

Aviation and the EU ETS

Lessons learned from previous emissions trading schemes

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ABSTRACT

Designing an emissions trading scheme requires in-depth knowledge about several aspects. This paper attempts to clarify some important design points of the forthcoming emissions trading scheme for aviation under the EU ETS. Five general key points of system design are acknowledged and comparisons are made to previous and current emission trading schemes. Above all, it is argued that initial allocations of emission permits and the trade barrier between the aviation sector and EU ETS need to be carefully examined.

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1. Introduction

In a constantly expanding global economy, aviation has a key role. There are no other methods of transportation that have the possibility to deliver passengers and goods across regions at the same speed and efficiency. According to Air Transport Action Group, ATAG, (2008) aviation contributes with 1.1 trillion US dollars to the global economy, corresponding to 2.3% of the world total GDP. The air transport sector also generates, directly and indirectly, 32 millions job opportunities globally. However, a large uncontrolled growth rate in the aviation sector also implies a growing impact on the environment.

In accordance to the goals set up by the Kyoto Protocol, carbon dioxide emissions from the members of the European Union decreased by roughly 5% between 1990 and 2003. Emissions from the aviation sector are however not restricted under the Kyoto Protocol. During the same time period the total contribution of carbon dioxides emissions from aviation increased by an astonishing 73% (Wit et al, 2005). According to the Intergovernmental Panel on Climate Control (IPCC, 2007) the aviation sector was responsible for 2% of global CO₂ emissions in 2007.

The aviation sector is estimated to grow with a rate of roughly 5% per annum. Depending on improvements in fuel efficiency and flight frequencies, this might potentially lead to an increase in emissions of greenhouse gases in the range of 3-4% annually. That is, if no effort is put into limiting and reducing the global environmental impact from the sector (IPCC, 2007). Thus, it is crucial to implement some control on emissions coming from the air transport sector. Based on the definition by Coase (1960) that ownership regards user rights rather than a physical relationship, theories for tradable permits for emissions emerged as one

economical instrument that leads to the sought after efficient market solutions (see Dales, 1968). Trading of emissions permits has been used historically to rectify environmental external costs with varying success. Starting on January 1st 2012 all emissions from civil international aviation, arriving and departing within the European Union, will be monitored and controlled through issuance of emission permits.

Introducing emissions trading for the aviation sector arises a few questions regarding the design and the execution of the scheme. There are a few key points that need to be carefully evaluated and discussed. In this paper we will discuss the following:

- *Method of allocation* – How should permits be allocated in order to achieve the best possible result from the system? Is there one method of allocating allowances that would be strictly preferred to any other?
- *Liability* – Is it of importance who is held liable for emissions from aviation? What options are available and suitable for the aviation sector?
- *Trade barriers* – Aviation can be either included or excluded (i. e. allowed or not allowed to trade with other industries) from the EU ETS.
- *Inter-temporal trading* – Both banking and borrowing are considered to be important parameters in the design of an efficient emissions trading scheme. Could trading over time be a problem for the system?
- *Hot-spots* – In accordance with current system design for the aviation sector, is there a potential threat of hot-spots where emissions from ground level sources cannot be counted the same as those from aviation?

In order to answer these questions and be able to draw some conclusions, strengths and weaknesses of previous emissions trading schemes will be examined. In section 2 we will discuss the five key points of system design more in-depth. Keeping these key points in mind,

section 3 will briefly discuss the effects and results of five previous and current emissions trading schemes. Following, in section 4, we will give some concluding remarks on what we have seen in previous systems and what to we aspects are of importance to consider when designing the system for civil international aviation.

2. Key design points

Allocation

Emission permits can either be distributed for free or by charging emitters a price for each allowance that they need for the coming period, the latter is normally done by auctioning. There are three main methods of distribution that we can consider for aviations implementation into the EU ETS.

- *Grandfathering* implies that permits are distributed free of charge based on historical emissions. This method of allocation has dominated the previous trading periods of the EU ETS and has also been suggested for the aviation. It is also the most common choice of allocation mechanism from a policy perspective as it is easier to gain political acceptance from the trading sectors (Anderson, 2001). When using grandfathering as the method of allocation one has to be careful in calculating the baselines of emissions. It is possible that historical emissions were unusually high (or low) due to some external unforeseeable force in the economy. For example, the 9/11 terrorist attacks on the United States in 2001 led to a huge decrease in demand for air transport reaching far into 2002 (Morell, 2007). If baselines would be calculated using these years, allocation would be a lot lower than actual emissions, thus generating very high market prices. Using baselines of historical emissions can also create competitive advantages for firms with relatively high historical emissions while generating high cost to, for example, low price carriers who have shown a

large growth during the past decennium (Frontier Economics[†], 2006; Morell, 2007).

It is also possible that grandfathering based on historical emissions lead to perverse incentives for firms to emit more today as they expect to receive more permits in the future by doing so (Hepburn et al, 2006).

