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Options for regulating the climate impacts of aviation

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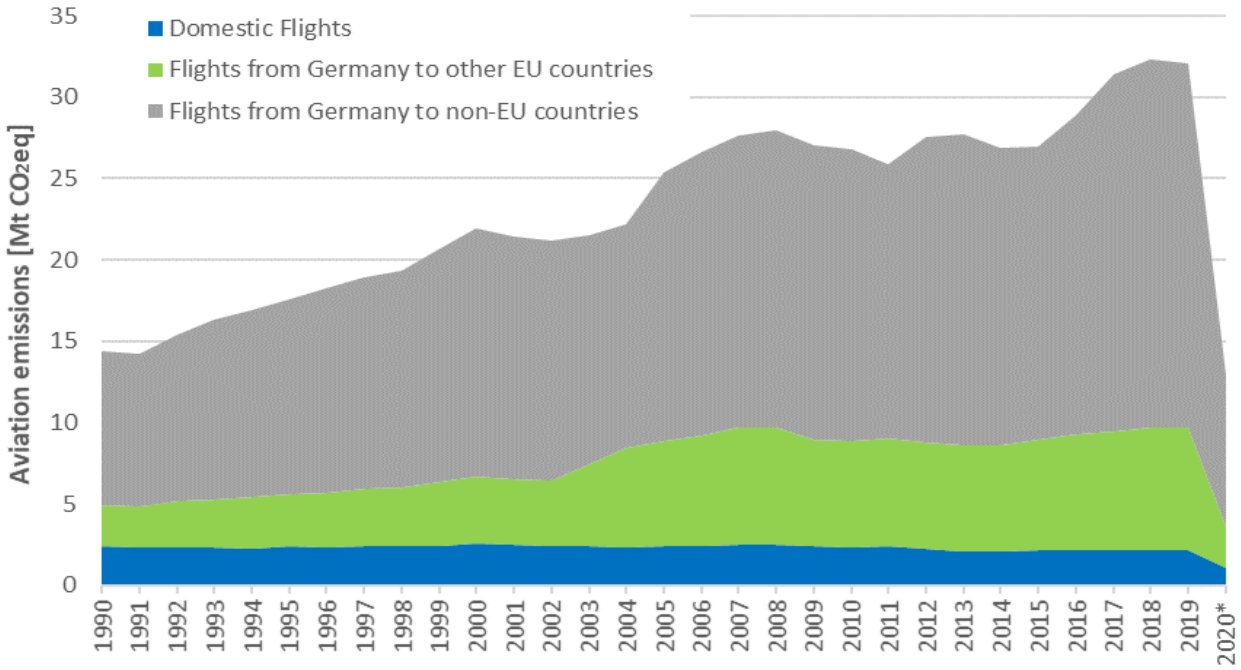
1 Aviation in the context of the goal of climate neutrality

Aviation is the most environmentally damaging mode of transport and contributes substantially to global warming. In 2018, aviation generated approx. 905 million tons of CO_2 (IATA 2019). This represents approx. 2.4% of all anthropogenic CO_2 emissions (Lee et al. 2020). Considered as a country and compared with the greenhouse gas emissions of other countries, aviation would be ranked about sixth in the list of largest emitters worldwide in 2018.

In Germany and the EU, the share of aviation in greenhouse gas emissions is even slightly higher: in 2018, national and international aviation caused approx. 3.6% of total greenhouse gas emissions in Germany (excluding the land use sector) and 4.1% in the EU. In Germany, emissions from international aviation, i.e. refuelling operations for flights to other countries, account for most of these emissions, at 94%. According to estimates by Oeko-Institut, about a quarter of these emissions stem from flights to other EU countries and about three quarters from flights to non-EU countries. Only approx. 6% of Germany's air transport emissions are caused by domestic flights (Figure 1).[1] The majority of air traffic is passenger traffic.

Figure 1 Development of aviation emissions



Source: The emissions from domestic flights within Germany and flights from Germany to all other countries are taken from Germany's National Inventory Report. The share of flights to other EU Member States and to non-EU countries and the emissions for 2020 are estimates provided by Oeko-Institut. The estimates of the share of flights to EU Member States are based on the EU28 (including the UK).

The climate-damaging effects of aviation go well beyond CO_2 emissions. Overall, the contribution of aviation to global warming is around three times higher than the contribution of CO_2 emissions alone

[1] Emissions from national and international aviation are listed separately in GHG inventory reports. The emissions in Germany's inventory are based on the sales data for kerosene and aviation turbine fuel documented in the energy balance. For kerosene, the division into national and international aviation is based on German air traffic statistics. The total emissions are GHG emissions in CO_2-eq and include emissions from international aviation, without taking into account the land use sector.

(Lee et al. 2020). This is because, in addition to CO_2 emissions, aircrafts also emit nitrogen oxides (NO_x), water vapour, soot, aerosol and sulphate aerosol particles. Contrails and contrail cirrus, i.e. clouds composed of ice crystals that can be generated by aircraft engines at high altitudes, are an important factor here. These non-CO_2 effects can lead to both warming and cooling effects (e.g. breakdown of methane in the atmosphere by nitrogen oxides). Even though the climate impact of some non-CO_2 effects still involves uncertainties, there is scientific consensus that non-CO_2 effects increase radiation and thus have a warming effect overall (UBA 2019; EASA 2020). According to calculations by Oeko-Institut, aviation caused around 5.5% of anthropogenic global warming in 2018.

Another challenge is that emissions from aviation (excluding the downturn due to the Covid-19 pandemic) have risen sharply over the past 20 years, while total greenhouse gas emissions in Germany and the EU fell significantly between 1990 and 2018. In Germany, emissions from international aviation increased by nearly 150% between 1990 and 2018, while in the EU they increased by approx. 140%. Emissions from domestic flights decreased slightly in this period (-13%) (EEA 2020). On an international level, emissions doubled between 1987 and 2018; growth rates, however, have been much higher since 2010 (at approx. 4-5% per year) than in the years before (Ritchie 2020). Prior to the Covid-19 pandemic, the International Civil Aviation Organization (ICAO) estimated that this growth would continue; it has projected that there would be nearly four times as much air traffic globally in 2050 compared to 2015 (ICAO 2018, p. 3; ICAO 2019, p. 18). According to current estimates, it seems unrealistic that there will be a reversal in these trends after the Covid-19 pandemic has ended.

