An Aviation Carbon Offset Scheme (ACOS)

Version 3.0 - Update

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Version 3.0 - Update

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Abstract

This paper provides a concept for the design of the Aviation Carbon Offset Scheme (ACOS) and aims at overcoming the deadlock that has continued for many years between developed and developing countries, hindering an agreement on instruments addressing greenhouse gas emission of the aviation sectors. We discuss key design options of such a scheme, including which entity should be responsible for purchasing offsets, how requirements for purchasing offsets can be divided between the covered entities, how the diverging situations of countries can be taken into account without providing incentives to evade the scheme and what needs to be considered to ensure environmental integrity. As a result we sketch out a scheme covering all countries, which takes into account differences them by means of a route-based differentiation of requirements, which does not generate any revenues and which would enable the aviation sector to contribute appropriately to the global challenge of addressing climate change. The following table summarizes the key design features of the ACOS concept:

Tab. 1: Overview of design features

Design element	Feature	Pages
Emission threshold	Carbon Neutral Growth (baseline: 2020)	9-10
Revenues	None	9-10
Accountable entity	Aircraft operators (e.g. airlines)	10-11
Offset requirements	Hybrid option (individual & sectoral rate)	11-15
Reflection of SCRC	Route-based differentiation (three to five route groups)	15-16
Differentiation criteria	De minimis (max. excl. 10% of CO_2 emissions). Economic indicator (GDP per capita, source: e.g. IMF)	16-17
Offset quality	Units eligible under UNFCCC for compliance, Generated after start of the ACOS	18-20
Administration	A body under ICAO	20-22
Monitoring	Emissions per route group (number of flights, plane type, fuel consumption, etc.)	20-22
Enforcement	ICAO Member States	20-22

Source: Authors' own compilation

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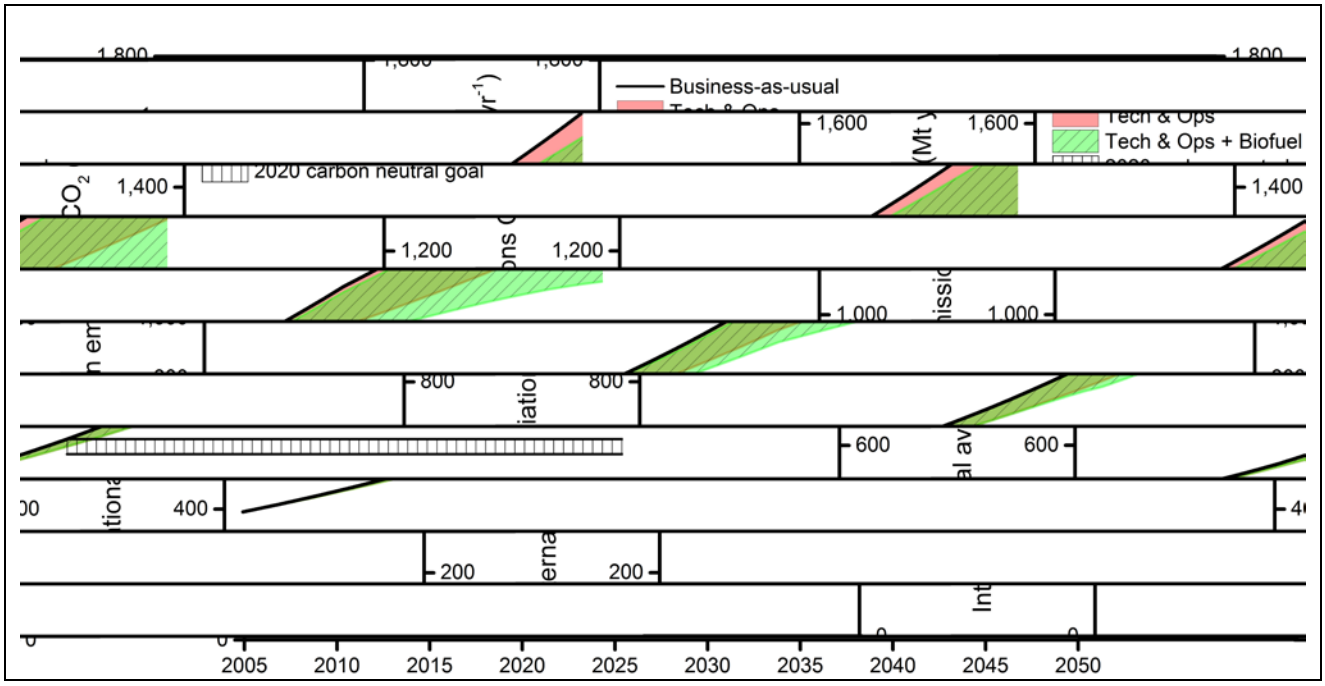
1 Introduction

Aviation contributes significantly to climate change. It gives rise to about 2% of global CO_2 emissions, has other physical and chemical impacts on the atmosphere that contribute to global warming, and its emissions and the other related effects are forecasted to increase rapidly (UNEP 2011). The International Civil Aviation Organisation (ICAO) recognises this fact and its 2013 Assembly has set two targets for the greenhouse gas emissions from aviation (Resolution A38-18):

- A 2% global average annual fuel efficiency improvement between 2010 and 2020 (and an aspirational goal of 2 % average annual improvements up to 2050)[1];
- Keeping the global net carbon emissions of international aviation from 2020 at the same level.

