assuming that only 50 per cent of MBM scheme costs would be passed through to ticket prices;

— use of alternative fuels would be accounted as zero CO_2 emissions;

— only CO_2 emissions from international aviation are accounted for; and

— non-CO_2 impacts are not included in this assessment.

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1. International Energy Agency (IEA), World Energy Outlook 2011. To be consistent with modelling data, 2010 USD were converted to 2006 USD. Carbon prices were converted to annual prices until the year 2036.
2. International Energy Agency (IEA), World Energy Outlook 2011. To be consistent with modelling data, 2010 USD were converted to 2006 USD. Fuel prices were converted to annual prices until the year 2036.

3.1.3 For the core study undertaken in 2012, scenarios were developed for each of the three options with different levels of revenue generation, where appropriate (see Table 1).

Table 1. Core study options and scenarios

	Options		
	Global offsetting	Global offsetting with revenue	Global emissions trading scheme (ETS)
Scenarios	100% of emissions below carbon neutral growth from 2020 are free		100% free allocation of allowances below cap
		Revenue generation equivalent to those generated under ETS where 50% of allowances are auctioned	50% free allocation and 50% auctioning of allowances below cap
		Revenue generation equivalent to those generated under ETS where 100% of allowances are auctioned	100% auctioning of allowances below cap

3.1.4 Although the core study addressed these six scenarios, for the purpose of reporting the results of the quantitative assessment, a single generic scenario without revenue generation was used as a reference. In the core study, it was assumed that MBMs would account for the sector's forecasted emissions growth above the 2020 level. The forecasted emissions scenarios reflected a medium improvement for aircraft technology and operations.

3.1.5 Subsequent to the core study in 2013, the Committee on Aviation Environmental Protection (CAEP) finalized a new set of fuel burn projections based on updated traffic forecasts and aircraft retirement curves. These projections also incorporated the emissions reduction potential for a range of new aircraft technologies, operational improvements and alternative fuels between 2010 and 2050. A supplementary study undertaken in 2013 accounted for the updated projections from CAEP. Timescales precluded updating the AERO–MS and APMT–Economics models with the new traffic and fleet forecasts; therefore, it was not possible to use these models for the supplementary study in 2013. An alternative spreadsheet-based model was developed within ICAO using similar assumptions (e.g. carbon price, cost-pass-through) to those used in the 2012 core study.

3.1.6 Under the 2013 supplementary study, two scenarios were used to account for a range of emissions reduction potential consistent with the CAEP trends analysis from new technologies and operational improvements:

- **Supplementary Study, scenario A**: reflects low aircraft technology improvements and moderate operational improvements; and

- **Supplementary Study, scenario B**: reflects optimistic aircraft technology improvements and high operational improvements.

  (See the Glossary for the details of scenarios A and B.)

3.1.7 Separate calculations were made to account for the potential use of alternative fuel. In one case, it was assumed that alternative fuels would address 25 per cent of the emissions gap between 2020 emission levels and forecasted growth in 2036 for both scenarios A and B. In the second case, it was assumed that 50 per cent of this emissions gap would be addressed by alternative fuels.

3.1.8 Neither the core study nor the supplementary study considered the administrative costs of a global MBM scheme. The quantitative assessment addressed only the economic impacts of purchasing emissions units and did not address the cost of operating the scheme or the cost for participants to meet the administrative obligations of the scheme (e.g. monitoring, reporting, verification, etc.). Administrative considerations were captured in the qualitative assessment.

3.2 MODELLING OUTPUTS

3.2.1 The six scenarios in the core study in 2012 (Table 1), as well as the two scenarios in the supplementary study in 2013 (described in 3.1.6), have results that reflect the study assumptions (environmental target, cost of fuel and CO_2, cost-pass-through). The quantitative modelling did not distinguish between offsetting or emissions trading since the same quantitative assumptions were used for all scenarios.

3.2.2 The results of quantitative assessment are reported as the forecasted impacts of MBMs in 2036. As emissions grow, the gap between the environmental objective (carbon neutral growth from 2020) and actual emissions gets larger; therefore, the impacts of MBMs are relatively small in the early years after 2020, and increase over time. The impacts also increase due to the assumption that the price of CO_2 (emissions units) and fuel will become more expensive in the future.

3.2.3 In the core study, the baseline scenario (assuming that there will be no MBM scheme) between 2020 and 2036 for international aviation is forecasted to be the following (as shown in Table 2 under the "Without MBM (baseline) scheme" column):

— emissions in 2020 would be 642 Mt, which would grow to 1 106 Mt in 2036 (72 per cent increase);

— traffic demand, measured in revenue tonne kilometres (RTK), would increase by 110 per cent from 743 billion RTK in 2020 to 1 561 billion RTK in 2036;

— total industry operating costs would increase 102 per cent from $579 billion[3] in 2020 to $1 173 billion in 2036;

— Operating revenues would increase 103 per cent from $595 billion in 2020 to $1 207 billion in 2036; and

— the operating results (operating revenues less operating costs) would be $33.7 billion in 2036, which is 2.8 per cent of operating revenues in 2036.

3.2.4 If an MBM scheme was implemented after 2020 and assuming a 100 per cent cost-pass-through, the study showed the following changes in 2036 as a result of the MBM scheme (see Table 2 under "With MBM scheme" column):

— within the sector, emissions would be 1 094 Mt, approximately 12 Mt lower than in the baseline case;

3. For modelling purposes, all financial values in the core study were converted from 2010 USD to 2006 USD.

— assuming the emissions gap above the 2020 level would be 464 Mt in 2036, 452 Mt would need to be reduced outside the sector through an MBM scheme;

— traffic is projected to be 1 543 billion RTK in 2036, which is 18 billion RTK (1.2 per cent) lower than without an MBM scheme (see Figure 1), although traffic would still grow 107 per cent from 2020 to 2036;

— total industry operating costs in 2036 would be $1 180 billion, which is $6.9 billion or 0.6 per cent more than the operating costs without an MBM scheme;

— operating revenues in 2036 would be $1 213 billion, which is $6.5 billion or 0.5 per cent more than the revenues without an MBM scheme; and

— the forecasted total profit level of $33.7 billion in 2036 without an MBM scheme would be lowered to $33.3 billion with an MBM scheme, which is $0.4 billion or 1.2 per cent less than the profit without an MBM scheme.