To reduce greenhouse gas emissions to net zero by mid-century, all sectors must take effective mitigation measures. Currently, insufficient measures are in place to bring aviation into line with the goal of climate neutrality by 2050. Current regulations on German, European and international levels fall short of providing effective incentives to significantly reduce emissions from aviation. On the contrary, aviation has substantial privileges in terms of taxation and carbon pricing – especially compared to other modes of transport and sectors. For example, most flights are not subject to VAT or energy taxes. These privileges can be traced back in part to the 1944 Chicago Convention[2] and ICAO policy.[3]

Against this background, there is an urgent need for action to develop existing measures for further reducing aviation emissions or to introduce new measures. The aim of this study is to make clear the privileged treatment of aviation compared to other modes of transport and to identify regulatory options for aviation at national and European level in order to reduce this unequal treatment. Equal fiscal treatment of aviation could be a first important starting point and is comparatively easy-to-implement on national (and European) levels to put aviation on a more climate-friendly course. However, much greater efforts will be needed to achieve this.

[2] Convention on International Civil Aviation (Chicago Convention) of December 7, 1944, Articles 15 and 24 of which contain tax-related provisions.
[3] See, in particular, ICAO's policies on taxation in the field of International Air Transport, Fourth Edition – 2016 (Supplement to doc 8632).

2 Current regulatory framework and options for action

This chapter first presents the current climate policy regulatory framework for aviation with a focus on taxation and carbon pricing of aviation on German, European and international levels. From this analysis, possible options for strengthening existing instruments or introducing new ones are identified. This is also carried out with a view to what measures can be implemented within the framework of the European Green Deal.

The options for action are presented primarily in terms of their legal and political feasibility. As far as possible within the scope of this study, the financial implications and incentive effects of these options are also discussed. The focus is on options for action that reduce the preferential treatment of aviation compared with other modes of transport and sectors. However, it is important to note that a direct comparison of the regulatory treatment of the different modes of transport is difficult because, for example, transport infrastructure is financed differently and the infrastructure is used in part to fulfil different purposes such as services of general interest (NEE 2017). Furthermore, a reduction in privileges is not enough to put aviation on the path to climate neutrality. Measures that go beyond the elimination of preferential treatment of air transport are thus also considered.

This study analyses the following five instruments:

- **energy taxation** on international, European and German levels (section 2.1);
- **value-added tax** on international, European and German levels (section 2.2);
- the German **aviation tax** (section 2.3);
- the **Emissions Trading System of the European Union** (section 2.4);
- ICAO's **Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA)** (section 2.5).

There are a number of other environmental policy instruments which have already been implemented or are under consideration, which are not discussed in this study. These include, for example, the promotion of alternative fuels through blending quotas, the promotion of new propulsion technologies, the adjustment of airport charges, or the decrease of subsidies for airports or aircraft manufacturers.

2.1 Energy tax

2.1.1 Current regulatory framework

On the European level, energy products for use as aviation fuel are generally exempt from taxation under Art. 14 (1b) of the EU Energy Taxation Directive 2003/96/EC[4]. However, under Art. 14 (2) of the Directive, Member States are free to tax domestic flights or to make bilateral agreements with other EU Member States which provide for taxation. However, Germany has not yet made use of this option. The other Member States have also adopted a wait-and-see approach and anticipate a

[4] Council Directive 2003/96/EC of 27 October 2003 restructuring the Community framework for the taxation of energy products and electricity, OJ L 283, 31.10.2003, p. 51, as last amended by amending Directive 2004/75/EC of 29.4.2004, OJ EU L 157 p. 100, as amended. OJ EU L 195 p. 31.

solution on EU level, with the result that none of the Member States currently imposes a tax on kerosene for aviation (UBA 2019).

A tax on kerosene could also be introduced under international law. The Chicago Convention only prohibits a tax on fuel that is already on board (i.e. not on refuelling) (CE Delft 2019b; UBA 2016). Outside the EU, 12 countries currently impose a kerosene tax, the level and scope of which varies. The levels of taxation, however, are very low; most are no higher than 10 €ct/l (CE Delft 2019a, p.29). An exception is Hong Kong, at approx. 70 €ct/l.[5] However, many air service and air transport agreements provide for the exemption of aviation from certain charges such as fuel – or at least make it more difficult to impose them (Pache 2005, S.5, 41 ff.; CE Delft 2019a, p. 28; UBA 2019, p. 82). For example, the Open Skies Agreement between the U.S. and the EU provides that kerosene is generally not taxed (see Art. 11(2)(c)). If two or more EU Member States introduced a kerosene tax, the joint committee of representatives from the EU and the U.S. would address the issue.

The EU Energy Tax Directive is transposed into national law by Germany's Energy Tax Act[6]. However, Section 27 of this act exempts kerosene from the energy tax if it is used in commercial domestic air transport and on flights to foreign destinations. Compared to the European regulation, this tax rate largely comes to nothing. While energy taxes are levied on other modes of transport (such as road and rail), air transport is exempt from energy taxation. This privileged treatment has become established practice. There are no plausible reasons, however, why it should be maintained or why air transport should be treated differently from other modes of transport.

EU Member States annually miss out on approx. €27 billion of revenue due to the tax exemption of kerosene on incoming and outgoing flights between EU Member States (CE Delft 2019a, p.113), calculated using the minimum tax rate for kerosene of 33 ct/l in the EU Energy Tax Directive. In 2019, the German government lost out on €584 million in tax revenue from domestic flights. If the kerosene for flights to foreign destinations is included, Germany's subsidisation amounted to approx. €8 billion (FÖS 2020, p.28) based on a tax rate of 65.45 ct/l in the Energy Tax Act.