Long-term projections of aviation emissions demonstrate that in-sector reduction options and the 2% efficiency improvement will not be sufficient to keep emissions constant from 2020 onwards (Fig. 1). The Assembly resolution acknowledges that emissions may increase due to the expected growth in international air traffic and decides to develop a global MBM scheme for international aviation.

Fig. 1: MBMs are needed to achieve carbon neutral growth from 2020 onwards



Source: Lee et al. 2013, authors' own calculations

One of the MBMs under discussion is an offsetting scheme. Offsets compensate emissions in one sector by reductions in another sector. The offsetting scheme would compensate the growth in aviation emissions above the 2020 target with emission reductions in other sectors. Because these emission reductions would be financed by the aviation sector, the aviation sector would

[1] The fuel efficiency is calculated on the basis of volume of fuel used per revenue tonne kilometre performed.

be able to deduct them from its emissions and thus keep the global net carbon emissions constant (carbon neutral growth).

1.1 Aviation Carbon Offset Scheme

The Assembly resolution calls upon States to finalise the work on the technical aspects of MBMs within the next three years. This paper provides an analysis of options for the following key design elements of an Aviation Carbon Offset Scheme (ACOS):

- the entity or entities which would be accountable for buying offsets;
- the rules which would determine the amount of offsets to be bought;
- the way in which specific situations of ICAO Member States could be taken into account;
- the way in which the environmental integrity of the scheme could be ensured (which depends on the quality of the offsets);
- organizational aspects of the scheme; and
- how the scheme would be implemented.

In addition to CO_2, aviation has other climate impacts arising from emissions of NOx, water vapour from contrails and induced cloudiness. ACOS does not intend to address these impacts.

1.2 Guiding principles

The ACOS aims at achieving **carbon neutral growth** of international aviation through emission reductions combined with offsetting. This means that if international aviation CO_2 emissions are above the 2020 level (the target), the difference between actual emissions and the target will need to be offset. While this would be a collective responsibility of the sector, different entities could be made responsible for parts of the collective obligation. Rules should be designed in a way that the covered entities are also **incentivised to reduce their emissions**.

The **environmental integrity** depends on the correct monitoring and reporting of emissions as well as on a high quality of offsets to ensure that they are backed by real emission reductions. At the same time **administrative costs and complexity** should be as low as possible without endangering the environmental integrity.

The scheme should **not lead to distortion in competition, be difficult to evade and should minimize carbon leakage** in order to ensure that all aviation emissions are covered and thus the environmental integrity is protected. If the scheme is easy to evade or it is possible to shift emissions so that they are not covered by the scheme, the principle of non-discrimination would also be undermined.

Global coverage is essential to maximise the environmental effect of the offset scheme. At the same time the offset scheme should be designed in such a way that it **accounts for the specific situation of the States** covered. Since earlier efforts to address the specific situation of States through the redistribution of revenues raised by a market-based instrument did not find sufficient support, the ACOS aims at avoiding the generation of any revenues.

2 Determining the accountable entity

First of all, it needs to be defined which entity would be accountable for purchasing offsets. There are many relevant actors in the aviation sector such as passengers, shippers, airlines, aircraft operators, airports, fuel suppliers, air navigation service providers (ANSPs), States or ICAO which may be assigned the responsibility of acquiring offsets. This decision will not have a major impact on most guiding principles – but it does influence administrative costs.

In order to keep the **administrative efforts** of the system low, it makes sense to keep the number of entities low and the number of information exchanges to a minimum. To **enhance the incentive to reduce emissions** and align it with the polluter pays principle, it is expedient to involve entities which have control over emissions. The first criterion rules out passengers or shippers; the second one makes entities that do not monitor emissions or receive emission reports – such as airports, air navigation service providers (ANSPs), States etc. – less suitable candidates. Hence, we see two options for the entity buying the offsets:

- **Aircraft operators** can directly monitor emissions and calculate the amount of offsets they need to buy. They could pass on the costs of offsets to consumers;
- A **central organization** established under or mandated by ICAO buys offsets based on emission reports from aircraft operators and divides the costs among them.

In both cases the costs for offsets would finally either directly or indirectly incur at the aircraft operator level. Since these costs would increase the operational cost, aircraft operators would be additionally incentivised to reduce emissions by further enhancing load factors, efficiency, etc. However, in terms of administration, the options are different.

When offsets are to be bought by a central organization, the organization which oversees the ACOS would be an obvious option. The organization can aggregate the total emissions covered and can thus easily determine the amount of offsets which need to be purchased in a given year. If the central organization purchases the offsets, the aircraft operators would not be required to surrender offsets but to transfer the amount of money equivalent to the number of emissions to be offset in the respective year times the average offset purchase price of the central organization in the same year.

A central organization could probably achieve economies of scale in buying offsets and acquire them at a lower price. However, as this organization would handle large sums of money, strong oversight would be required, and the organization would need to set up an administrative branch to handle payments from aircraft operators. This would reduce the benefit of lower costs to some extent.

The possible economic benefits of a central organization have to be weighed against a number of disadvantages. There may be political objections to a central organization charging aircraft operators directly as this could be interpreted as taxation by an international organization. The organization may need to be empowered with enforcement mechanisms to ensure payments. And since the organization would not know the costs of the offsets in advance, aircraft operators may face an uncertainty in terms of the costs they incur.