- *Benchmarking* is another method of free allocation. It is also, like Grandfathering, based on some baseline of historical emissions, however, it adds a sector specific measure. Morell (2007) suggests that revenue ton kilometers should be used for aviation. If this is done, aircraft operators with high efficiency levels, i. e. the ones operating at high capacity without unused space on board the aircraft, will benefit. By using benchmarking, short haul flights would be penalized (due to generally higher emissions per passenger) possibly leading to higher demand for other types of transportation. Morell (2007) argues that this is the desirable way of allocating allowances for the aviation sector in the EU ETS.
- *Auctioning* allowances has great support in the scientific literature. Hepburn et al (2006) promote auctioning particularly for the EU ETS stating that it would lead to less competitive advantages for some firms and that it would increase the over all efficiency of the scheme. Auctioning would also eliminate the perverse incentives such as delaying fleet renewal to keep emissions at a high level for future calculations of historical levels. There is a strong presence of asymmetric information when calculating base-line emission levels, aviation operators are more likely to accurately estimate their historical levels of emissions than their counterpart. One question that arises with auctioning is how to use the revenue that the auction generates (Andersen, 2001; Morell, 2007). In Morell's (2007) opinion the revenues

[†] Frontier Economics prepared the report on behalf of The European Low Fares Airline Association (ELFAA), it is the first industry response to the implementation of aviation in the EU ETS.

from an auction should go to CO₂ reducing activities, they could however be used in any way deemed suitable by the controllers.

Currently, all participants interested in receiving emissions allowances will have to apply for them, a large part will be issued free of charge by grandfathering based on average historical emission levels between 2004 and 2006 while only 15% will be available for auctioning. The general idea with the EU ETS is to increase the number of allowances put up for auctioning in each period. The revenues from auctioning can be used quite freely by each member state but it is suggested they be used in emissions reducing activities such as research for more fuel efficient engines. For the first year of trading, i.e. 1st of January to 31st of December 2012, the total amount of allocated emissions allowances will sum up to 97% of the historical emissions to decrease to 95% in the following trading period, phase III of the EU ETS.

Liability

Another interesting question regarding emissions trading for the aviation sector is who will be held liable for emissions and surrendering permits? As of now, the proposal of implementing aviation into the EU ETS states that aircraft operators should be held liable for surrendering permits corresponding to their emissions, this is considered a *downstream* approach where the source of emissions is held liable. Bohm (1999) argues that such a *downstream* approach might lead to some potential problems such as (i) high transaction costs and (ii) exclusion of smaller actors for the trading scheme. If we consider these two criteria, to keep transaction costs as low as possible and to include as many of the emissions sources as possible, the most efficient choice should be obtained. It might be more efficient to place liability on some agent prior to the emitting source, a so called *upstream* approach. Another important criteria is that the chosen source directly or indirectly should be able to influence fuel consumption and

hence have incentives to lower them (Andersen, 2001; Frontier Economics, 2006). This gives a number of options to consider.

- *Fuel suppliers* would simply include the price of allowances in the fuel price, making the aircraft operators inevitably bear the cost of emissions. Even though fuel suppliers do not have any influence on actual fuel consumption an increase in fuel prices would generate a reaction from the air craft operators, thus lowering emissions. Andersen (2001) argues that this option could potentially make it less costly for aircraft operators as there would be no need to enter the market for allowances. Thus, by making fuel suppliers the liable source all firms, large and small, would be implemented into the system. However, in a non-intra-EU trading system it would be easy for non-EU based aircraft operators to avoid paying for emissions simply by refuelling outside of the EU (Frontier Economics, 2006).
- *Aircraft operators* have the largest direct influence over fuel efficiency and fuel consumption. Flight frequency can easily be adjusted to comply with any emission target. Air craft operators are also in direct control of fleet renewal to increase fuel efficiency. The current proposition that air craft operators should be held accountable for retiring permits limits liability to firm size and thus not accounting for all emissions[‡].
- *Airports and Air Traffic Controllers (ATC)* do have some influence on fuel consumption during taxi, take-off and landing. It would be possible to place liability on them instead of aircraft operators. In some cases airports auction their slots to airlines, costs for emissions permits could simply be added on to the price of these slots and in the end air craft operators and its consumers would bear the cost.

[‡] See directive 2008/101/EC for more detail on non-labile firms.

Inter-temporal trade

Inter-temporal trading in form of both banking and borrowing is regarded as one of the key design points of emissions trading that help achieve efficient results. Banking allows firms to store allowances issued now for future use in order to achieve lowest possible present value of the cost of emissions reduction (Kling and Rubin, 1997; Tietenberg, 1999). Allowing borrowing of permits from future trading periods is a more risky venture. If firms are allowed to borrow permits from future allocations and then leave the scheme these permits will not be accounted for. Rubin (1995) argues that the lowest possible cost of abatement is achieved when the system allows for full inter-temporal flexibility.