2.1.2 Options for action

In order to remove the unequal treatment of aviation at EU level, an amendment of the Energy Tax Directive is required. However, the principle of unanimity between Member States on tax issues (Art. 113 TFEU)[7] makes amendments to the directive – and thus also the introduction of an EU-wide kerosene tax – difficult (UBA 2016). Therefore, Germany could and should advocate a repeal of the unanimity rule with regard to the Energy Tax Directive. However, this also requires unanimity and can therefore also be averted by the veto of a single Member State. Nevertheless, in the context of the revision of the Energy Tax Directive – planned for summer 2021 – Germany should advocate the EU-wide application of a minimum tax rate for kerosene in aviation in order to achieve a uniform solution and thus a greater effect. In this context, it would be best to differentiate between intra-European and international flights as the introduction of a kerosene tax on international flights in particular would require existing air transport agreements to be amended (for details see Pache in

[5] Hongkong – Customs and Excise Department: https://www.customs.gov.hk/en/trade_facilitation/dutiable/types/.
[6] Energy Tax Act of July 15, 2006 (BGBl. I p. 1534; 2008 I p. 660, 1007), as last amended by Article 204 of the Ordinance of June 19, 2020 (BGBl. I p. 1328).
[7] Treaty on the Functioning of the European Union (consolidated version) OJ C 326, 26.10.2012, p. 47.

T&E, p.59 et seq. and 77 (2020)). A 33 ct/l tax on kerosene refuelled in Europe could reduce CO_2 emissions from aviation by about 11% (CE Delft 2019a, p.113).

The introduction of a kerosene tax is legally possible on both European and national levels. From a legal perspective, a kerosene tax that is linked to the refuelling of kerosene in Germany is possible according to Pache (2005). As a minimum compromise, the taxation should amount to at least 33 ct/l, as proposed by the EU Commission and laid down in the EU Energy Tax Directive. A more appropriate approach would be to take the tax rates stipulated in Section 2 (1) of the German Energy Tax Act as a basis, which would be much higher – regardless of whether the tax is based on energy content or greenhouse gases. According to CE Delft (2019a, p. 81), the introduction of a kerosene tax (of more than 33 ct/l) on the refuelling of kerosene in Germany would lead to a 12% decrease in passengers and emissions (21.9 Mt CO_2). Any job losses in the aviation industry arising from kerosene taxation on European or national levels must, however, be set against the higher tax revenues, which in turn have a positive impact on the overall economy in the form of higher government investments or tax cuts (CE Delft, pp. 81,113, 115). In Germany, such a kerosene tax would have a strong progressive impact on the highest-income households as they fly particularly often. For households with incomes in the bottom five income deciles, however, the effects are regressive (FÖS 2021, pp. 33–35).

If Europe-wide action is blocked by individual EU Member States, action by Germany alone and action by a group of Member States within the framework of bilateral agreements or within the framework of "enhanced cooperation" under Art. 20 TEU[8] could be considered. Since solely national action would have a smaller effect on CO_2 emissions, action undertaken with other Member States would be preferable. For an enhanced cooperation approach, at least nine EU Member States would have to participate. This could be a politically very effective regulation if, in addition to Germany, France, the Benelux countries and Sweden, Spain, Portugal and Italy also participated. This is because these nine Member States would cover around three-quarters of intra-European emissions from aviation.

The countries involved in such enhanced cooperation could use the existing scope under Art. 14 (2) Energy Tax Directive, with the result that this approach would also be possible without (a short-term) reform of the EU's Energy Tax Directive. In addition, Art. 14 (2) Energy Tax Directive also opens the possibility of a coordinated approach based on bilateral agreements between two or more Member States. It is to be expected that, if Germany goes ahead with a kerosene tax on national level, the probability of such agreements and the removal of the kerosene tax exemption at EU level will increase. In addition, enhanced cooperation or bilateral agreements between EU Member States can, in turn, constitute the core of an EU-wide tax solution (UBA 2019, p. 82).

2.2 Value added tax

2.2.1 Current regulatory framework

Currently, value added tax of 19% is levied only on domestic flights in Germany. No VAT is charged on cross-border flights between two countries within the EU or international flights to non-EU countries.[9] In German law, this results from Section 26 (3) of the German Value Added Tax Act

[8] Treaty on European Union (consolidated version), OJ C 326, 26.10.2012, p. 13ff.
[9] This tax exemption also applies to feeder flights with an international ticket.

(UStG).[10] Air transport thus receives subsidies of around €4.2 billion annually in Germany (for 2017, UBA 2019, p. 97). Other modes of transport are not exempt from VAT. Germany levies the reduced rate of VAT of 7% on the domestic leg of international rail transport. However, many other EU Member States do not levy VAT on international rail travel.

EU Member States follow the same principle as Germany: no EU country imposes VAT on international flights; however, 22 EU Member States impose VAT on domestic flights (13 Member States – Austria, Finland, France, Italy, Latvia, Lithuania, Luxembourg, Poland, Portugal, Slovakia, Slovenia, and Spain – apply reduced rates; Cyprus, Denmark, Ireland, Malta, do not impose VAT on domestic flights at all) (CE Delft 2019a).[11] Based on an average VAT rate of 19%, EU-wide subsidies thus account for more than €30 billion annually (CE Delft 2019a, p. 113).

The reasons for why air transport services should be exempt from the general taxation of consumption laid down in Art. 1 of the EU VAT Directive 2006/112/EC (VAT Directive)[12] are not readily apparent (TU Chemnitz 2020, p. 27). According to the transitional provision in Art. 371 in conjunction with Annex 10 Part B No. 10 of the VAT Directive, Member States may maintain the tax exemption for "the transport of passengers and […] the transport of goods accompanying them, such as luggage or motor vehicles, or the supply of services relating to the transport of passengers." However, Member States are free to waive use of this tax exemption for international passenger transport by air and levy VAT (Bundesregierung 2003, p. 6; TU Chemnitz 2020, p. 28). However, this only applies to the domestic part of the journey. For the part of the journey outside Germany, the tax cannot currently be levied due to the territorial principle anchored in Article 48 of the VAT Directive: "The place of supply of passenger transport shall be the place where the transport takes place, proportionate to the distances covered." In a response to a minor question on the taxation of cross-border flights, the German government has confirmed that EU Member States are free to levy VAT on cross-border passenger air transport (Bundesregierung 2003, p. 2).