If aircraft operators bought the offsets, the costs of the offsets could be higher. However, aircraft operators could develop strategies to manage these costs similar to the strategies used for aircraft fuel costs, which could give them a competitive advantage over other operators. In do-

ing so, they could achieve a higher level of certainty over the costs. In this option, aircraft operators would not need to pay a central international organization.

On balance, we consider the advantages of requiring aircraft operators to buy offsets to be larger than the benefits of a central organization, mainly because of the economic freedom it provides to aircraft operators and the lack of a need for payments to be made to a central organization.

Based on these arguments we propose that aircraft operators should be made the accountable entity for purchasing offsets. However, other entities such as aircraft manufacturers, airports, ANSPs or governments would indirectly contribute to reducing CO_2 emissions of international aviation or involved in administering the ACOS.

3 Breakdown of the target

Entities would need to buy enough offsets so that the total amount of offsets equals the amount of emissions exceeding the target. If aircraft operators are obliged to purchase offsets, each operator would need to know how many offsets it would need to buy. Basically there are at least the two following options:

(1) Individual rate: Divide the target among aircraft operators so that each of them has its own target;

(2) Sectoral rate: Determine a share of actual emissions which needs to be offset.

(3) Hybrid option: One part of the requirement to offset emissions would be determined through option 1 while the other part would be determined through option 2.

3.1 Individual rate: Divide the target among aircraft operators

Under option 1 each aircraft operator would be required to offset all emissions above its 2020 level. Aircraft operators with emissions below or equal to their 2020 emissions would have no need to acquire offsets. In this way the sector-wide target would be broken down among the aircraft operators. There are several ways to divide the target among aircraft operators. The division could be based on emissions in a base period[2], or on transport performance in a base period (benchmarking[3]).

If the division is based on historic emissions, it would have the advantage that the emissions can be determined unequivocally. Each participant gets the direct incentive to keep emissions below his historical base period emissions, the costs per emission above the threshold are directly translated into the cost for offsets. The disadvantage is that operators which have reduced their emissions before or in the base period (early action) would not be rewarded. More-

[2] The base period could be one single year or a number of years to eliminate the impact of exceptional events within the base period.

[3] Under the benchmark approach either the globally aggregated aviation emissions or the aggregated emissions of the top x% of best performing aircraft operators would be divided by the respective transport volume measured in RTK. The resulting emission factor (CO_2/RTK) is the benchmark. The base period emission of an individual aircraft operator would be determined by multiplying its transport volume in this period with the benchmark. Aircraft operators whose actual emissions are relatively lower than those of others would profit because they would receive a comparatively higher baseline and would thus need to purchase fewer offsets.

over a special increase of 2020 emissions might be induced by operators resulting from the knowledge that these emissions will be counted as the individual baseline. Operators with faster growing activities would, in addition, have a rapidly increasing shortfall. A division based on historic transport performance rather than emissions would not penalise early action (since aircraft operators which have lower emissions per revenue tonne kilometre (RTK) would need to require fewer offsets) but would still leave faster growing aircraft operators short.

3.2 Sectoral rate: Determine a share of actual emissions

Under option 2 the target would not be divided. All aircraft operators would instead be obliged to offset a certain share of their actual emissions. If the target in a given year is, for example, equivalent to 80 % of the total emissions, on average each aircraft operator would have to offset 20 % of its emissions in that year.

This offset share can be determined either ex-ante (e.g. for year x+1 based on the emissions in year x-1) or ex-post. If it is determined ex-post, aircraft operators would need to estimate the expected share when deciding on the offset acquisition strategies. However, since they already need to handle many uncertainties in the strategies such as demand and fuel price, etc., the incorporation of the offset price may not be problematic, particularly as this uncertainty is somewhat linked to individual and global output. If the offset share is determined ex-ante, this uncertainty is apparently eliminated. However, since it is unlikely that the target is exactly met, any shortfall or excess in offsets needs to be corrected ex-post. The difference between both options in terms of environmental integrity is likely to be negligible but the ex-post approach seems to be administratively somewhat leaner.

3.3 Hybrid option: Combination of option 1 and 2 (x/y %)

Under option 3 parts of the emissions would be determined by option 1 while the other part would be determined by option 2. The contribution of option 1 and 2 for determining the actual offset requirement may also vary over time so that the contribution of one of the options may decreases over time while the contribution of the other option would increase.

3.4 Discussion and conclusion

If the target is not divided (option 2) all entities need to acquire the same amount of offsets per unit of emissions, whereas in the case of a division of the target (option 1) some operators might have to acquire offsets and others might not need to or to a lower extent. So in the case of no division, all aircraft operators would have a similar incentive to reduce emissions as it would reduce their costs whereas in the case of a subdivision of the threshold only those operators with a shortfall would have the incentive.

Both options are aligned with the polluter pays principle, though not entirely. If the target is not divided, each polluter pays for only a share of the additional emissions it causes. If the target is divided, growing aircraft operators pay the full costs of additional emissions, but stagnant or decreasing aircraft operators do not pay, even though they emit.

An advantage of option 1 is that the marginal costs of emitting CO_2 equal the social costs. In theory, this would lead to a socially optimal level of emissions. In option 2, the marginal costs

of emitting CO_2 would be lower than the social costs, resulting in emissions that are higher than socially optimal, but lower than in a situation without ACOS.

An advantage of option 2 is that it does not require the politically difficult process of dividing the target among aircraft operators. To avoid lock-in of the aviation market's current structure, such division would involve designing several additional provisions for fast growing routes or aircraft operators, for reflecting early action, and for new entrants and aircraft operators ceasing operations. In several market-based instruments and in setting standards, these issues have proven to be very difficult to handle. It is expected that dealing with such issues in a global system with very different starting points of states, routes and aircraft operators, this would be even more difficult.