Table 2. Core study results

	Without MBM scheme (baseline)			*With MBM scheme*	
	2020	*2036*	*Change from 2020*	*2036*	*2036 Change from baseline*
CO_2 emissions, Mt	642	1 106	+464	1 094	-12 (-1.1%)
Traffic demand, billion RTK	743	1 561	+818	1 543	-18 (-1.2%)
Operating costs, billion USD	579	1 173	+594	1 180	+6.9 (+0.6%)
Operating revenues, billion USD	595	1 207	+612	1 213	+6.5 (+0.5%)
Operating result, billion USD (profit)	16.2	33.7 (2.8%)	+17.5	33.3 (2.7%)	-0.4

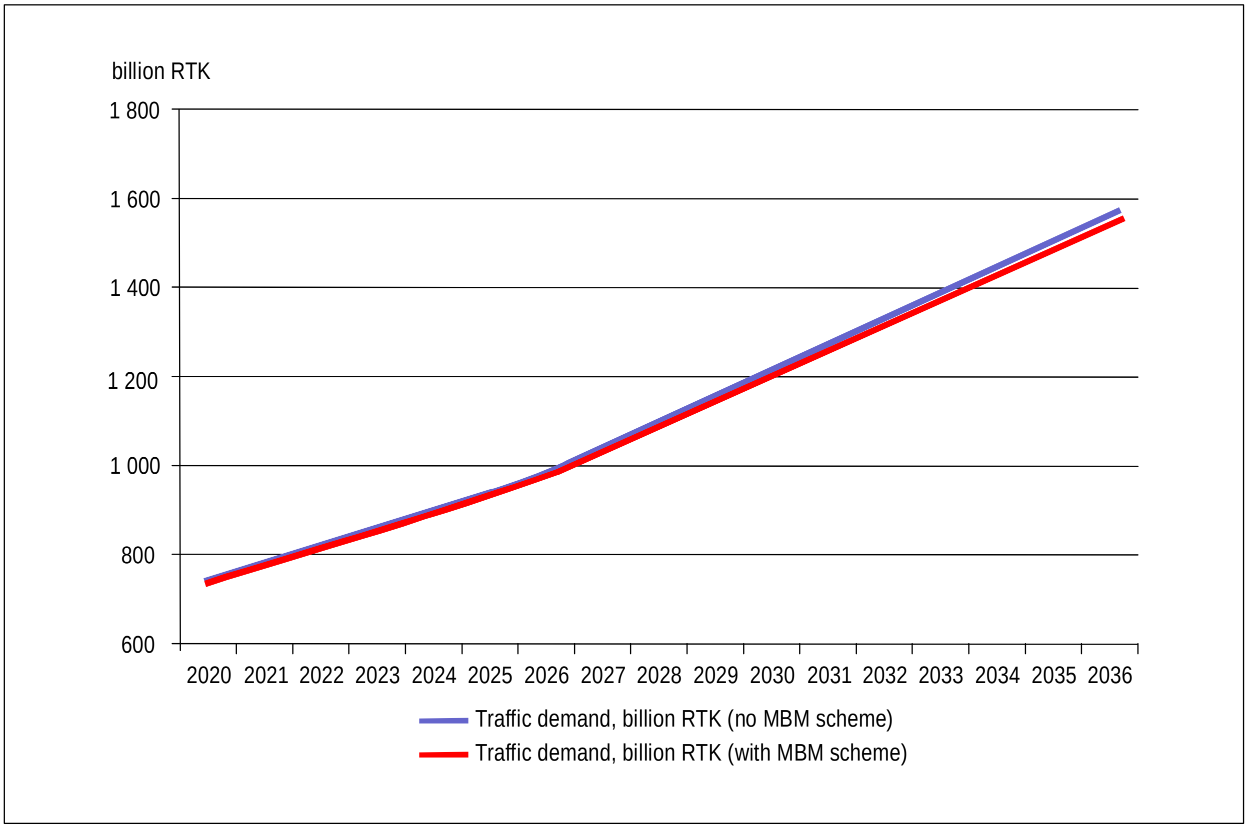

Figure 1. Core study — impact of an MBM scheme on traffic demand

3.2.5 The impacts of MBMs increase for revenue generating scenarios. The impacts on operating costs and operating revenues increase approximately 1 per cent compared to the impacts of non-revenue generating scenarios. Similarly, traffic demand (measured in RTK) is lower by 2 per cent, however, with 100 per cent of costs being passed through to ticket prices, the impact on profitability shows very little difference in any of the core study scenarios.

3.2.6 In the supplementary study, scenario A (low technology and moderate operational improvements) and scenario B (optimistic technology and operational improvements) apply assumptions that result in growth levels both above and below the growth level in the core study (see Table 3 – e.g. 72 per cent increase in core study, 85 per cent increase in scenario A and 63 per cent increase in scenario B). Assuming a 100 per cent cost-pass-through, trends in the supplementary study are consistent with the core study. However, in the case of the operating results, the supplementary analysis forecasted a higher impact on profits than that of the core study.

3.2.7 The supplementary study forecasted that, in 2036, the operating costs of the industry could rise as a result of an MBM scheme by $13.2 billion in scenario A, and by $11.4 billion in scenario B. Revenues were predicted to increase by $4.7 billion in scenario A, and by $2.5 billion in scenario B. (See Table 4.)

3.2.8 Despite the differences in revenue and operating costs, the results of the supplementary study were consistent with the core study, specifically related to traffic, emissions, seat costs, etc. The supplementary study considered the impact of MBMs in the context of different scenarios regarding future emissions reductions from the sector. Under scenario A, only a very low portion of reductions in CO_2 emissions would be made through technology and operations. However, under scenario B, 166 Mt of further reductions could be achieved through additional improvements in technology and operations in 2036.