In addition, according to Article 148 of the VAT Directive, no VAT is to be levied on the supply, repair or maintenance of aircraft and other related services in international air transport.[13] However, EU Member States may levy VAT on fuel and airport or service charges (CE Delft 2019a, p. 26).[14]

[10] The German Value Added Tax Act in the version published on 21 February 2005 (BGBl. I p. 386), as last amended by Article 15 of the Act of 21 December 2020 (BGBl. I p. 3096).
[11] In addition to taxing airfares, VAT may also be imposed on fuel or charges incurred in connection with flying such as airport or service fees.
[12] Council Directive 2006/112/EC of 28 November 2006 on the common system of value added tax (OJ L 347, 11.12.2006, p. 1 et seq.), as last amended by Council Directive (EU) 2020/2020 of 7 December 2020 amending Directive 2006/112/EC as regards temporary measures relating to value added tax on COVID-19 vaccines and in vitro diagnostic medical devices in response to the COVID-19 pandemic (OJ L 419, 11.12.2020, p. 1).
[13] According to Art. 148 of the VAT Directive, Member States shall exempt the following transactions:
(e) the supply of goods for the fuelling and provisioning of aircraft used by airlines operating for reward chiefly on international routes;
(f) the supply, modification, repair, maintenance, chartering and hiring of the aircraft referred to in point (e), and the supply, hiring, repair and maintenance of equipment L 347/32 EN Official Journal of the European Union 11.12.2006 incorporated or used therein;
(g) the supply of services, other than those referred to in point (f), to meet the direct needs of the aircraft referred to in point (e) or of their cargoes.
[14] For example, the U.S. and Canada impose a sales or transportation tax on flights between their countries and, in the case of the U.S., also to Mexico. Mexico imposes a general transportation tax of 4% on international flights (CE Delft 2019, p. 26).

The fact that none of the EU Member States levies VAT on international flights can be traced back to the decades-long policy pursued within the framework of the ICAO. ICAO bodies approved the common practice in relation to the sale or use of international air transport of setting the VAT rate at zero (ICAO 2000, para 16).[15] The International Air Transport Association (IATA) justifies the zero percent VAT rate by arguing that international air transport takes place outside any tax jurisdiction and across different jurisdictions. It also argues that the exemption of aviation creates a level playing field across national borders (CE Delft 2019a; IATA o. D.).

However, the agreements under the ICAO do not mean that no VAT *can* be levied on tickets for international flights. According to Article 24 of the 1944 Chicago Convention, only the contents of an international aircraft (items remaining on board) cannot be taxed (ICAO 1944). Not charging VAT on international flights has merely become an *established* practice. This was also confirmed by the German government in its response to a minor inquiry in 2003: "There are no binding regulations under international law that stand in the way of lifting the tax exemption" (Bundesregierung 2003, p. 2).

2.2.2 Options for action

The privileging of international air transport through VAT exemption should be ended. The most effective way to achieve this would be to regulate the levying of VAT on an international level to create a level playing field across national borders. However, given the established practice of not charging VAT on international flights, this has not seemed a promising option to date.

In order to create a level playing field, at least within the European single market, an EU-wide solution for levying VAT on national and international flights should be found. Various options can be considered here. The simplest and most sensible option seems to be to change the legal situation so that VAT is levied on the entire flight in the country of departure. This would rule out double taxation in the European area (UBA 2019, p. 82). According to the current VAT Directive, this is not possible since VAT can only be levied on transport in the country in which it takes place, corresponding to the distances covered (territorial principle of Art. 48). However, an exception to this principle could be enshrined in the VAT Directive. A second option would be a notional revenue share on the domestic part of international flights or on the entire journey of an international flight with the exception of the part in the destination country (i.e. also the third countries flown over) (TU Chemnitz 2020, p. 25). A practical challenge in this context, however, is differentiating the distance travelled by territory and the VAT regulations that are applicable there. Compared to cross-border rail transport, where the distance can be divided according to rail kilometres travelled, it is somewhat more difficult to ascribe the kilometres travelled to countries that are flown over.

An amendment to the VAT Directive requires the unanimity of the EU Member States. As the ongoing reform process of the Directive has been protracted so far, an EU-wide regulation on VAT on international flights does not appear to be the most realistic option for action in the short term. However, in its sustainable and smart mobility strategy in December 2020, the EU Commission included a review of VAT exemptions for international transport in its Action Plan for 2022 (EC 2020b). This could provide new impetus for changing the regulation at EU level.

As long as no agreement can be reached at EU (or international) level on the removal of privileges for aviation, Germany should increase the aviation tax to replace the uncollected VAT on

[15] The 1944 Chicago Convention, which established the ICAO, set tax privileges for air transport (Article 15 and 24), see https://www.icao.int/publications/documents/7300_orig.pdf.

international flights (see section 2.3). Alternatively, the German government could impose a VAT on the domestic portion of international flights. This option would not require further coordination at EU level and could be implemented without amending the EU's VAT Directive.

The price signals associated with the introduction of a value added tax – or a corresponding increase in the aviation tax – would be a first step toward reducing air traffic and creating incentives to switch to greener alternatives. For Germany, a study commissioned by the EU Commission concludes that imposing 19% VAT on all flights would lead to a 16% reduction in passengers and emissions from aviation (21 Mt CO_2) (CE Delft 2019a, p. 81).

2.3 Aviation tax

2.3.1 Current regulatory framework

Aviation tax - also known as air ticket tax - is levied in Germany on commercial passenger flights departing domestically. The tax rate is regulated in § 11 of Germany's Aviation Tax Act. The ticket tax is levied on the airlines and passed on to the passengers. It is intended to generate government revenue, but it also has an environmental incentive effect (UBA 2019, p. 97).