Moreover, such distributional processes are subject to lobbying and do not always lead to fair results. Unfair target-setting for individual aircraft operators could result in market distortions. Since option 2 bypasses the process of setting targets for aircraft operators, it does not distort markets.

However, a significant drawback of option 1 and 2 is that they put a relatively higher burden on either fast growing aircraft operators (option 1) or incumbent aircraft operators (option 2). Neither of these options may thus be acceptable for all aircraft operators. Option 3 would include elements from both options and would neither give a relative advantage to fast growing or incumbent aircraft operators but strike a balance between the diverging interests. Specific provisions for fast growth or new entrants would not be required since these developments of the market structure would implicitly be reflected through the part of the requirements based on actual emissions so that at least some complexity could be avoided. The following table summarizes the different pros (▲) and cons (▼) of each of the options:

Tab. 2: Comparison of options to bread down the target

	1) Individual rate	2) Sectoral rate	3) Hybrid (x/y%)
Environmental integrity	▲ Incentives to reduce emissions within the aviation sector	▼ Incentives to purchase offsets (rather than reducing emissions within the sector)	▲ ▼ Incentives to reduce emissions within the aviation sector higher than in option 1 but lower than in option 2
Environmental economics	▲ ▼ Aircraft operators have the same marginal costs (= social costs) provided that emissions are above the individual baseline	▲ ▼ Aircraft operators have the same average costs	▲ ▼ Aircraft operators have neither the same marginal nor the same average costs
Early action	▼ ▲ Early movers would be penalized (fewer base period emissions); could be addressed through a benchmark approach	▲ Early movers would implicitly profit (fewer actual emissions)	▲ Early action should be addressed through a benchmark approach and would implicitly profit in the part of the requirement determined by option 2
Fast growth	▼ Higher burden on growing aircraft operators than on incumbent aircraft operators	▲ No specific provisions for reflecting growth required	▲ Changes in the market structure can be reflected by Option 2, no specific provisions for reflecting growth required
New entrants	▼ May require establishing a reserve including rules how to fill and how to use it	▲ No specific provisions for reflecting new entrants required	▲ Changes in the market structure can be reflected by Option 2, no specific provisions for

	1) Individual rate	2) Sectoral rate	3) Hybrid (x/y%)
			reflecting new entrants required
Individual emissions declining below the 2020 baseline	▼ May require establishing specific provision	▲ No specific provisions required; would be reflected implicitly	▼ May require establishing specific provision for option 1
Perverse incentives	▼ Incentive to increase emissions in the base period	▼ Tragedy of the commons (all have to pay if some increase their emissions)	▼ Incentive to increase emissions in the base period and tragedy of the commons
MRV	▼ Route specific data for base period and actual years required	▲ Route specific data only in actual years required	▼ Route specific data for base period and actual years required
Administrative issues	▼ High complexity, special provisions for early action, new entrants, etc. required	▲ Low complexity, fewer provisions to reflect market developments	▲ Low complexity, fewer provisions to reflect market developments
Political support	▲ ▼ Preferred by large incumbent aircraft operators	▲ ▼ Preferred by fast growing aircraft operators	▲ Could balance interests of incumbents and growing aircraft operators

Source: Authors' own compilation

Option 1 takes account of the specific situation of incumbent aircraft operators which already have a large volume of traffic. In their past decisions they could not take into account the new regulation which would be introduced by the ACOS. In this regard, fast growing aircraft operators are in a better position because they do not yet have a large traffic volume and can consider the new requirements when they decide on extending their traffic supply. This difference in starting positions justifies the inclusion of option 1 into the hybrid option. However, incumbent airlines have also gradually improved their carbon efficiency in the past. Due to this autonomous efficiency gains they can provide their based year traffic volume with significantly less CO_2 emissions in the future. The contribution of option 1 to determining the offset requirements could therefore be gradually reduced over a period of about 10 years so that at the end of that period the requirement would be purely based on the sectoral rather than on the individual rate, which – at that time – would be derived from a somewhat distant period in the past and does not have to deal significantly with the actual market situation at the end of that period.

We favour determining the number of emissions to be offset by an individual aircraft operator based on the hybrid option (3) which takes into account both the individual rate (option 1) and the sectoral rate (option 2). To take account of early action we suggest applying the benchmark approach for the base period rather than actual emission. Other provisions to reflect changes of the market structure compared to the base period would not be required because such changes would be sufficiently reflected through the share of offsets which is determined based on option 2. We also suggest gradually reducing the share of option 1 in the hybrid option since the reason justifying its inclusion at the beginning disappears over the course of several years. This approach is simple and treats all aircraft operators operating on the same route in the same way, thus refraining from distorting competitive markets.

4 Differentiation of the obligation

The Assembly resolution specifies that an MBM should take the different situation of States (in particular developing States) into account without distorting markets. Hence, obligations should be differentiated. The resolution mentions two options to this end:

- A phased implementation of an MBM for particular routes; or
- De minimis exemptions for States with a small share in global aviation activity measured in revenue tonne kilometre (RTK).

In the sections below, we analyse how such differentiation could be implemented.