Table 3. Changes as a result of MBMs in 2036 — comparison of core study and supplementary study

		Supplementary study	
	Core study	*Scenario A*	*Scenario B*
CO_2 above 2020 levels	464 Mt (+72%)	609 Mt (+85%)	443 Mt (+63%)
In-sector CO_2 reduction	12 Mt	13 Mt	6 Mt
Outside-sector CO_2 reduction	452 Mt	596 Mt	437 Mt
Change in traffic demand (RTK billion)	-1.2%	-1.0%	-0.6%
Change in operating result (profit)	-0.1 pts[4]	-0.6 pts	-0.7 pts

Table 4. Supplementary study — changes as a result of MBMs in 2036

	Scenario A			*Scenario B*		
	Without MBM scheme	*With MBM scheme*	*Change*	*Without MBM scheme*	*With MBM scheme*	*Change*
Operating revenues, billion USD	1 385.5	1 390.2	+4.7	1 385.5	1 388.0	+2.5
Operating costs, billion USD	1 386.8	1 400.0	+13.2	1 331.7	1 343.0	+11.3
Operating result, billion USD	-1.3	-9.8	-8.5	53.8	45.0	-8.8

3.2.9 The use of alternative fuels was addressed separately from the assumptions for technology and operations in scenarios A and B. This is a reflection of the high level of uncertainty around the availability of alternative fuels for the sector. The modelling assumed the price of alternative fuel would be comparable to that of conventional fuel and that the use of alternative fuel was accounted as zero CO_2 emissions.

4. Pts are “points” used to express an absolute change in per cent. Points are used rather than a percentage when the initial figure — profit — is expressed as a per cent (thereby avoiding the expression of a per cent of a per cent). In the core study 0.1 pts represents a change in profitability from 2.8 per cent to 2.7 per cent, as per Table 2.

3.2.10 Both scenarios A and B assumed that either 25 per cent, or 50 per cent, of the emissions gap beyond the 2020 level would be addressed by alternative fuels in 2050. As the assessment was undertaken over the period from 2020 to 2036, the amount of alternative fuels was scaled back from 2050 to 2036. The emissions gaps to be addressed by MBMs in these two cases are presented in Table 5.

Table 5. Supplementary study — emissions gaps to be filled by MBMs, assuming the use of alternative fuels

	2036 emissions above 2020 level (Mt), with no alternative fuels	*2036 emissions above 2020 level (Mt), with 25% alternative fuels*	*2036 emissions above 2020 level (Mt), with 50% alternative fuels*
Scenario A	609	461	323
Scenario B	443	295	157

3.2.11 Assuming that 25 per cent of the emissions gap would be addressed by alternative fuels, the impact of MBMs on traffic demand is approximately half that of the scenarios without alternative fuel for both scenarios A and B. However, the financial cost of the MBMs in this case does not decline in the same way as traffic demand; this is partly due to the large emissions gap (75 per cent) that would still need to be addressed by MBMs (see Table 6).

3.2.12 Assuming that 50 per cent of the emissions gap would be addressed by alternative fuels would further lower the portion of the gap to be filled by an MBM scheme in 2036. This results in a lower impact on traffic demand and a smaller impact on revenues, as illustrated in Table 6.

Table 6. Supplementary study — MBM impacts, assuming the use of alternative fuels

	Scenario A, with no alternative fuels	*Scenario A, with 25% alternative fuels*	*Scenario A, with 50% alternative fuels*	*Scenario B, with no alternative fuels*	*Scenario B, with 25% alternative fuels*	*Scenario B, with 50% alternative fuels*
In-sector CO_2 reduction (Mt)	13	7	4	6	4	1
Reduction of traffic demand (RTK)	-1.0%	-0.5%	-0.3%	-0.6	-0.3%	-0.1%
Cost increase as a portion of revenue	+1%	+1%	+0.8%	+0.8%	+0.6%	+0.4%
Average cost per seat (3 000 km)	$2.3	$2.3	$1.8	$2	$1.5	$1
Average cost per seat (10 000 km)	$7.6	$7.6	$6	$6.5	$5	$3.3

3.3 COST IMPLICATIONS

3.3.1 In the core study, the cost of an MBM scheme on an average long distance flight of between 10 000 to 12 000 kilometres was estimated to be approximately $10 per seat. The supplementary study estimated the impact to be in the range of $7 to $8 for a 10 000 kilometre flight. On short-haul flights the cost implications were consistent between the two studies. Between 900 and 1 900 kilometres, the core study estimated the price impact would be approximately $1.5 per seat and the supplementary study estimated $2 per seat on a 3 000 kilometre single flight.

3.3.2 The total emissions to be offset by purchasing credits from outside the aviation sector in 2036 were estimated to be 452 Mt in the core study. The remaining 12 Mt of CO_2 reductions would come from within the sector as outlined in the previous section (see Table 3). In-sector reductions include 11 Mt resulting from lower traffic demand (19 billion lower RTK) and 1 Mt resulting from improvements in fuel efficiency. Given the assumed price of $41.35[5] per tonne of CO_2 in 2036, the total cost to purchase emissions units would be $18.7 billion under the core study.

3.3.3 The cost of purchasing emissions units in the supplementary study was in the same order of magnitude as the core study. As indicated by the cost of MBMs relative to total revenues (see Table 6), the cost implications are up to 1 per cent in both scenarios A and B with a limited impact on the overall profitability of the sector. Under scenario B, with alternative fuels filling a portion of the gap, the MBM costs for a short-haul flight could be as low as $1 to $1.5 per seat on each flight and from $3.3 to $5 per seat on a long-haul flight (see Table 6).

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5. $45 USD (2010) carbon price converted to USD (2006) for modelling purposes.

Chapter 4

QUANTITATIVE ASSESSMENT — SENSITIVITY ANALYSIS

Sensitivity analyses for the quantitative assessment of a global MBM scheme were undertaken to assess the range of results derived by changing the assumptions used in the quantitative assessment.