In Germany, the air ticket tax is levied on the basis of destination regions. These are divided into three distance classes.[16] As of 1 January 2021, the tax rates are €12.88, €32.62, and €58.73 per passenger for a flight departing in Germany.[17] For domestic flights, the tax is paid for both the outbound and the return flight due to the double domestic departure. The tax rates were moderately increased as part of Germany's 2030 Climate Action Programme, effective from 1 April 2020 (Deutscher Bundestag 2019) and then slightly decreased again on 1 January 2021 since the aviation tax rate depends on the previous year's tax revenues, including auctioning revenues from the EU Emissions Trading System. According to Section 11 (2) of the Aviation Tax Act, these are to amount to a maximum of €1.75 billion. As a result of the cap on taxation, the tax per passenger decreases when passenger numbers increase.[18] This absolute cap on revenues from air ticket tax puts a limit on the effect of the tax as a price signal, which aims to provide incentives for more environmentally-friendly behaviour.

The tax applies to the entire flight from its departure in Germany to the destination airport; the distance class is not determined by airports that serve only as a stopover or transfer. Passengers who only change planes in Germany do not pay ticket tax. Feeder flights within Germany are also

[16] Intra-European flights, distances up to 6,000 kilometres and long-distance flights; Wikipedia offers a graph showing these, see https://de.wikipedia.org/wiki/Luftverkehrabgabe.
[17] Ordinance on the reduction of tax rates in 2021 pursuant to Section 11 (2) of the Aviation Tax Act of 1 December 2020 (BGBl. I p. 2762).
[18] At the same time, auctioning revenues from the EU Emissions Trading System are limited: aviation is allocated just under half of the total number of allowances required free of charge. As a result, the revenue from the auctioning of allowances for aviation amounted to only €114 million to €123 million in 2018 and 2019 respectively, while aviation was given more than €650 million in 2019 alone through free allocation (see also Section 2.4). The auctioning revenues for aviation in Germany from the EU ETS thus account for only a small portion of the maximum allowable revenue from aviation taxes and auctioning revenues (€17.9 million in 2019 from a maximum allowable €1.75 billion; see https://www.dehst.de/DE/Europaeischer-Emissionshandel/EU-Emissionshandel-verstehen/Versteigerung/versteigerung_node.html). Nevertheless, offsetting the auctioning revenues against the ticket tax reduces the incentive for industry to cut emissions: if emissions do not fall, the aviation tax falls so that total revenue does not exceed the cap, see. Klinski/Keimeyer (2019), p. 21.

not taxed separately; the tax rate for the destination applies. Flights taken by children under two years of age and flights for purely sovereign, military or medical purposes are not taxed (BMF n.d.).

Most flights departing from Germany on which ticket taxes are levied are in the short haul class (83% in 2019). 5% of passengers paid the medium haul rate and 12% the long haul rate (Destatis 2020b).

In addition to Germany, five other EU Member States (France, Italy, the Netherlands, Austria, Sweden) levy air ticket taxes that are also differentiated by distance or only apply above a certain distance. Compared to Germany, the air ticket tax is significantly lower in Austria and Italy and slightly lower in Sweden ((CE Delft 2019a, pp. 20–21). In 2020, France increased its ticket tax to €20.27 for intra-European flights and to €63.07 for more distant destinations (Ministère de la Transition Écologique 2020). In the Netherlands, a ticket tax of €7 per flight applies from 2021 (Netherlands government 2019).[19] The United Kingdom levies a comparatively high ticket tax within Europe, averaging approx. €45 per passenger. Norway levies a comparatively low tax (€8.77). France and the United Kingdom also differentiate their ticket taxes by first, business and economy class (CE Delft 2019a, pp. 20–21).

2.3.2 Options for action

It may also make sense to establish a coordinated regulation within the EU for ticket taxes in order to create a level playing field in the European single market and to avoid evasive actions and passengers choosing departure points where the ticket tax is lower or where no ticket tax is levied at all. Against this background – and as long as no VAT is levied on international flights – Germany should advocate the introduction of minimum rates for an air ticket tax in the EU.

At the same time, Germany should also raise the air ticket tax on a national level. The rate should be based on at least the uncollected VAT. Legally, there are no objections to proceeding unilaterally in imposing and increasing the ticket tax (Klinski/Keimeyer 2019, pp. 21–22). The German Federal Constitutional Court has made it clear that legislators have considerable leeway in designing the ticket tax, which could be used.[20]

Several approaches to increasing the air ticket tax are available:

Increasing air ticket tax for short-haul flights

Germany could increase the tax for short-haul flights. Here, there is no significant risk that passengers will try to avoid the tax by choosing other flight routes (UBA 2019, pp. 97–98). Against this background, it seems sensible to continue to double tax domestic flights by levying VAT and ticket taxes in order to create incentives for switching to alternative modes of transport for domestic journeys.

Uniform increase in all air ticket tax rates to balance VAT exemption

Air ticket tax rates could be increased to roughly balance the VAT exemption for international flights. For an intra-European, cross-border flight in the first distance class, which account for the majority of flights on which a ticket tax is levied (approx. 83% in 2019), the ticket tax would need to be approx.

[19] Outside the EU, Australia, Brazil, Mexico and the USA, for example, levy comparatively high ticket taxes (CE Delft (2019a), pp. 21–22).
[20] BVerfG, Urt. v. 5.11.2014 – 1 BvF 3/11 (Rn. 41 ff.), NVwZ 2015, 288.

€60 to balance the VAT exemption, assuming a typical ticket price of €300.[21] This amounts to over four times the current ticket tax of around €12.88. For the third distance class and assuming a typical ticket price of €1,000, the air ticket tax would need to be approx. €200, which is about three to four times higher than the currently levied ticket tax of €58.73.