4.1 Differentiation by nationality of the aircraft operator or route-specific

Two basic approaches can be distinguished for distribution of obligations:

- Aircraft operator-based: different aircraft operators would have different requirements, depending on the country in which they are registered;
- Route-based: different routes would have different requirements, depending on the country of departure and/or arrival.

The impact of both approaches with regard to carbon leakage and distortion of international competition are quite different:

- An aircraft operator-based differentiation would be administratively simpler than a route-based differentiation because all flights of an aircraft operator would fall within the same regime. However, it would also distort competition on routes on which aircraft operators from different States operate. Aircraft operators which face lower requirements would have lower costs and could increase their market share at the expense of aircraft operators which face higher requirements. Hence, while this could be seen as a way to take the specific situation of States into account, it would not satisfy the criteria of minimizing market distortion;
- A route-based differentiation would imply that aircraft operators fly routes with different CO_2-related requirements. All direct routes between country-pairs would be assigned to one of three to five route groups with diverging requirements for reflecting SCRC. This would probably be administratively more complex than an aircraft operator-based differentiation. However, it would have the advantage that on direct routes, there is no distortion of competition as all aircraft operators face the same requirements. On indirect routes there could still be a distortion of competition, but only when the passenger has a choice between hubs in countries with different requirements. The specific situation of States can be taken into account without problems arising.

Hence we conclude that a route-based differentiation best satisfies the criteria which the resolution sets for MBMs.

4.2 Ways to implement the difference in obligation by routes

If the total amount of offsets is calculated, a percentage of offsets compared to a unit of emissions has to be defined depending on the flight routes concerned.

The differentiation of requirements to contribute to global CO_2 mitigation efforts can be implemented by means of different **stringency levels**: On routes between two highly developed countries aircraft operators would need to buy offsets for a larger share of their emissions than on routes between two less developed countries. An extreme case would be that some routes would be completely exempted. For example, if aviation emissions are 20 % above the collective target, aircraft operators could be required to buy offsets for 30 % of their emissions on routes between highly developed countries, and 10 % on routes between two less developed countries. Routes to or from the least developed countries (LDC) could be exempted altogether.

The table below illustrates how the requirements to surrender offsets could be differentiated if four country groups (CG) were established:

Tab. 3: Country and route groups

Departure \ arrival	CG1	CG2	CG3	CG4
CG1	2020+X	2020	2020-Y	0
CG2	2020	2020	2020-Y	0
CG3	2020-Y	2020-Y	2020-Y	0
CG4	0	0	0	0

Source: Authors' own compilation

LDC would, for example, be assigned to CG4. Flights within the country group but also flights arriving from or departing to other country groups would initially be exempted from requirements to purchase offsets. Industrialized countries would, for example, be assigned to CG1. Flights within the country group would face the highest offset requirements while flights to or from CG2 or CG3 would face lower requirements.

One special case could be a **phased approach**, only differentiating routes into routes for which offsets are due with an equal percentage of fuel consumed and routes, which are not included for the time being. A gradual expansion of the system to include all routes at a certain point in time would be decided. However, all flights should be subject to monitoring requirements from the start of the system, even those which would temporarily be excluded from mitigation requirements.

However, any easing of requirements on some routes induces more stringent requirements for others to ensure that the 2020 target is actually met.

An approach with different stringency levels is our preferred approach as all routes are then included in the scheme from the beginning and it would be easier to take into account the specific situation of States for the entire timeline of the scheme. In addition if all routes are included from the start, the possibility of evading the system is minimized.

4.3 Criteria for differentiation of routes

The differentiation of routes into groups could be based on several criteria or a combination thereof:

(1) The share of routes in total aviation (a de minimis threshold);

(2) The maturity of aviation markets, e.g. expressed as the number of arriving or departing revenue tonne kilometre (RTK) per inhabitant;

(3) Economic development, e.g. expressed as GDP per capita.

In the ICAO Resolution, the Council is requested to assess the impact of exempting flights to and from developing states whose share in global aviation activities is below 1% (A38-18, paragraph 17).[4]

Assuming that global aviation activity can be measured in RTK and further assuming that developing states would be all States which are neither EU nor OECD, slightly more than 50 States would be covered while about 100 would be exempted. Such a threshold would exclude approximately 25 % of emissions. The economic development of the States above the threshold varies greatly. It appears that the share in total revenue tonne kilometres is a function of total demand (population times income per head), rather than of the maturity of the aviation market or economic development. Therefore we do not see how such a threshold can be applied equitably.

The maturity of the aviation market can be expressed in a number of ways, ranging from simple indicators such as income elasticity of demand, RTK per unit of GDP and RTK per head to more complex indicators such as the sum of GDP and revenue growth divided by traffic growth (University of Westminster 2010). Because there is no common definition, more analysis would be needed to evaluate whether a good indicator can be established.

For reflecting differences in economic development among countries the following indicators may be considered:

- GDP per capita;
- Existing groupings such as by the World Bank (high income OECD, high income non-OECD, middle income, etc.) or UN (LDC, SIDS, etc.)

In the end, data acceptance and availability may be more important than the appropriateness of each of the individual criteria. It would also be possible to let each country choose its appropriate category, which would maximize acceptability. And since all indicators change over time, the assignment of routes between country-pairs to route groups needs to be reviewed regularly, e.g. every five years.

A combination of a de minimis threshold and a measure of economic development would have the advantage that good indicators exist for both the size of the markets and the economic development of countries linked by a route. The value of the de minimis threshold should be determined in a way that it exempts at maximum of 10% of the global CO_2 emissions from international aviation.