4.1 COST-PASS-THROUGH

4.1.1 The ability for operators to pass costs through to customers depends on several variables and these variables can change over time. For example, the "elasticity" of demand (impact of ticket price on level of sales) can impact the willingness of operators to pass cost through to customers. In some cases, such as where aviation allowances are distributed for free, it may be possible to pass more than 100 per cent of costs to customers, though this was not modelled. In order to analyse varying levels of cost-pass-through, several MBM scenarios were modelled using a 50 per cent and 75 per cent cost-pass-through, in addition to the 100 per cent cost-pass-through reflected in this report.

4.1.2 For the purpose of reporting the results of the sensitivity analysis, the 50 per cent cost-pass-through was used and the following observations were made:

— the traffic demand would be less impacted with 50 per cent cost-pass-through because the costs to customers would not rise to the same extent as when 100 per cent of costs were passed through to ticket prices. For example, in the core study, an MBM would reduce RTKs by 18 billion with a 100 per cent cost-pass-through, however, under the 50 per cent cost-pass-through it would drop to 9 billion. Similarly, emissions reductions from within the sector would drop from 12 Mt to 6 Mt under the 50 per cent cost-pass-through;

— the cost to customers was lower with a 50 per cent cost-pass-through, in the case of the supplementary study, for scenario B by as much as half. As a result, RTKs did not decline to the same degree under this scenario; and

— because operators absorb some of the cost of purchasing emissions units, profits are more strongly affected with a 50 per cent cost-pass-through (see Table 7). The impact of MBMs represents approximately 1 per cent of total revenues.

4.1.3 In conclusion, assumptions in the quantitative analysis regarding the ability to pass the MBM costs to customers can have a significant impact on the expected operating result. Although emissions reductions within the sector are small, cost-pass-through also impacts traffic demand, and therefore, the amount of CO_2 reduction within the sector.

4.2 CARBON PRICE

4.2.1 In order to measure the sensitivity of the carbon price on the impact of MBMs, an analysis was undertaken using a carbon price closer to the current market level; that is, \$3 per tonne of CO_2, which reflects a blend of current prices for different emissions units.

4.2.2 The MBM impacts under the current market price of carbon would be significantly reduced compared to the MBM impacts under the assumptions for the carbon price (see 3.1). The impact on traffic demand would be too small to quantify. There would be no measurable impact on profits and the cost on a per seat basis would be less than $0.5 at any distance (see Table 8).

Table 7. Supplementary study — sensitivity analysis, MBM impacts with cost-pass-through scenarios

	Scenario A		*Scenario B*	
	100% cost-pass-through	*50% cost-pass-through*	*100% cost-pass-through*	*50% cost-pass-through*
Reduction of traffic demand (RTK)	-1.0 %	-0.7%	-0.6%	-0.5%
Change in operating result (profit)	-0.6 pts	-1 pts	-0.7 pts	-0.8 pts
Cost increase as a proportion of revenue	+1%	+1.2%	+0.8%	+0.9%
Average cost per seat (3 000 km)	$2.3	$1.5	$2	$1.1
Average cost per seat (10 000 km)	$7.6	$5	$6.5	$3.5

Table 8. Supplementary study — sensitivity analysis, MBM impacts with $3 carbon price

	Scenario A	*Scenario B*
Reduction of traffic demand (RTK)	-0.1%	0%
Change in operating result (profit)	0 pts	0 pts
Cost increase as a proportion of revenue	±0.1%	±0.1%
Average cost per seat (3 000 km)	$0.1	$0.1
Average cost per seat (10 000 km)	$0.4	$0.4

Chapter 5

QUANTITATIVE ASSESSMENT — IMPACT ON DEVELOPING COUNTRIES

Following the request of the Assembly "to continue to explore the feasibility of a global MBM scheme by undertaking further studies on the technical aspects, environmental benefits, economic impacts and the modalities of such a scheme" (paragraph 18 of Resolution A37-19), the Council at its 196th Session[1] *expressed the need for further evaluation of the options to take into account the additional evaluation criterion "Ability to accommodate the special circumstances and respective capabilities [SCRC] of developing countries". This request was addressed in both the Quantitative and Qualitative assessments. Various approaches to accommodate SCRC were considered in the Qualitative assessment (Chapter 6), while the potential impacts of MBMs on developing countries were assessed in the 2012 core study of the quantitative assessment.*

Three approaches (see below) were used to assess impacts of MBMs on developed and developing countries. It should be recognized that there may be other approaches for assessing the impacts of MBMs in relation to the SCRC of developing countries. If there is a need for more analysis, further policy guidance would be necessary to establish the basis for defining special circumstances and respective capabilities in the context of international aviation.

5.1 ASSUMPTIONS AND SCENARIOS

5.1.1 These approaches were used to assess the impacts of MBMs on developing countries:

— s**ix regions** — the impacts of MBMs on six geographic regions was undertaken to assess if they would impact one region more or less than another;

— l**east developed countries (LDCs) and non-LDCs** — a comparison of the impacts of MBMs on LDCs (48 countries, as defined by the United Nations and the World Bank) and non-LDCs was undertaken to assess whether MBMs would impact LDCs more than non-LDCs; and

— as an additional verification of results, **economic development/aviation activity** parameters were used to analyse the impact of MBMs. Several parameters were considered including, income, education, life expectancy, revenue tonne kilometres, available tonne kilometres, etc. While recognizing the sensitivity to the definition of development, two parameters were used as examples for the purposes of this study only: per capita income; and international aviation activity in terms of available seat kilometre (ASK) by departing flights from individual countries.

5.1.2 The assessment concentrated on two key issues: whether the implementation of an MBM scheme will affect developed and developing countries differently; and, whether the impacts on developing countries will differ from the MBM impacts at the global level.

1. Council Decision 196/7.

5.2 MODELLING OUTPUTS

Six Regions

5.2.1 The traffic forecast in 2020 (without an MBM scheme) shows that Europe and Asia/Pacific will have the largest share of CO_2 emissions from international aviation with 36.6 per cent and 31 per cent, respectively, followed by North America with 14.8 per cent. The remaining three regions accounted for much smaller portions with Latin America and the Middle East, both at 6.7 per cent, and Africa with 4.2 per cent (see Figure 2).