Trade barriers

Implementing aviation into the already existing EU ETS can be done in several ways. One could choose to just account for aviation as any other polluter in the market, this is called an *open trading scheme*. However, research is divided on whether or not CO₂ and its associated emissions should be counted the same for aviation and land based emission sources (IPCC, 1999; Lee and Sausen, 2000; Wit et al, 2005). IPCC (1999) suggests that the radiative forcing (RF[§]) from aviation's greenhouse gases compared to that of CO₂ alone has a factor of 2.7^{**}. If emissions from aviation are counted differently, aviation should be completely separated from the rest of the EU ETS, a so called *closed trading scheme*. This would mean that a unique ETS would be formed for aviation alone. One could argue that a cap on emissions for the aviation sector might hold back economical growth in the sector. However, this limitation would force liable sources to achieve higher fuel efficiency and hence derive more

[§] Radiative Forcing (RF) is used to measure the impact of greenhouse gases on global temperature. For further discussion about RF, see IPCC, 1999.

^{**} Measured with the use of Radiative Forcing Index (RFI), simply the total RF from a source divided by the RF of its CO₂ emissions alone. As a comparison, the RFI for all human activities is roughly 1 and the RFI for greenhouse gases alone is 1.5.

environmental friendly solutions (Cames and Deuber, 2004). A third option, *semi-open trading scheme*, has been suggested by the European Commission since aviation is not included in the Kyoto Protocol. It has been deemed necessary to separate aviation from other trading as to not create any disruption in the abatement of emissions in all other sectors. Therefore, allowances will be earmarked to either aviation or other industries in the rest of the EU ETS, with the possibility for participants in the scheme for aviation to use permits issued to all other sectors but not vice versa, hence keeping the same cap for everyone else without risking any excess allowances to spill over from the aviation sector.

Hot spots

CO₂ emissions do not have a different effect on global warming depending on what altitude it is emitted meaning that 1 tonne of CO₂ from aviation is equal to 1 tonne of CO₂ from any other industry. However, other greenhouse gases that are CO₂ related, such as O₃ and NO_x that do not share the same characteristics as CO₂. These gases can have either greater or smaller effect on global warming depending on what altitudes they are emitted at. CO₂ only accounts for 37% of the climate impact from aviation (Lee and Sausen, 2000). Therefore, it is possible that the accumulated effect on global warming and climate change will be larger from aviation when only CO₂ emissions are regulated given that the sector is allowed to purchase allowances from other industries, as suggested under the proposed system design. It has been suggested that allowances should be subject to some exchange rate when used for aviation (Lee and Sausen, 2000; Sausen et al, 2005; Wit et al, 2005).

3. Previous Emissions Trading Schemes

As previously stated, this section will discuss, and hopefully clarify, some weaknesses and strengths of historical and current emissions trading schemes relating to the five key points discussed in the previous section.

3.1 EU Emissions Trading System (EU ETS).

In an attempt to reduce the levels of emitted greenhouse gases in accordance with the goals expressed in the Kyoto Protocol, the European Union initiated a cap-and-trade program intended to cover roughly 45 percent of total CO₂ emissions within the area, thus making the EU ETS the largest emissions trading scheme to date. Phase I of the EU ETS stretched from January 1st 2005 to the end of 2007. In this initial phase of the scheme the focus of emissions reduction was put solely on CO₂ although leaving the door open for implementation of other greenhouse gases in phase II.

Each member state have their own targets for emission reductions and they are allowed to distribute the allowances to energy intense sectors within the state. Each member state is also responsible for calculating baselines of emissions. In phase I, 95 percent of allowances were distributed free of charge with a reserve of 5 percent left for auctioning if the member states choose to do so, the share of allowances intended for auctioning will increase for each compliance period and was 10 percent in phase II. Note that these levels of auctioning refer to how much a member state is allowed to put up for auction, this is an upper ceiling rather than a fixed level. In phase I, only 4 member states chose to put up any allowances for auctioning (Betz and Sato, 2006). Phase III of the EU ETS will start in January 2013 and in 2020, the current goal is that emissions will be 20% lower than 1990 levels at the end of phase III.

Problems and solutions

Permit prices were highly volatile at the beginning of phase I. By 2006 when data was published on actual verified emissions and this showed that they were lower than the distributed amount of permits, prices plummeted. According to Rogge et al. (2006) there were a number of contributing factors to the over-allocation of allowances that was seen during phase I of the EU ETS. For example, the information on which baseline emissions were calculated could have been uncertain thus leading to miscalculations. Another important aspect was that when calculating future reductions of emissions an optimistic view of growth rates was used, leading to over allocation.

One major set back for the EU ETS came when the new member states were to be introduced into the trading scheme. There was a dispute of how historical emissions and emission baselines should be calculated for these, primarily eastern European nations. Many eastern European nations rely on fossil fuels for energy production and hence their relatively high historical emissions lead to very demanding emission reductions. The European Commission disregarded these nations own calculations of historical emissions and enforced tighter caps. When this paper was written both Poland and Estonia had won the dispute and are now in reality allowed to set their own emissions targets. Naturally, they are expected to set more generous reduction targets on national firms thus generating more permits and effectively lowering the market price.