4.4 Conclusion on how to take into account specific situations of countries

There are many ways in which to differentiate between countries in a global offsetting scheme. In order to minimize market distortions, the differentiation should not take the nationality of aircraft operators into account. Instead, the differentiation should be implemented with vary-

[4] The EU Commission (COM (2013) 722) proposed its own definition for a “de minimis exemption”, which needs to be analysed in more detail and is not further pursued here.

ing stringency for different route groups. The criteria for assigning routes to route groups could be based on a combination of economic and aviation indicators such as a de minimis threshold for routes between developing countries.

5 Environmental integrity

The quality of offsets[5] is important for the environmental integrity of the ACOS because CO_2 emissions will not be reduced in the aviation sector itself but elsewhere. If the certificates used to offset CO_2 emissions in the aviation sector are not issued for real emission reductions, global CO_2 emissions would not be reduced. Therefore only offsets, which represent measurable and additional emission reductions with long-term benefits for the environment, should be eligible under the ACOS:

- Emission reductions need to be additional to ensure that the emission reduction would not have happened anyhow because it would have been economically attractive or required for other reasons (air quality, etc.).
- Long-term benefits are required in order to guarantee that the reductions are permanent and are not released again.[6]

If the offsets stem from cap and trade schemes, it needs to be ensured that the targets of these schemes are significantly below the business as usual projections and do not result in so-called hot air, i.e. offsets which do not represent a real emission reduction. Moreover it has to be ensured that units surrendered for offsetting emissions under ACOS are not used for other purposes elsewhere to avoid any double counting.

Currently it is difficult to predict which offsets would be available after 2020. The variety of potential offsets may include:

- units generated under the Kyoto Protocol's flexibility mechanisms, Clean Development Mechanism (CDM), Joint Implementation (JI) and International Emissions Trading (IET) among Kyoto Protocol Parties provided that these mechanisms remain available after 2020;
- units issued under sectoral mechanisms currently negotiated under the UNFCCC (New Market Mechanism – NMM & Framework for Various Approaches – FVA);
- units generated by countries or groups of countries under domestic emissions trading schemes or other market-based instruments;
- units issued by private initiatives such as the Gold Standard or the Verified Carbon Standard (VCS), currently mainly aiming at offsetting emissions from companies under corporate social responsibility (CSR) initiatives.

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[5] Offsets are often considered as units generated under project-based baseline and credit schemes. However, this is a very narrow understanding of the offsetting concept as it excludes all allowances from cap and trade schemes. In this paper, we therefore use a broader definition of offsets, which includes all emission reduction units or emission allowances that are issued for activities outside the physical coverage of the respective scheme. In the case of the ACOS, units issued for activities outside of the aviation sector would be considered as offsets.

[6] This could, for example, occur if CO_2 emissions are sequestrated through enhancing forests. A forest fire may reverse the sequestration and release the CO_2 again.

The outcome of the UNFCCC negotiations is difficult to predict. Many developed countries consider market-based mechanisms as a central building block of the new global climate agreement, but diverge regarding the way in which new mechanisms should be designed and existing mechanisms should be improved. Many developing countries highlight that market-based mechanisms require a level of mitigation ambition high enough to generate a market price and consider the implementation of such mechanisms contingent on the outcome of the negotiations on mitigation targets. Some developing countries reject all market-based approaches under the UNFCCC since they consider the commodification of natural resources as the cause rather than the solution of climate change.

Since the outcome of these negotiations is uncertain, it is difficult to determine which units will be available after 2020 and to which extent they represent reliable offsets that ensure environmental integrity. It would be premature to limit the eligibility of specific units the ACOS at this point in time because changes in the design of market-based mechanisms may, in the course of the negotiations, make their environmental quality better or worse. Currently it is more important to agree that any unit used for offsetting aviation emissions must not undermine the environmental integrity of the ACOS and to agree on the general criteria for assessing whether this requirement has been fulfilled or not.

Units issued under the UNFCCC may in principle be eligible. However, past experience shows that the environmental integrity of many offsets issued under the UNFCCC has also been questioned. Concerns raised with regard to units issued under the CDM[7] relate, among others, to the following issues:

- Determination of additionality: project developers have usually more detailed information than regulators (information asymmetries); it is therefore always difficult to determine whether a project was carried out due to the support provided by the CDM or whether it would have been carried out anyway. If a project would have been carried out anyhow, no units should be issued since otherwise those units would not represent additional emission reductions and would thus undermine the environmental integrity of the scheme.
- Perverse incentives: For some industrial gas projects such as HFC-23 with very low mitigation costs, the revenues from the CDM provided the perverse incentive to increase the generation of greenhouse gases in order to generate more offset units; due to the review of the calculation methodologies these incentives are eliminated for new projects; however, for existing projects many such units have been issued and thus have already undermined the credibility of the CDM.
- Signal to noise issue: For some projects such as large power plants the impact of the CDM is much smaller than the likely variations of other input variables such as fuel prices. Since the determination of additionality involves large uncertainties in these cases, it is often suggested that such types of projects are excluded entirely.

To address these loopholes, the EU excluded certain unit types for compliance under the European Union Emissions Trading Scheme (EU ETS). Units from CDM projects reducing industrial gases such as HFC-23 and N_2O from adipic acid production were thus excluded from the third

[7] For more details on the concerns see, inter alia: Schneider 2009, AEA 2011 or Spalding-Fecher et al. 2012.

period of the EU ETS. Units from hydropower projects which did not comply with the requirements of the World Commission on Dams had already been excluded from the start of the EU ETS. Similar eligibility requirements may be needed to ensure the environmental integrity of the ACOS.