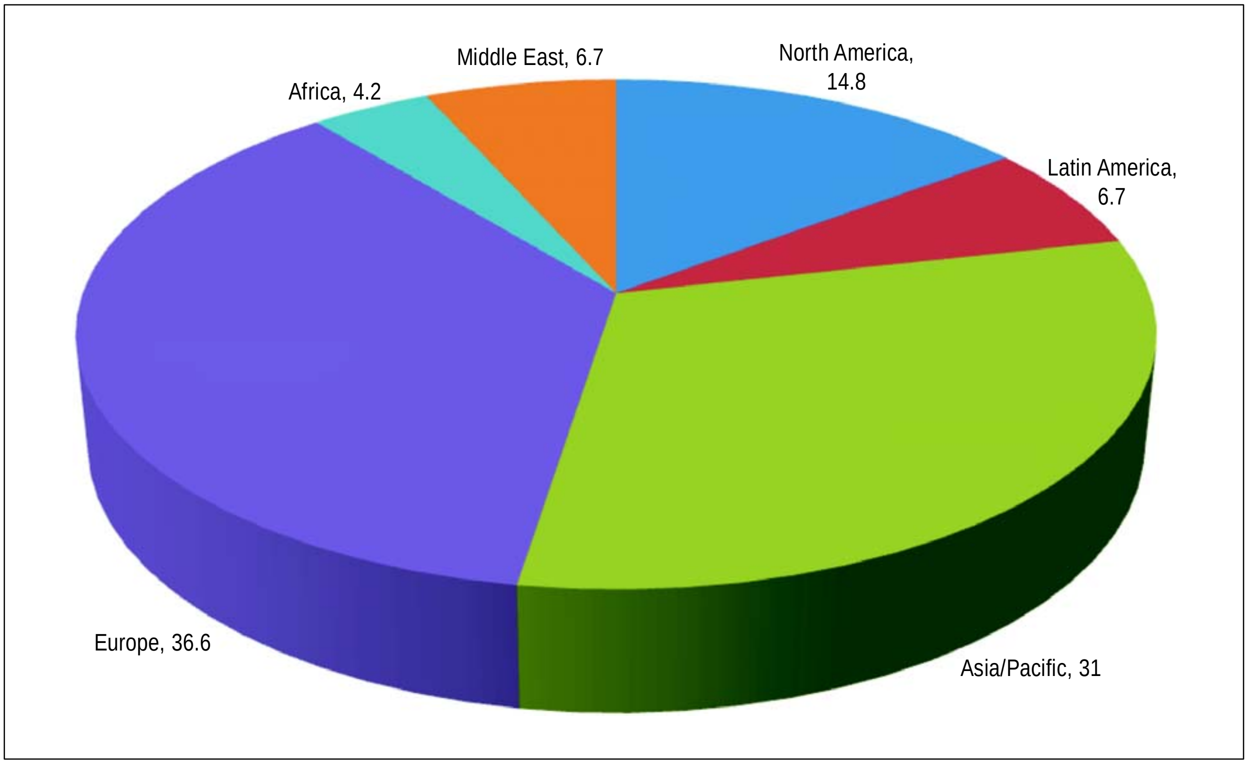

Figure 2. Estimated regional share of CO_2 from international aviation in 2020

5.2.2 The forecast without MBMs (see Table 9) shows that:

— the biggest growth in demand from 2020 to 2036 would be observed in Asia/Pacific and Africa at 125 per cent, and the Middle East with 126 per cent. North American and European traffic would grow by about 99 per cent and 96 per cent, respectively.

— The same tendency would be observed in profit growth. In the regions of Asia/Pacific and Africa, profit was estimated to grow 131 per cent and 128 per cent, respectively, while more modest growth would be observed in North America and Europe with 98 and 91 per cent, respectively.

Table 9. Core study — regional forecasts in 2036 without MBMs

	North America	*Latin America*	*Asia/ Pacific*	*Europe*	*Africa*	*Middle East*	*Global*
CO_2 emissions, Mt	156	77	363	379	50	81	1 106
Per cent increase from 2020	+64	+81	+82	+61	+86	+89	+72
Traffic demand, billion RTK	226	106	534	519	65	111	1 561
Per cent increase from 2020	+99	+116	+125	+96	+125	+126	+110
Operating result, billion USD (2006)	4.5	2.3	10.7	12.4	1.6	2.2	33.7
Per cent increase from 2020	+98	+118	+131	+91	+128	+120	+108

5.2.3 If an MBM scheme was implemented after 2020 and assuming a 100 per cent cost-pass-through, the core study estimated the following changes from the non-MBM (baseline) scenario in 2036 (see Table 10).

— marginal differences in the impacts of the MBMs between regions;

— the profitability in all regions would be lowered by 1.1 per cent on average, which is consistent with the global impact. Africa and Asia/Pacific show slightly better results, with profitability lowered by 1 per cent; and

— the traffic demand would be lowered by 1.2 per cent on average compared to the non-MBM (baseline) scenario. A 1.4 per cent reduction would be observed in the Middle East.

Table 10. Core study — regional impacts of MBMs, changes from non-MBM (baseline) scenario in 2036

	North America	*Latin America*	*Asia/ Pacific*	*Europe*	*Africa*	*Middle East*	*Global*
In-sector CO_2 reduction	-1.2%	-1.1%	-1.1%	-1.1%	-0.8%	-1.1%	-1.1%
Changes in traffic demand (RTK)	-1.2%	-1.2%	-1.1%	-1.2%	-1.1%	-1.4%	-1.2%
Changes in operating result (profit)	-1.1%	-1.2%	-1.0%	-1.2%	-1.0%	-1.3%	-1.1%

5.2.4 The impact of an MBM scheme on regions demonstrated a maximum reduction in traffic of 1.4 per cent in the Middle East. Nonetheless, traffic in this region will continue to grow by 110 billion RTK (122 per cent) from 2020 to 2036. Without an MBM scheme, RTKs were forecasted to grow by 111 billion RTK (126 per cent). In the meantime, the MBM scheme would address an 89 per cent CO_2 increase between 2020 and 2036 in the Middle East.

LDCs and Non-LDCs

5.2.5 The 48 countries, defined as LDCs, make up a very small percentage of total international RTK, approximately 1 per cent. The data (see Table 11) demonstrates the significant difference in size between the two groups.