3.2 US Acid Rain Program

As the first large scale emissions trading scheme in the world, Title IV of the 1990 Clean Air Act Amendments (1990 CAAA) primarily aimed towards reducing emissions of sulfur dioxide (SO₂) but also nitrogen dioxides (NO_x). Prior to Title IV (known as the US Acid Rain Program) the Environmental Protection Agency (EPA) aimed at reducing a number of air

pollutants. The early programs aimed to reduce emissions were basically ‘command-and-control’ programs where firms received emission targets that they had to follow. In an attempt to lower reduction costs the EPA introduced tradable emission reduction credits. Firms could earn these by abating more than their set up targets and then trade them to other firms who had larger abatement costs or they could bank them for future periods (Tietenberg, 1998).

The US Acid Rain Program focused on emissions from electric utilities relying on fossil fuels. The target for the emissions reduction was set to 8.95 million tons of SO₂ and 2 million tons of NO_x compared to 1980 emissions, thus, a 50 % reduction of SO₂ emissions. The reduction target was to be reached with a cap-and-trade scheme consisting of two phases. Phase I, beginning January 1st 1995, included the so-called Table A units, or the largest polluters in the scheme. From January 1st 2000 all other electric utilities using fossil fuels would be included. Additional reductions of total amount of permits will introduced every year to be fully implemented by 2010 when the total emission reduction target of 8.95 million tons of SO₂ is to be fulfilled.

Problems and solutions

The initial allocation of allowances to Table A listed units were 8.70 millions in 1995, an equivalent of equally many metric tons of emitted SO₂. This initial allocation of allowances was based on total emissions from Table A listed units in 1985, a total of 10.68 million tons. However, due to unforeseen changes in input prices (deregulation of rail road transport prior to 1995 introduced coal with lower amounts of sulfur that was too expensive compared to its high sulfur substitute before the deregulation (Ellerman et al. 1997)) and earlier attempts to meet emissions targets the total emissions from table A listed units only summed to 5.30 tons in 1995. This gap between actual and allowed emissions led to permit prices being much

lower than previously anticipated. Prior to the start of the program in 1995 expectations of the price of permits were as high as 1500 dollars according to Bohi and Burtraw (1997). Instead, auction prices in 1995 cleared at around 130 dollars (Bohi and Burtraw, 1997, Conrad and Kohn, 1996) Market volume was also a lot smaller than expected with only 9% of the affected units reporting that they will rely on trading permits to fulfill their commitments regarding emissions (Rico, 1995).

Although not limited to small geographical areas, emitters of SO₂ and NO_x contribute to acid rain on a regional, not global, level. Therefore there is some risk of local ‘hot spots’ to form when a national emissions trading scheme is implemented to control a regional problem of this sort. At an early stage of the US Acid Rain program two separate trading zones were considered, one for the western states and one for the eastern (Rico, 1995). However, emissions were already somewhat regulated through local health standards, included in these standards were both NO_x and SO₂ (Rico, 1995). In 1979 the so called ‘bubble-policy’ was added to the Clean Air Act, this policy limited local emissions under the existing command-and-control scheme but at the same time let firms interact to achieve lowest possible cost for abatement. This also helped in limiting the creation of ‘hot-spots’ as levels of emissions could not increase above certain levels in one particular area while decreasing in another.

3.3 UK Emissions Trading Scheme

The UK emissions trading scheme (UK ETS) was a voluntary trading program for greenhouse gases initiated in 2002 by the UK government as a part of the UK Climate Change Program. The goal of the UK ETS was to reduce emissions, measured in tons of carbon dioxide equivalents (tCO₂e), compared to a baseline of average historical emissions in the years 1997-

2000. The UK ETS was an economy wide program with two types of participants, referred to as Direct Participants and Agreement Participants.

Through an initial descending clock auction 32 so called Direct Participants bid future emission reductions in exchange for a subsidy until a market clearing price of 53.37 pounds per reduced tCO₂e in 2006 was established. At this price, given the total budget from the UK government of 215 million pounds in subsidies, resulted in 3.96 million tCO₂e avoided in 2006. The scheme design was that the Direct Participants would increase their reductions of emissions with 20% of the final emissions reduction target starting at a level of 20% of the 2006 target in 2002. Hence, total abatement of emissions summed up to 11.88 tCO₂e. Thus, the 32 Direct Participants took part of a cap-and-trade program where each of the firms got endowed with permits equaling their emissions at the baseline subtracted their goal of abatement. The Direct Participants were obliged to report on their total emissions by the end of March every year, starting in 2003. Trading of permits also increased during these periods every year.

The UK ETS also included roughly 6000 firms referred to as Climate Change Agreement Participants (CCA). These were firms who prior to the implementation of the scheme had agreements regarding reductions in emissions with the government stretching to 2010. The CCA's were, unlike the Direct Participants' cap-and-trade system, subject to a baseline-and-credit system. The CCA's received an economical incentive of 80% reduction of the total payments to the Climate Change Levy (this is another instrument in the UK Climate Change Program aimed at taxing all energy use by the industrial as well as the public sectors). If the CCA's, on the one hand, fulfilled their targets they received permits that they could trade or bank for future use. If they, however, failed to meet their emissions target they had the

possibility to purchase additional permits to make up for the difference. The CCA's were to report their total emissions biennially starting at the beginning of 2003. This led to that the majority (as many as 60%) of trades with emission allowances, over the lifetime of the scheme, took place in January and February of 2003 and 2005 (Smith and Swierzbinski, 2007).