Another option would be also to establish project-based aviation offsets. Such units may be attractive from the perspective of aircraft operators if they also develop their own mitigation projects which they can use in their environmental communication strategies. Since the ACOS will eventually cover all aviation emissions, such offset projects need to be established outside the core aviation sector and may include measures such as efficiency improvements or fuel switch of airport buildings or improvements of ground logistics. A fundamental question for this approach would be whether the administration – including scrutinization and verification of the design and implementation of such mitigation projects – should be established under the ICAO or elsewhere. Since such measures are quite similar to projects types which are already established under the CDM, we do not see any merit in establishing parallel structures under the ICAO but rather recommend developing such aviation specific offsets projects under the CDM, provided that it would be available after 2020.

In summary, we can conclude that environmental integrity can only be ensured through stringent eligibility criteria which exclude any unit that does not guarantee emissions are actually reduced elsewhere. Eligibility should also be limited in terms of years of generation so that only units generated after the start of the ACOS would be eligible. Units from other schemes should at least comply with the environmental standards established under UNFCCC and should only be eligible if they are recognized for compliance towards UNFCCC targets. This would, however, require a thorough conformity check of such schemes which ensures environmental integrity and avoids double counting.

6 Organizational aspects

Based on the elements discussed above the organization of ACOS can be outlined. A flow chart with key elements is shown in Fig. 2. Key actors in the proposed scheme are the ACOS administration, States and aircraft operators. Prior to the start of the compliance period the rules need to be specified by the ACOS administration defining route-obligations in order to enable aircraft operators to assess how many offsets they will be required to surrender for compliance. This is carried out by comparing historical or projected emission with the target and the consideration of eventual recalculations, taking into account surrendered offsets of the most recent year.

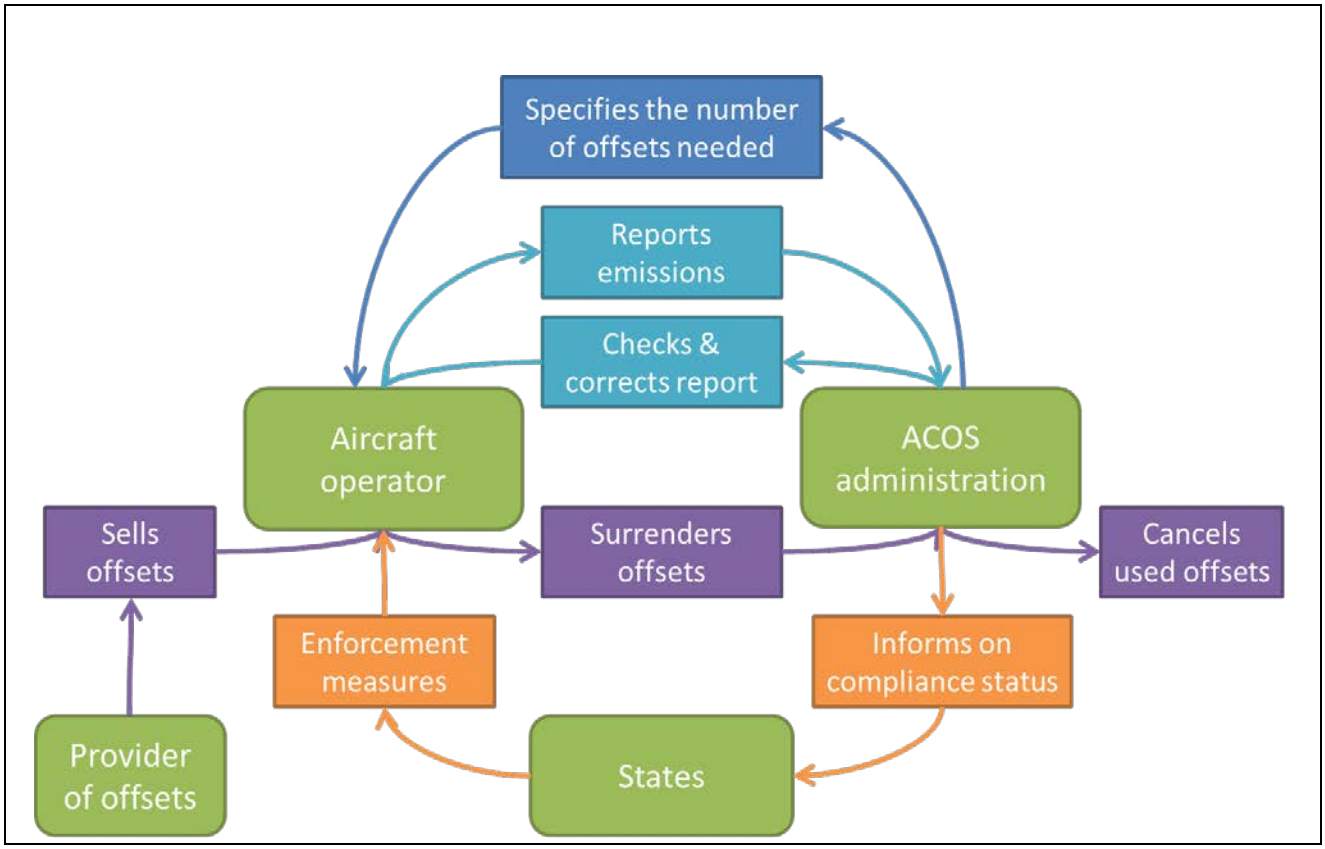
The aircraft operators are responsible for monitoring emissions and reporting these to ACOS administration, which operates a registry in which all aircraft operators, their annual emissions and compliance status are recorded and published. Aircraft operators are currently obliged to record the amount of fuel on board before take-off and after landing; based on this information emissions can be calculated for every flight and attributed to routes. Aircraft operators will have to report their emissions per route to the ACOS administration as different routes will face different obligations. Emission reports should include background information which enables checking the accuracy of the report. The exact parameters required for reporting would have to be defined when implementing the monitoring system; possible parameters include flights per route, plane type, and fuel used. The ACOS administration receives the report for