Table 11. Core study — LDCs and non-LDCs — impacts of MBMs in 2036

		Non-LDC	*LDC*	*Global*
CO_2 emissions (Mt)	Without MBM scheme	1 090.5	16.0	1 106.5
	With MBM scheme	1 078.5	15.9	1 094.4
In-Sector CO_2 reduction (Mt and %)		-12.0 (-1.1%)	-0.1 (-0.6%)	-12.1 (-1.1%)
Traffic demand (billion RTK)	Without MBM scheme	1 541.6	20.1	1 561.7
	With MBM scheme	1 523.0	19.9	1 542.9
Changes in traffic demand (billion RTK and %)		-18.6 (-1.2%)	-0.2 (-1.0%)	-18.8 (-1.2%)
Operating result (profit), billion USD	Without MBM scheme	33.1	0.5	33.7
	With MBM scheme	32.8	0.5	33.3
Changes in operating result, as a % of revenue		-0.37 (-1.1%)	-0.004 (-0.9%)	-0.4 (-1.1%)

5.2.6 The comparison of LDCs and non-LDCs showed a similar pattern to that of the six regions in terms of the consistency with the global results. However, LDCs were not as affected as non-LDCs by MBMs. In proportional terms, the impacts on traffic levels and profits were smaller in LDCs, although reductions in CO_2 were also smaller.

Economic Development and Aviation Activity Parameters

5.2.7 The results of the comparison using development parameters were consistent with the global results. The impact of MBMs on travel demand (RTK) in countries with higher economic development and higher aviation activity was consistent with countries which had lower economic development and lower aviation activity. Impacts on CO_2 emissions and profit levels were within 0.1 per cent of each other.

5.3 COST IMPLICATIONS

5.3.1 The results show a slightly higher reliance on the purchase of emissions units from outside the sector in Africa: 0.8 per cent of emissions are reduced within the sector (see Table 10). This trend was also confirmed in the comparison of LDCs and non-LDCs where the in-sector CO_2 reduction was 0.6 per cent in LDCs compared to a 1.1 per cent reduction in non-LDCs and a 1.1 per cent reduction at the global level. A smaller reduction within the sector would require the purchase of more emissions units from outside the sector.

5.3.2 The cost of an MBM scheme does not appear to affect the relative profitability between any region or group of States. The smaller emissions reductions within the sector in some regions could reflect fleet differences such as smaller aircraft or less fuel efficient aircraft, or could reflect shorter flight distance within the region.

Chapter 6

QUALITATIVE ASSESSMENT

In parallel to the quantitative assessment of the economic and environmental impacts of MBMs, a qualitative assessment of the three MBM options was also undertaken. During this exercise, the main elements, referred to as "design features", were identified for each of the three MBM options. Furthermore, the choices available within each design feature were described. This assessment helped identify the main differences between the MBM options, including the differences in administrative complexity.

6.1 DESIGN FEATURES OF A GLOBAL MARKET-BASED MEASURE SCHEME

6.1.1 Ten main design features, essential for setting up a global MBM scheme, were identified. These features are summarized below. Consideration of the legal instruments best suited to implement a global MBM scheme, were also reviewed.

Design features	
• Participants	• Compliance period
• Environmental objective	• Monitoring, reporting and verification
• Distribution of obligation	• Enforcement/review mechanism
• Emissions units	• Special circumstances and respective capabilities
• Compliance assurance (registries)	• Revenue generation

6.1.2 It is important to understand the interrelationships between design features; decisions made in one design feature may influence other design features.

6.1.3 In setting up a global MBM scheme, one of the primary decisions is the choice of ***participants***, that is, the entity that will periodically quantify GHG emissions and comply with the scheme by surrendering an adequate amount of emissions units. The two potential participant choices that were explored were "States" or "aircraft operators", although others could be considered (e.g. fuel suppliers).

6.1.4 Either States or aircraft operators could be given compliance obligations, as the participants, in any of the MBM options. A key finding was that in a global MBM scheme both States and aircraft operators would have important roles to play. It will be essential to distinguish between the compliance obligations placed on the participants and a number of other responsibilities for implementing, administering and enforcing the scheme, which should be performed by an implementing entity, either at a national or a global level.

6.1.5 The choice of participants will influence the choice of a number of other design features such as distribution of obligations, monitoring, reporting and verification (MRV) methods, compliance assurance, SCRC and enforcement.

6.1.6 Any MBM scheme must have a clear ***environmental objective*** in order to determine its stringency. Under any emissions offsetting scheme, an environmental objective could be expressed as a baseline, above which all emissions would need to be offset. In a case of emissions trading, an upper limit or a cap would be established, and emissions allowances would be created for each tonne of CO_2 under the cap.

6.1.7 The same level of stringency can be achieved under an offsetting or an emissions trading scheme (ETS), which could be above or below current emissions levels.

6.1.8 The ***distribution of obligation*** among participants establishes individual obligations that collectively respect the baseline or cap. In offsetting, an individual baseline is set for each participant above which all emissions have to be covered via the purchase of emissions units. Under an ETS, participants would receive an allocation of emissions allowances, representing a portion of emissions below or up to the cap. Participants surrender allowances, or other emissions units, equal to their emissions.

6.1.9 Four different approaches to distributing the obligation were considered: grandfathering,[1] benchmarking,[2] flat percentage of emissions,[3] and auctioning.[4] Any of these approaches, except for auctioning, which can only be used in an ETS, could be used in either an offsetting or emissions trading scheme. Combinations of approaches can also be used. Each approach has attributes, which would need to be considered when choosing a distribution method in a particular scheme. For example, under grandfathering or benchmarking approaches, special adjustments for new entrants and fast-growing participants would need to be considered. A flat percentage of emissions approach would treat all operators in the same way, therefore no adjustments for new entrants and fast-growing participants would be needed. Under the auctioning approach, all participants would need to purchase allowances.