There should be distinctions between types of ticket: For business class tickets, the tax should be significantly higher than for economy class tickets as passengers in more expensive classes bring about higher per capita emissions than in the cheaper segment and, due to the higher ticket prices, the uncollected VAT revenues are also correspondingly higher. This is already the situation in the UK: business class seats on long-haul flights over distances exceeding 3,000 km are subject to taxes (Air Passenger Duty) of approx. €200 from April 2021; for shorter routes, these taxes are around €30 (British government 2020).[22]

It is also conceivable that a ticket tax could be levied on incoming flights as well. The amount of the tax levied on incoming flights should depend on whether the country of departure has already levied a ticket tax on the flight. This would provide an incentive for other countries to introduce an appropriate ticket tax. It would also avoid unequal treatment of domestic flights (double payment of ticket tax) and short-haul flights to neighbouring countries (single payment of ticket tax) and achieve the same incentive effect. None of the EU Member States has introduced a ticket tax on incoming flights to date. According to an initial assessment, it is legally possible to implement one since there is no ban on double taxation and there are also no apparent reasons why such taxation would not be permissible.

Another option for further developing air ticket taxes is to classify journeys differently. In addition to distance classes, an element of CO_2 regulation could be incorporated in the aviation sector (Oeko-Institut 2020a). This could prevent evasive action on journeys within the EU. This could be the case, for example, for a flight from Hamburg to Bangkok with a change in either Frankfurt or Istanbul. In the first case, the first part of the flight falls under the EU ETS (and is possibly subject to a kerosene tax and/or synthetic fuel quota); in the second case, no part of the flight would be affected by intra-EU regulations. To adjust the air ticket tax, a carbon border adjustment mechanism, which is being discussed in the context of the European Green Deal, could be implemented.

Removal of cap on revenues from air ticket tax and the linking of revenues from the EU ETS

In addition, the cap on revenues from air ticket tax and the linking of the amount of the ticket tax to the tax revenues of the previous year, including revenues from emissions trading, should be repealed. This would be very easy to implement: the corresponding paragraph § 11 (2) of Germany's Aviation Tax Act would be deleted.

Levying air ticket tax on freight transport

An air ticket tax should also be levied on the carriage of freight because the current regulation only applies to passenger traffic; no ticket tax is levied on air freight.

[21] On ticket price levels, see https://www.bdl.aero/de/publikation/analyse-der-klimaschutzinstrumente-im-luftverkehr-zur-co2-reduktion/ and https://quotas.de/wp-content/uploads/2018/11/ETR_10_2018_Swiss_Schober_Krautscheid_Sauter_FA-compressed.pdf.
[22] For flights in private jets carrying less than 19 passengers, the ticket taxes are more than €600 for long-haul flights and about €90 for flights under 3,000 km.

Up to now, only France levies a tax on the air freight of departing flights; the tax is very low, amounting to €1.37 per ton of air freight (Gouvernement Francais 2020). In 2019, the Netherlands decided to introduce an air freight tax on departing flights. There, too, the levy is set very low and is tiered based on the noise pollution caused by the aircraft in question (€3.85 per ton of freight for noisy aircraft and €1.93 per ton of freight for quieter aircraft) (Netherlands government 2019). It was planned that this tax would be introduced on 1 January 2021; this was postponed, however, due to the Covid-19 pandemic.

There are no constitutional objections in Germany to extending the air ticket tax to freight traffic. As a "transport tax," ticket tax is not bound by the narrow criteria for excise duties. In this respect, it could also be applied to tax business freight (transport of goods for sale). Moreover, like an excise tax, it could be designed in such a way that it is passed on to air freight customers who can price the additional burden into their products (Klinski/Keimeyer 2019, p. 22). There are also no apparent reasons why extending the air ticket tax to freight would violate European law.

Between 2012 and 2018, freight transported by air to and from Germany increased by 16% (Destatis 2019). Since 2001, air freight transported in this context has doubled to almost five million tons (BMVI 2019, 240f.) and it is predicted that air freight traffic will continue to grow in the future (Boeing 2019). One third of the freight is transported as belly freight in the belly hold of passenger aircraft (FreightHub n.d.). A large portion of this freight is high value goods such as electrotechnical goods, machinery, optical equipment, pharmaceutical products, and jewellery, because delivery times for these goods are critical (BDL 2017). The average value of air freight is €86/kg and far exceeds the value of goods transported by rail, ship or lorry (BDL 2018).

The following aspects need to be considered when designing a levy on air freight (see also Oeko-Institut; FÖS; FFU Berlin (i.E.):

- **Pricing of incoming flights**: While the current ticket tax only applies to departing passengers, air freight tax should also encompass incoming freight so as to have a more comprehensive steering effect. In doing so, the levy could be reduced if the country of departure also imposes a tax on air freight.
- **Rate of air freight tax**: To have a steering effect, a tax on air freight would have to noticeably increase the cost of transporting freight.[23] The existing tax on air freight in France and the one planned in the Netherlands at less than €4/ton is insufficient for this purpose. As a comparison: the current rate of ticket tax on passenger transport would have to amount to approx. 130 €/ton for the short-haul class, 1,330 €/ton for the medium-haul class and 590 €/ton for the long-haul class for a comparable transport volume.[24] To balance the uncollected VAT on air freight, the rates would have to be even higher.[25] At the same time, it is expected that in the event of a unilateral introduction of a very high aviation tax on freight, goods would be transported by lorry to neighbouring countries and sent by plane from there. Whether this comes about depends on

[23] However, data on the elasticity of air freight demand is not available (CE Delft (2019a), p. 44).
[24] In the EU ETS, a passenger and luggage are assumed to weigh 100 kg; the conversion factor for passenger kilometres to ton kilometres is therefore 10.
[25] Information on the amount of such a tax cannot be provided here as sufficient data on average prices of air freight within distance classes is not available. Prices are highly variable and depend on many factors that do not play a role in the transport of passengers (handling of various goods, available capacity for accompanying freight in the belly of passenger aircraft, speed of delivery, etc.).

not only the tax rate, but also the cost of transport by lorry and the urgency of the freight. A uniform regulation within the EU would significantly minimise this risk.