checks and may request clarifications and/or corrections if needed. Based on the emissions reported and the rules defining the amount of offsets to surrender, the ACOS administration calculates the number of offsets that the operator has to surrender for cancelations.

The aircraft operator will have to buy the number of offsets corresponding to their obligation to surrender allowances. The offsets will need to meet certain criteria in order to fulfil the criteria of environmental integrity (see chapter 5). The offsets are surrendered to the ACOS administration and cancelled by the administration to make sure no credit is used twice.

The ACOS administration reports on the compliance status of operators to all States. In case an operator is not compliant, e.g. has not surrendered sufficient offsets or has not reported emissions, the States in which the operator's aircraft touches ground shall undertake enforcement measures previously agreed when setting up ACOS. Possible enforcement measures could be limitation, suspension or revocation of the operating authorisations or technical permissions of the operator, detention of aircraft and refusal to provide service.

Fig. 2: Flow chart of ACOS



Source: Authors' own drawing

Verification of emission reports should be carried out on a high administrative level under the ACOS. As good statistical data on aviation movements is available in general, the verification could be conducted by randomly selecting a certain amount of operators per year. This would result in lower administrative costs compared to the employment of verifiers by operators.

7 Adoption

ACOS should be adopted as a new volume of Annex 16 “Environmental Protection”.

In accordance with Resolution A38-18, the ICAO Council, amongst others, should make a recommendation on a global MBM that appropriately addresses the major issues, problems and key design elements and report the results for decision by the 39th Session of the ICAO Assembly in 2016. This work should be supported by the Member States and the Committee on Aviation Environmental Protection (CAEP) of the ICAO. In accordance with Article 48 of the Chicago Convention the decision of the Assembly shall be taken by a majority of the votes cast.

In a next step, the new volume of Annex 16 “Aviation Carbon Offset Scheme” with the standards and recommended practices (SARPs) of the global offsetting scheme should be adopted by the Council in accordance with Article 54 and 90. The adoption requires the vote of two-thirds of the Council at a meeting called for that purpose and shall then be submitted by the Council to each contracting State. The new volume of the Annex 16 shall become effective within three months after its submission to the contracting States unless in the meantime a majority of the contracting States register their disapproval with the Council.

Further, in accordance with Article 90 lit. b), the Council shall immediately notify all contracting States of the coming into force of the new volume of Annex 16.

In accordance with Article 38, any State which finds it impracticable to comply in all respects with the global offsetting scheme ACOS, or which deems it necessary to adopt regulations or practices differing in any particular respect from those established by the ACOS, shall give immediate notification to the ICAO of the differences between its own practice and that established by the ACOS.

8 Conclusion

The design of ACOS aims at ensuring carbon neutral growth of the aviation sector with a minimum of administrative complexity. In addition, global coverage and the minimization of carbon leakage have been guiding ideas, always reflecting the need to take into account the specific situation of States. Contentious debates on the distribution of revenues with a high risk for continuing the prevailing deadlock are also avoided since ACOS does not involve any financial flows except for the direct purchase of offset units by aircraft operators. The key design elements of such a scheme and their recommended characteristics are summarized below:

- **The accountable entity for buying the offsets should be the aircraft operator**
  - Offset acquisition is done by those who have the direct incentive to reduce emissions;
  - Reduction of administrative costs;
  - Costs of offsets are not perceived as a charge, leading to higher political acceptance.
- **The amount of offsets to be purchased by aircraft operators would be determined based** on both the sectoral and individual rate (hybrid option)
  - All aircraft operators would have a similar incentive to reduce emissions;
  - The hybrid option strikes a balance between the conflicting interests of incumbent and fast growing aircraft operators ;

  - No elaboration of provisions for new entrants and fast growing aircraft operators needed.
- **Specific situations of States will be taken into account by different stringency levels for different route groups**
  - No distortion of competition on direct routes as all aircraft operators face the same requirements;
  - Specific situation of States can be reflected through a combination of aviation market indicators and measures for economic development;
  - All routes are included in the scheme from the beginning;
  - Possibility of evading the system is minimized.

The environmental integrity of the scheme strongly depends on the quality of offset units which shall be used to compensate CO_2 emissions from aviation. Therefore only offsets which represent **measurable and additional emission reductions** with **long-term benefits** for the environment should be eligible under ACOS.

Certainly, many more details need to be discussed and agreed. However, these basic design elements could constitute a good starting point for developing the global aviation carbon offset scheme under the ICAO since it provides a design for an offset scheme which covers all countries, takes into account differences among countries and would enable the aviation sector to contribute appropriately to the global challenge of addressing climate change.

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