6.1.10 One core difference between offsetting and ETS is that tradable emissions allowances would be created in an ETS. ***Emissions units*** (credits or allowances) from other carbon markets would be used in an offsetting scheme where emissions are offset above an environmental objective. Under an ETS, emissions units from other carbon markets could be used in addition to the specific aviation allowances created by the scheme. To ensure an appropriate level of quality and environmental integrity for offsetting, it would be important to develop eligibility criteria for emissions units used for compliance with any of the MBMs.

6.1.11 ***Compliance assurance*** is required to ensure the integrity of the scheme and the equitable treatment of all participants. Compliance obligations are generally tracked through a registry which, at minimum: records the environmental objective of the scheme; the emissions of each participant; the obligation of each participant to surrender emissions units and the tracking of emissions units to meet participants' obligations. Often verification processes for reporting emissions and the surrender or cancellation of emissions units will also be captured in the registry. In an offsetting system, it may be sufficient to create a centralized database or an accounting system, where a file is created for each participant to record its obligations and compliance status. Under an ETS, there is a need to create and distribute emissions allowances, as well as to track the movement of all allowances until they are cancelled.

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1. Grandfathering sets a reference level based on historic emissions, e.g. total CO_2 in a previous year divided among participants.
2. Benchmarking establishes a reference level based on efficiency such as emissions per unit of output, e.g. CO_2/RTK.
3. Flat percentage of emissions mean that all participants reduce emissions by a fixed percentage of their individual totals, e.g. 15 per cent below 2013 total emissions. It should be noted that this approach requires percentages to be continuously calibrated to meet the environmental objective.
4. Auctioning applies to emissions trading where allowances below the cap are auctioned rather than provided to participants for free.

6.1.12 In any offsetting or emissions trading scheme, there would be a need to establish a ***compliance period*** during which the parameters of the scheme (e.g. cap, baseline, individual obligations to participants, rules for banking and borrowing, etc.) are set. The compliance period should be long enough to provide predictability and stability over time for participants.

6.1.13 A robust ***monitoring, reporting and verification*** (MRV) system is a core design element in any MBM option. In a context of international aviation, MRV is the obligation of participants to monitor and report verified emissions.

6.1.14 An MRV system should ensure that one unit of emissions emitted and recorded in one jurisdiction is directly comparable to a unit in another jurisdiction. In a global MBM scheme, it would be essential to establish standard methodologies and technical guidelines on MRV to be used by participants. This is important to ensure effective functioning of the MBM scheme and to minimize market distortion.

6.1.15 The nature of MRV would be similar for each of the three options for a global MBM scheme. MRV will depend on other design features, such as choice of participants, scope of a scheme and exemptions. For example, with a simple MBM scheme, which applies to all international flights, it may be sufficient to use fuel sales or purchases for the estimation of emissions of participants. If any exemptions or thresholds for participation were introduced in an MBM scheme, it could require a more complex MRV system such as monitoring of fuel on a flight-by-flight basis. This complex MRV system would be important to account for only those emissions covered by the MBM scheme.

6.1.16 Due to the need to ensure the use of standard and consistent MRV methodologies by participants, MRV is an area where specific ICAO guidance material could be necessary.

6.1.17 An ***enforcement/review mechanism*** would be necessary under any MBM option to ensure the compliance of participants with the requirements of a global scheme. The enforcement mechanism would largely depend on the participants in a global MBM scheme. If States are participants, an internationally agreed mechanism could be established. If operators are participants, an enforcement mechanism applied by States could be established; however, this does not preclude the option of using an international approach to ensuring compliance.

6.1.18 A global MBM scheme for international aviation should address the ***special circumstances and respective capabilities (SCRC) of States***. A range of tools to address SCRC was considered:

1) market blocks differentiation, whereby a block, or group, of States may have modified design features;

2) exemption thresholds;

3) phased implementation;

4) emissions units sourcing, which means that emissions units are created in specific States;

5) revenue channelling, in which MBM revenues coming from specific States would be channelled back to those States creating no net financial impact;

6) technical assistance;

7) special treatment for early action, fast growth and new entrants; and

8) technical exemption thresholds (firefighting, recreational aviation).

6.1.19 Some of these approaches are non-exclusive, and they could be combined with each other to provide a package of tools to address SCRC. These approaches can be implemented in any MBM option, the key aspect when choosing the optimal approach would be to ensure that market distortion is minimized.

6.1.20 To enable ***revenue generation***, a decision would need to be made on the revenue collection mechanism, possible uses of revenue, revenue distribution mechanism and the assurance of the compliance for uses of revenue. Revenue mechanisms could differ in offsetting and emissions trading options, however, the other elements, like uses of revenue and revenue distribution mechanisms, could be very similar.

6.2 LEGAL INSTRUMENTS FOR A GLOBAL MARKET-BASED MEASURE SCHEME

6.2.1 In addition to considerations on the design features, there was a high-level assessment of the legal instruments that could be used to establish a global MBM scheme. Three ***legal instruments*** were considered:

1) International Convention;

2) Assembly Resolutions; and

3) Standards.

6.2.2 Legal instruments are not mutually exclusive and can be used in combination for the implementation of a global MBM scheme.

6.2.3 The advantage of an International Convention is that it would be binding upon Parties that ratify or accede to it. The execution of enforcement provisions could be facilitated under a Convention; however, it may take several years for the instrument to be adopted and even longer to enter into force. Should sufficient consensus exist among Member States of ICAO, a global MBM scheme may be developed through an Assembly Resolution. However, a Resolution would not be legally binding, which could complicate its enforcement. It would be challenging for Standards alone to manage all elements of a global MBM scheme. Standards could be useful tools in complementing other instruments by developing certain technical requirements of a global MBM scheme. These technical requirements may include rules for monitoring methodologies, fuel consumption reporting as well as recording, surrendering, cancelling and acquiring emissions units.

6.3 ADMINISTRATIVE COMPLEXITY

6.3.1 The three main differences in the design features of the options for a global MBM scheme (offsetting and ETS) were identified from the implementing entity perspective: use of emissions units in an offsetting versus use of emissions allowances and other emissions units in an ETS; allocation of an individual baseline for participants in offsetting versus distribution of allowances in an ETS; and different accounting requirements to ensure compliance under the two systems.