Problems and solutions

A report from the National Audit Office (NAO, 2004) suggests that baselines for direct participants were, in some cases, not demanding enough thus resulting in what seemed to be an 'over-achievement' though it was likely due to over-generous allocations. In some cases historical emissions, on which baselines were calculated, drastically dropped in the years prior to the scheme with the following result that baselines and targets were higher than actual emissions at the start of the scheme. This meant that some firms could go on with business as usual, meet their set up targets with ease and receive subsidies from the government. Total abatement from the 32 Direct Participants over the complete lifetime of the scheme summed up to roughly 18.6 million tCO₂e, some 6.7 million tons more than initially agreed upon. The over generous allocations that marked the first years of the scheme left a large excess supply of permits in the bank. If abatement from the 32 Direct Participants would have remained at high levels, a large excess supply of permits would have been left for CCA's to purchase after 2006, when the scheme ended for the Direct Participants, thus severely damaging the market for tradable permits over the coming years until 2010 when the trading period ran out for the CCA's (Smith and Swierzbinski, 2007). With permit prices of close to nothing there would simply be no incentives for the CCA participants to reduce emissions further. However, in 2004 the 6 largest over-achievers took upon themselves to further reduce emissions by 8.9

million tCO₂e thus retiring a large part, but not all, of the excess supply of permits in the bank.

One clear flaw of the design of the UK ETS was the two differentiated participating groups. Letting the DP's and the CCA's trade on the same market although they were bound to different time frames. A system design like this leaves no room for error from one part of the trading groups. Had there instead been a trading barrier limiting trade between DP's and CCA's the potential threat that the large excess resulting from over-compliance would have been avoided. A large part of the problem was the possibility for DP's to bank permits for future use after 2006 when the last compliance period had ended for them, thus potentially leaving a large portion of permits in the bank for the CCA's.

3.4 Chicago Climate Exchange

The Chicago Climate Exchange (CCX) is another voluntary, yet legally binding, emissions trading scheme where companies can join to help reduce emissions. CCX is planned to have a life span over 7 years, starting in 2003 and ending in 2010. The scheme, a cap-and-trade system, is divided into two phases, phase I and II. Participants of the CCX took upon themselves to reduce their emissions by 1 % each year below baseline (average of emissions between 1998 and 2001). Thus the aim of phase I of the CCX was to reduce emissions to a level of 4 % below baseline emissions. For companies choosing to continue in phase II emission targets were set to 6% below baseline in 2010. For companies who choose to join after the initiation in 2003, thus joining phase II, linear annual reduction targets were set up resulting in a 6% reduction below baseline emissions.

The CCX is open to participants all over the world, but a majority of participating members are based in the US. As opposed to the UK Emissions Trading Scheme where the government created an economical incentive to participate through pay-outs under compliance the CCX has no such economical incentive. Instead the CCX offers a good marketing possibility and a head start to potential future obligatory emissions trading schemes.

There are 4 ways of participating in the CCX.

- *Members* are companies and organizations with large greenhouse gas emissions who commit to reduce their emissions within the two phase program.
- *Associate members* are companies and organizations with minor greenhouse gas emissions who commit to offset all of their indirect emissions from energy consumption and transportation.
- *Participant members* can be divided into sub groups. Offset providers and offset aggregators are allowed to create emissions reductions through for example reforestation projects and trade them on the market. Members are also allowed to create offsets. Therefore one criterion is that the offset providers and offset aggregators do not have large emissions of their own. Offset aggregators are umbrella organizations for small offset providers. Liquidity providers are participants who do not take part of any emissions reduction activities but solely want to trade on the market for other reasons.
- An *Exchange participant* is anyone who enters the market to purchase Carbon Financial Instruments to account for their emissions.

Permits to emit, called Carbon Financial Instruments (CFIs), can be acquired in two ways. At the beginning of each year members and associate members are given (free of charge) the

number of CFIs corresponding to their baseline of emission minus the promised reduction for that year. Offsets providers and offset aggregators can also generate CFIs through verified emissions reduction activities (ICAO, 2007). Worth to mention is that members are not allowed to offset more than 50% of their annual emissions reduction targets and hence the market is somehow protected against flooding of CFIs (Hamilton et al, 2008).

Problems and solutions

As in the case with UK Emissions Trading Scheme the first years of the CCX were marked by over-compliance. As of June 2009 results of emissions reductions had been released for all phase I compliance periods and the first compliance period of phase II, meaning 2003-2007. The first period resulted in 11.5% lower emissions than aimed for, the corresponding number for the second period is 14%. The third and fourth periods had over-compliance of 12.2% and 9.2% respectively. In 2007 actual emissions were 4.2% lower than promised. As a result of this, the price CFI's have been generally low in the CCX. Market clearing prices at the beginning of trading in 2003 were 98 cents for each ton of emitted carbon dioxide.