Further options

Another option for reforming the air ticket tax would be progressive taxation: it could take into account the amount and distances of flights that a person takes per year. A Frequent Flyer Levy (FFL) would make each flight taken within a certain period of time progressively more expensive, creating an incentive to fly less. An Air Miles Levy (AML) would increasingly make the distance flown more expensive. Since low income groups fly less frequently and less far, they would not be as affected by price increases as high income groups (New economics Foundation 2015). The Committee on Climate Change in the United Kingdom has responded positively to the idea of introducing such a levy (UK Committee on Climate Change 2019; BBC 2019). However, practical implementation could prove difficult, e.g. with a view to data protection compliance.

Impact of air ticket taxes

On domestic flights in Germany, an increased air ticket tax could lead to a noticeable drop in demand in the short term, especially for private travel. This is because inexpensive domestic flights will become more expensive due to the double levy on outbound and return flights and the levied VAT.

On international flights, the current German tax rates only lead to a relevant price increase and thus to noticeable effects for very cheap tickets, because it is mainly people with higher incomes who fly a lot (Lassen 2016; Gössling et al. 2009). Low price signals for this group are not expected to have a significant steering effect. With moderate to high ticket prices in each distance class, the one-time reduction in demand due to current tax rates is less than 2%, according to calculations by Oeko-Institut. However, annual growth in air transport demand is expected to continue unchanged from the lower level. Only in the case of very low-priced tickets does the current aviation tax have a relevant impact on the ticket price. However, a significantly higher tax that balances the uncollected VAT would lead to a drop in demand from private passengers of more than 11% for medium ticket prices in all distance classes. The effect would be even stronger for low ticket prices.[26] As with the levying of kerosene taxes, the levying of VAT on international flights or raising the air ticket tax to the rate of VAT in Germany would have a strong progressive impact on the highest-income households as they fly particularly often. For households whose incomes are in the bottom five income deciles, however, the effects are regressive (FÖS 2021, pp. 36–37).

If Germany were unilaterally to raise the air ticket tax sharply, it would be possible for passengers to travel to neighbouring EU countries with lower ticket taxes to start their journeys from there, thus avoiding the German tax. However, travelling further to the airport would only be worthwhile for long-haul flights; on short-haul trips, it is likely that travellers would pay a higher price or switch to alternative modes of transport. For business travel, it can be assumed that the higher ticket prices would generally be paid. Since nearly 83% of passengers took journeys within the first distance class

[26] For smaller price changes, price elasticities of -0.4 to -1.2 are assumed depending on the journey type (work, leisure) and distance (infras (2016)). An elasticity of -1 means that demand decreases by 1% if the price increases by 1%. The data available on price elasticities in aviation is very limited and the amounts given here involve high uncertainties. They also do not apply to large price changes.

(flights within Europe) in 2019,[27] it seems reasonable to assume that the divergence effects would be rather small (Destatis 2020a).

2.4 EU Emissions Trading System

2.4.1 Current regulatory framework

The EU's climate target under the Paris Agreement covers not only intra-European flights, but also emissions from flights from the EU to third countries (CEC 2020). However, the EU Emissions Trading System (EU ETS) currently only covers intra-European flights and not – as originally planned – all outbound and inbound flights.

The cap set for aviation emissions was previously set at 95% of average emissions in the years 2004 to 2006. The sector received mainly free allowances (85%) in the third phase of the EU ETS from 2013 to 2020 and only 15% in allowances from auctions.[28] In other sectors covered by the EU ETS, allowances are allocated free of charge to avoid carbon leakage. However, free allocation cannot be justified in the current scope of the aviation ETS as all intra-European flights are priced uniformly under the EU ETS, regardless of the nationality of the aircraft or operator. Free allocation could at best be understood as assisted entry into emissions trading. Free allocation has not been re-evaluated since the scope was reduced to intra-European flights; however, revisions are now under public discussion for the fourth trading period (2021-2030) (UBA 2019; Oeko-Institut 2020a). Other modes of transport, such as rail or private transport, do not receive free allocation or compensation for the costs they incur under the EU ETS or the new national emissions trading system.

For aviation, there are currently specific allowances in the EU ETS, the EUAA (European Aviation Allowances), which cannot be used by the stationary installations. However, airlines can buy allowances from stationary installations to cover their emissions. It has been necessary to do this every year since aviation was included in the EU ETS (2012-2019) as the free and auctioned allowances for aviation covered only a portion of the emissions actually emitted. Indeed, by the time of the Covid-19 pandemic in 2020, European aviation emissions had risen sharply since the reference years for the cap (2004-2006). For the fourth phase of the EU ETS (2021-2030), the cap for the aviation sector is expected to decrease at the linear reduction factor of 2.2%, as for stationary installations. This results in a 27% reduction in the cap in 2030 compared to 2005. Further dovetailing of the aviation ETS and the stationary ETS and the revision of the linear reduction factor are being discussed within the scope of the upcoming revision of the ETS Directive due to the tightening of the EU's climate target for 2030.

Currently, the EU ETS covers only CO_2 emissions of the aviation sector. However, the ETS Directive allows for gases other than CO_2 to be included. In the stationary ETS, emissions of nitrous oxide (N_2O) and perfluorinated carbons (PFCs) are already included for certain installations. In 2015, the EU Commission was tasked with developing a proposal on ways in which the climate impact of non-CO_2 effects of flying could be included in the EU ETS. A study has been submitted (EASA 2020), but a regulatory proposal has not been made to date.

[27] Of the total number of taxable transactions under Section 11 of Germany's Aviation Tax Act.
[28] EU Commission, https://ec.europa.eu/clima/policies/ets_en.

2.4.2 Options for action

The ETS Directive is currently being revised to adapt the EU ETS to the new 2030 climate target. The revision focuses on, among other things, the market stability reserve, the strengthening of the aviation ETS, and the expansion of the ETS to other sectors such as shipping. A proposal from the EU Commission is expected in summer 2021. The reform of the EU ETS offers the opportunity to increase the effectiveness of emissions trading for aviation by means of various measures. Compared to an amendment of the EU Energy Tax Directive, an amendment of the EU ETS only requires a qualified majority and could be implemented relatively quickly (Oeko-Institut 2020a).