6.3.2 These differences were translated into the following administrative steps for implementing entities under the two systems. In an offsetting system, it may be sufficient to create a centralized database or an accounting system, where a file is created for each participant to record its obligations and compliance status. The implementing entity would maintain such an accounting system. An effective and transparent auditing process would need to be established to ensure that participants acquired and cancelled eligible units.

6.3.3 Under an ETS, there is a need to create and distribute emissions allowances, as well as to track allowances until they are cancelled. Additional market oversight would be needed. Under an ETS, a number of functions would be similar to an offsetting accounting system. A registry would need to be established to track the creation, retirement and all transactions of allowances. Registry security measures would be needed because emissions allowances kept in a registry have a value. Under both systems, a decision on the eligibility of different types of emissions units that are acceptable is required.

6.3.4 The greatest difference between the two systems from the participants' perspective is the use of tradable emissions allowances in the ETS, which would create additional responsibilities and opportunities.

6.3.5 In an ETS, participants would receive emissions allowances with a value, which could be traded. Aircraft operators would need to record the value of the allowances in their financial balance sheets and would have the possibility of trading allowances, which would involve risks similar to trading other financial assets as well as greater flexibility.

6.3.6 In relation to compliance assurance, participants would need to open and manage their accounts in an ETS registry, because all the transactions of allowances take place in the registry. In an offsetting scheme, participants could be subject to audits as part of the accounting process.

Chapter 7

FEASIBILITY OF MARKET-BASED MEASURES OPTIONS

7.1 The results of the qualitative and quantitative analyses of the three options (global mandatory offsetting, global mandatory offsetting with revenue, and global emissions trading) showed that all three options are technically feasible and have the capacity to contribute to achieving ICAO's environmental goals.

7.2 Global mandatory offsetting could be less complex than global mandatory offsetting complemented by a revenue generation mechanism and global emissions trading.

7.3 Global mandatory offsetting complemented by a revenue generation mechanism could be more complex than global mandatory offsetting, due to the need to establish revenue generation and disbursement mechanisms. It would also be necessary to decide on how revenue will be used. The economic impact on participants is more significant than global mandatory offsetting. However, raising revenue creates a revenue stream that could be used to mitigate the environmental impacts of aircraft engine emissions, including mitigation and adaptation, as well as assistance to and support for developing States, as per the guiding principle n) in Resolution A37-19, Annex.

7.4 Global emissions trading (cap-and-trade system) could be more complex and have higher upfront costs than the offsetting options, due to the need to administer aviation allowances. However, it should offer more flexibility for participants through the creation of additional emissions units, for example, an allowance, which can be traded in the marketplace. Auctioning allowances would create a revenue stream that could be used to mitigate the environmental impacts of aircraft engine emissions, including mitigation and adaptation, as well as assistance to and support for developing States, as per the guiding principle n) in Resolution A37-19, Annex.

Appendix 1

LIST OF NOMINATED MBM EXPERTS

States/organizations	*Name*	*Title*
Australia	Scott Stone	General Manager Aviation Environment Department of Infrastructure and Transport
Australia	Shona Rosengren	Director Aviation Safety — Policy and Governance Air Traffic Policy Branch, Aviation and Airports Division Department of Infrastructure and Transport
Brazil	Adriano Santhiago de Oliveira	Environmental Analyst Coordinator on GHG Emission Monitoring Climate Change Department Secretariat of Climate Change and Environmental Quality Brazilian Ministry of Environment
Brazil	Luiz Brettas	Civil Aviation International Environmental Advisor Department of International Relations National Civil Aviation Agency — Brazil / ANAC
Canada	Leigh Mazany	Director, Environmental Policy Transport Canada
Canada	Stephen Hairsine	Policy Advisor, Environmental Policy Analysis and Evaluation Transport Canada
China	Yue Huang	Economic Engineer China Academy of Civil Aviation Science and Technology
China	Xingwu Zheng	Professor Civil Aviation University of China
China	Wang Ren	Advisor on Climate Change Issues Civil Aviation Administration of China
India	Amit Garg	Public Systems Group Indian Institute of Management Ahmedabad
Japan	Shigehiko Yamaguchi	Policy Coordinator for Global Environment Aviation Strategy Division Civil Aviation Bureau, Japan (JCAB)

Mexico	Alejandro Rios Galvan	Director, Fuel Services Airports and Auxiliary Services, Mexico
Nigeria	Peter Alawani	Deputy General Manager Nigerian Civil Aviation Authority
Republic of Korea	Junhaeng Jo	Director/Research Fellow Center for Transport and Climate Change The Korea Transport Institute (KOTI)
Singapore	Weijen Leow	Chief, Climate Finance Ministry of Finance
Singapore	Lee Chee Tong	Senior Economist Policy and Planning Division Civil Aviation Authority of Singapore
Singapore	Jacky Chong	Economist (International/Environment) International Relations Division Civil Aviation Authority of Singapore
Switzerland	Urs Ziegler	Head Environmental Affairs Section Federal Office of Civil Aviation Switzerland
United Arab Emirates	Alejandro Piera	Permanent Advisor of the United Arab Emirates on the Council of ICAO
United States	Maryalice Locke	Program Manager Office of Environment and Energy Federal Aviation Administration
United States	Kim Carnahan	Office of Global Change Bureau of Oceans & International Environmental & Scientific Affairs Department of State
United States	Kevin Welsh	Senior International Advisor Office of Environment and Energy Federal Aviation Administration
European Commission	Timothy Fenoulhet	Air Transport Directorate Safety & Environment Directorate General for Mobility and Transport European Commission
European Commission	Philip Good	Policy Analyst Environment Directorate-General European Commission
European Commission	David Batchelor	Policy Officer Aviation and International Transport Affairs Directorate General for Mobility and Transport European Commission

Air Transport Action Group (ATAG)	Paul Steele	Executive Director Air Transport Action Group
International Air Transport Association (IATA)	Brian Pearce	Chief Economist International Air Transport Association
International Coalition for Sustainable Aviation (ICSA)	Tim Johnson	Director, Aviation Environment Federation (AEF)

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