3.5 The Regional Greenhouse Gas Initiative

The Regional Greenhouse Gas Initiative (RGGI) is a relatively new mandatory emissions trading scheme that caps CO₂ emissions from the power sector in ten US states. Each member state auctions of their permits thus raising revenues that are used for renewable energy sources and consumer benefits in the local economy. Auctions for emission permits are held quarterly with the first one in September 2008. The first compliance period, consisting of three years, started on January 1st 2009. Currently the scheme has a proposed lifetime of three compliance periods resulting in a total of 10 percent lower emissions in 2018. Since the RGGI is at the beginning of the first compliance period, and no data on abatement and the

successfulness of the scheme has been released, it is hard to draw any conclusions from the scheme. So far, five auctions have been held and the market clearing prices have ranged between 2.19 and 3.51 US dollars. Since the RGGI relies on auctioning to distribute their allowances it will be interesting to follow the results of the scheme in the future.

4. Lessons learned and concluding remarks

As a concluding remark, let us briefly discuss what we have seen in previous emissions trading schemes and how their weaknesses and problems can be avoided in the coming trading scheme for aviation under the EU ETS.

Allocation

Over all emission reductions have, sometimes greatly, succeeded set out targets in all of the schemes subject to this analysis. It is interesting, and above all, important to know the reasons for this in order to design efficient trading schemes in the future. There are two possibilities to why actual emissions would exceed targets. Firstly, baselines and emission quotas can be calculated too generously. This could be done with or without the regulators knowledge. One could expect emission targets to be more generous in voluntary emission trading schemes to attract more participants for example. It is also possible that information on historical emissions is hard to obtain thus resulting in error margins, large or small. Some variables used to calculate targets, such as growth rate, can be optimistically estimates leading to higher than normal emission targets. When emission targets are too generous some firms might be able to continue with business as usual while receiving permits that they can trade on the market. In this case permits become a pure subsidy and the market for emissions will not regulate the emissions of these firms. In the second case, firms might over-achieve their targets. This is to

be considered positive since emissions are actually decreasing, more so than they were set out to from the beginning.

The current proposition for the trading scheme for aviation states that 85% of permits should be allocated for free using an average of emissions during the years 2004 to 2006. This proposition leaves 15 percent of permits to be allocated through auction, if the participating member states choose to do so. It is important that baselines, based on historical emissions, are calculated correctly. There are a number of distortions in the market that have led to lower demand of air transport and thus to lower emissions for some periods. The terrorist attacks of 2001 led to a down shift in demand that stretched far into 2002. The current financial crisis also has a negative impact on air travel.

If a larger part of permits for the aviation sector would be allocated through auctioning, over-allocation might potentially be avoided since agents on the market rarely would purchase far more permits than needed. However, auctioning does not guarantee the avoidance of over-allocation. This might occur if permit prices are low but can be avoided with a reserve price, however, this has not been observed in any of the previous schemes that we have examined. A natural price ceiling will however apply as no agent in the aviation sector would bid higher than the market price for emission permits in the EU ETS. Hepburn et al (2006) suggest that auctioning should be implemented to a greater extent for the whole EU ETS. Further they argue that auctions could be held roughly every six months to create price stability of permits. Auction, as contrary to grandfathering, is harder to implement on a political level possibly due to the common assumption that it will lead to higher consumer prices.

Method of allocation is also interesting from a distributional point of view. Distribution of emission permits is a distribution of wealth. Ultimately the different allocation methods distribute this wealth to different groups. Auctioning gives a good possibility to use the revenues for additional environmental improvements, such as deforestation or research for fuel efficient engines. Of course, revenues can also be used in any other way, such as tax reliefs for example.

Liability

All of the previous schemes have chosen to hold the direct source of emissions liable for retiring permits, thus implementing a *downstream* approach in allocating liability, in all cases these same agents have also received permits allocated to them. However, these choices are not always clear. In the US Acid Rain program similar results would probably have been achieved by placing liability on coal suppliers be liable. Again, the choice to allocate liability and permits to the direct source of emissions might be due to the fact that it is easier to win political acceptance in this way or simply because transaction costs are at the lowest. Ultimately, the importance does not lie in where the liability and permits are allocated to but rather that the allocated amount of permits is correct in regard to the emissions reduction targets.

Air craft operators have been suggested by the Commission as the liable source of choice. However, this leads to smaller agents being excluded from trade and thus not covering all emissions. Airports (or air traffic controllers) could be an alternative to air craft operators. Given some certain assumptions, the choice of liable agent should not affect the outcome of trade, the interesting criterions are instead to minimize transaction costs and to make the scope of the scheme as large as possible, i. e. to include as much emissions as possible

(Bohm, 1999). There are no clear advantages or disadvantages with either air craft operators or airports (air traffic controllers) that leads to the conclusion that one is strictly better than the other. Both options can easily be implemented. Airports have the clear advantage that, since all air crafts fly to and from them, all flights can be included while air craft operators have the advantage that they are in greater control over fuel consumption and therefore emissions. The question of importance is what alternative would generate the lowest transaction costs of the two. A combination of these two alternatives as liable agents also be possible. Air craft operators could, for example, be held liable for the cruise part of the flight, where they have exclusive control over fuel use and thus emissions. In addition, airports (or air traffic controllers) could be held liable for taxi, take-off and landing, areas where they have influence on emissions.

Inter-temporal trade

The idea behind tradable emissions permits is that the market will allocate permits as to achieve the lowest cost of abating a certain given amount. The same statement also holds over time where an individual firm can allocate its present and future emissions permits as to achieve the lowest possible cost of abatement. However, looking at previous systems for emissions trading none has allowed borrowing from future permits while already issued permits have been allowed to be banked for future use in all of the schemes. Naturally, borrowing poses a problem of asymmetric information where the legislators do not know whether or not the firm will stay in the scheme for the following period. Thus, allowing firms to borrow from future allocations introduces a risk that these borrowed permits will not be paid back in the future. Banking posed a huge threat to the UK ETS where a large excess of allowances would have been left in the bank after 2006 (i. e. the last trading period of the DP's) potentially ruining the whole system. Fortunately drastic measures saved the scheme

from this. However, this problem cannot be blamed entirely on banking but rather on over-generous initial allocation leading to the creation of this huge excess supply. It is possible that if borrowing is allowed air craft operators use a greater part of their permits today and strive for new fuel efficient technology to account for the lower supply of permits tomorrow. In other words, allowing for full inter-temporal trade within the system might lead to more fuel efficient air crafts in the future.

Trade barrier

If one sector has a high cost of abatement without having the possibility to purchase additional emission permits from firms with lower cost of abatement the same emission reduction will apply, but it will be more costly as the firms with higher costs have to abate. One can of course argue that it is in fact the aviation sector that faces higher costs of abatement, and by allowing them to purchase and use emissions from other sectors this problem will never emerge. However, there are other explanations for the use of such a trade barrier in the EU ETS between aviation and the other trading sectors. The EU ETS is the Commission way of achieving the European goals of emissions reduction under the Kyoto Protocol, since the aviation sector is not controlled under the Kyoto Protocol allowing it to trade under the same regime would jeopardise achieving the goals that are set up. For this reason, the Commission has decided to impose this one-way trade barrier such that the aviation sector will be able to use permits from the other sectors but not vice versa. The barrier to trade might be a pure political instrument, with a growth rate exceeding increases in fuel efficiency aviation is expected to have a harder time complying with the goals of the emissions trading scheme, meaning that aviation as a sector probably will be a net purchaser of permits rendering the trade barrier non-effective.

None of the other emissions trading schemes that we have looked at have used any trading barriers between sub-groups, although it was discussed at an early stage of the Acid Rain Program. Legislators estimated that without a trading barrier eastern utilities would sell a large portion of their permits to western utilities thus creating local hot-spots of emissions in the west. Title 1 under the Clean Air Act does however include restrictions on local air qualities so the proposition of two separated trading zones was abandoned (Rico, 1995, Tietenberg, 1998). In the UK ETS we saw two sub-groups that were allowed to engage in trade with each other. The over generous allocation to the DP's posed a threat to ruin the market for permits under the trading scheme. One could argue that separated markets would have avoided this problem altogether but when looking at the reason for this large over-achieving actually creating the problem it can easily be seen that more strict allocations would have avoided the problem as well.

Hot-spots

Since emissions of CO₂ do not have any impact on climate at a local level but rather on a global level there are usually no hot-spot problems regarding trade of CO₂ permits. But, whereas emissions of CO₂ can be accounted for on a one-to-one basis between emitting sectors the impact from other greenhouse gases from aviation on global warming is supposedly larger due to the high altitudes where most of the emissions occur. Evidence suggest that the impact on global warming from aviation is greater than from other sectors due to high altitudes (IPCC, 1999; Lee and Sausen, 2000; Delft, 2005). Allowing the aviation sector to use permits issued for other sectors might increase the negative impact on climate that the systems aims to avoid. Hence, there is a potential threat of “hot-spots” in some sense when implementing aviation into the EU ETS. There was a potential threat of local hot-spots forming under the Acid Rain program, at an early stage two separated trading zones were

discussed as a measure to eliminate the threat but as it showed, the Clean Air Act includes policies prohibiting local air qualities to be lower than a certain level. In a similar way, the problem under the trading scheme for aviation in the EU ETS could be avoided by not allowing the aviation sector to trade with other sectors or by establishing a rate of exchange of permits, however, there is no empirical evidence to support any specific size of such an exchange rate.

Concluding Remarks

The trading system for aviation is unique and different from all the previous systems that we have looked at. Nonetheless, we can learn from previous systems and draw some conclusions from their designs. Firstly and possibly most crucially, as we have seen, initial allocations have played a key role in creating efficient markets for trading of permits. All of the previous schemes that we have looked at have had problems where actual emissions have been lower than expected. This has resulted in different problems later on in the scheme, extremely low market prices for example. It is understandable that it is hard to achieve political acceptance for a trading scheme and at the same time impose tight emissions caps. This was shown in particular by the law suits from some member states of the EU against the Commission regarding too strict emissions targets where the Commission has lost some of its authority and thus damaging the credibility of the scheme.

Secondly, the controversial gateway of trading between aviation and the other sectors should be carefully examined since there is reason to believe that greenhouse gases from aviation will lead to greater environmental impact than those from the other trading sectors. It is understandable that the Commission does not want to put emission targets under the Kyoto protocol in danger by introducing additional tradable permits on the market.

No emissions trading scheme will ever be free of problem at a beginning stage but we can learn from previous mistakes as well as successes in order to minimize the initial problems.

References

- Andersen, A. (2001): 'Internation Air Treansport Association, Emissions trading for aviation', IATA.
- ATAG. (2008): 'The Economic and Social Benefits of Air Transport 2008'
- Betz, R. and Sato, M. (2006): 'Emissions trading: lessons learnt from the 1st phase of the EU ETS and prospects for the 2nd phase', *Climate Policy*, 6, 351-359.
- Bohi, D. R., D. Burtraw (1997): 'SO₂ Allowance Trading: How Do Expectations and Experience Measure Up?', *The Electricity Journal*, vol. 10, issue 7, 67-75.
- Bohm, P. (1999): 'International Greenhouse Gas Emission Trading – with Special Reference to Kyoto Protocol', *Tema Nord* 1999:506.
- Cames, M and Dueber, O (2004): 'Emissions trading in international civil aviation', Öko-Institut, Berlin.
- Coase, R. H. (1960): 'The Problem of Social Cost', *Journal of Law and Economics*, Vol. 3, 1-44.
- Conrad, K., R. E., Kohn (1996): 'The US market for SO₂ permits, Policy implications of the low price and trading volume', *Energy Policy*, Vol. 24, No. 12, 1051-1059.
- Dales, J. H. (1968): 'Land, Water and Ownership', *The Canadian Journal of Economics*, Vol. 1, No. 4, 791-804.
- Ellerman, D. A., R. Schmalensee, P. L. Joskow, J. P. Montero and E. M Bailey (1997): 'Emissions Trading under the U.S. Acid Rain Program: Evaluation of Compliance Costs and Allowance Market Performance', Center for Energy and

Environmental Policy Research, Massachusetts Institute of Technology,
Cambridge.

Frontier Economics (2006): 'Economic consideration of extending the EU ETS to include aviation. A report prepared for the European Low Fares Airline Association (ELFAA), Frontier Economics Ltd, London.

Hamilton, K., M. Sjardin, T. Marcello and G. Xu (2008): 'Forging a Frontier: State of the Voluntary Carbon Markets 2008'.

Hepburn, C., M. Grubb, K. Neuhoff, F. Matthes, M. Tse (2006): 'Auctioning of EU ETS phase II allowances: how and why?', *Climate Policy*, 6, 137-160.

ICAO (2007): 'Report on Voluntary Emissions Trading For Aviation', VETS Reports, International Civil Aviation Organization.

IPCC (1999): 'Aviation and the global atmosphere', A special report of IPCC working groups I and III in collaboration with the Scientific Assessment panel to the Montreal Protocol on Substances that Deplete the Ozone Layer, Intergovernmental Panel on Climate Change, Cambridge University Press.

IPCC (2007): Fourth Assessment Report, Working Group III.

Kling, C. and J. Rubin (1997): 'Bankable permits for the control of environmental pollution', *Journal of Public Economics* 64, 101-115.

Lee, D. S., R. Sausen (2000): 'New Directions: Assessing the real impact of CO₂ emissions trading by the aviation industry', *Atmospheric Environment* 34, 5337-5338.

Morell, P. (2007): 'An evaluation of possible EU air transport emissions trading scheme allocation methods', *Energy Policy* 35, 5562-5570.

NAO, (2004): 'The UK Emissions Trading Scheme – A New Way to Combat Climate Change', Report By the Comptroller and Auditor General HC 517 Session 2003-2004.

- Rico, R. (1995): 'The U.S, Allowance Trading System for Sulfur Dioxide: An Update on Market Experience', *Environmental and Resource Economics*, 5, 115-129.
- Rogge, K., J. Schleich, R., Betz (2006): 'An Early Assessment of National Allocation Plans for Phase 2 of EU Emission Trading', Working Paper Sustainability and Innovation, Nr. S 1/2006
- Rubin, J. D. (1995): 'A Model of Intertemporal Emissions Trading, Banking and Borrowing', *Journal of Environmental Economics and Management*, 31, 269-286
- Smith, S. and J. Swierzbinski (2007): 'Assessing the performance of the UK Emissions Trading Scheme', *Environmental & Resource Economics*, vol. 37 issue 1, 131-158.
- Tietenberg, T. (1998): 'Tradable Permits and the Control of Air Pollution in the United States', working paper, Colby College.
- Tietenberg, T. (1999): 'Tradable Permit Approaches to Pollution Control: Faustian Bargain or Paradise Regained?'
- Wit, R.C.N., B.H. Boon, A. van Velzen, M. Cames, O. Dueber and D.S. Lee (2005): 'Giving wings to emission trading', Publication no.: 05.7789.20, Delft, CE.