Abolition of free allocation

In the EU ETS, free allocation of allowances is justified by a high risk of carbon leakage. However, as explained in section 2.4.1, the current scope of the aviation ETS does not provide a high risk for this. Therefore, removing or reducing the free allocation is an important option for reducing the preferential treatment of aviation compared to other sectors. This would also increase the incentive effect for emission reductions and could generate considerable additional revenue from the auctioning of allowances. Germany should therefore work towards a corresponding amendment to the ETS Directive as part of the upcoming revision.

Abolishing free allocation would resolve the current distortion of the market caused by the different historical emissions of airlines and lead to more equal treatment of airlines (Oeko-Institut 2020a, p. 3). In addition, the new entrants reserve would no longer be necessary. Along with the auctioning of all allowances, this could reduce the administrative burden, both for airlines and Member States. The additional revenues could – in addition to the uses already envisaged under Article 3d (4) of the ETS Directive to combat climate change – be paid into a special fund to promote, for example, the development and production of e-fuels (Oeko-Institut 2020a, p. 3). The modernisation and innovation funds for stationary installations in the EU ETS already function in a similar way.

In 2019, approx. 29 million emission allowances were allocated free of charge in the aviation sector. This represents a subsidy of about €650 million at EU level (at a carbon price of about €22/t CO_2). The EU Commission assumes a carbon price of €30-65/t CO_2 in 2030, depending on the scenario (EC 2020a). Retaining the current cap (-27% in 2030) could generate revenue from additionally auctioned allowances of approx. €21.5 billion in the period 2021 to 2030.

As part of ongoing consultation on the revision of the ETS Directive by summer 2021, the currently envisaged reduction factor could be increased from 2021 onwards (see above). If free allocation were to be maintained, it would reduce the total number of allowances allocated for free. Airlines would have to purchase more allowances from stationary installations to cover their emissions. A linear reduction factor of 3.8% instead of 2.2% would also lead to higher carbon prices, but the cost burden for airlines would still be lower than if free allocation were completely abolished (Oeko-Institut 2020a, pp. 3–4). Abolishing or reducing free allocation is therefore clearly preferable to adjusting the cap.

Changing the scope of the EU ETS

The EU Commission’s Impact Assessment on the EU’s new climate targets questions the full inclusion of international aviation ("full scope") as it mainly presents scenarios that would exclude emissions from flights between the EU and third countries (EC 2020a). It is therefore likely that the

current limit of incorporating only intra-European flights in the EU ETS will be maintained for the time being. Outbound and inbound flights from third countries could be covered by CORSIA (see chapter 2.5) or priced through bilateral agreements between the EU and third countries, e.g. through a kerosene tax (see chapter 2.1). Extending the scope of the EU ETS beyond intra-European flights is currently not a politically realistic option. However, the German government should work to ensure that the current scope of application is maintained and not restricted as a result of CORSIA.

Separate sectoral target with a limit on purchasing allowances from stationary ETS

Currently, about half of the allowances surrendered by airlines come from stationary installations under the EU ETS, with an upward trend up to 2030. There is no limit on the amount of additional purchases from the stationary ETS. Increasingly limiting the use of allowances from stationary installations via a quota system could strengthen the limit on aviation emissions (UBA 2019, p. 76). Such a cap would lead to a real ETS for aviation and could significantly increase the prices of aviation allowances (EUAAs). Allowance prices in the stationary sector (EUAs) would not be affected. Oeko-Institut (2020a, p. 7) proposes a limit of 50% of verified emissions for purchases from the stationary sector, which would decrease over time in line with the Paris Agreement. This means that under current conditions, the purchase of a maximum of one EUA per EUAA would be permissible. This option would continue to allow "one-way" trading between sectors in the EU ETS. However, this approach is expected to face strong headwind from the aviation industry.

Another option would be to end the purchasing of allowances from other sectors completely, resulting in a closed EU ETS for aviation. The current cap is too ambitious for this, as half of European air traffic could not then be covered by allowances. The cap would have to be adjusted and the carbon price for aviation would be completely decoupled from the carbon price of the stationary ETS. A closed system would likely face even more opposition than a limit on the purchase of EUAs and is therefore not recommended.

Inclusion of non-CO_2 effects

For the mitigation of non-CO_2 effects of aviation, metrics or calculation methods are needed to compare the effect with CO_2 emissions. A common scale is also important to capture potential trade-offs of reducing different emissions to determine the net climate impact (EASA 2020, p. 36). For example, fuel-efficient engines reduce CO_2 emissions, but these engine modifications increase combustion temperature, producing more NO_x (UBA 2019, p. 89). In addition, the climate impact of non-CO_2 emissions compared to CO_2 emissions is not linear to fuel consumption because it is highly dependent on the location and timing of emissions (e.g. flight altitude and travel conditions) (UBA 2019).[29]

Under the Framework Convention on Climate Change, the Kyoto Protocol, the Paris Agreement and EU directives, CO_2 equivalents (CO_2-eq) based on Global Warming Potential over a 100-year period (GWP100) are used to report aggregated emissions of various gases. However, GWP is only partially suitable for aggregating the climate impact of all non-CO_2 emissions which have different time frames for their climate impacts. Therefore, different calculation methods for CO_2-eq are being discussed for aviation (EASA 2020; UBA 2019). The choice of calculation method for CO_2-eq

[29] This is not based on individual flights, but rather provides an average for the total climate impact of global aviation. The actual climate impact of an individual flight depends primarily on the specific flight altitude and climatic conditions.

influences the additional efforts that result for calculation and data collection and the amount of the reduction incentive. EASA (2020) discusses different methods, but also emphasizes that the choice of metric depends on the intended policy measure and incentive effect. In principle, it remains problematic to attempt to compare short-lived and long-lived GHGs in one metric. Since non-CO_2 effects depend on, among other factors, the time of day, climatic conditions, flight altitude, and flight route, an accurate quantification of these effects must be determined on a flight-specific basis using modelling. Therefore, airlines should be required to implement a detailed monitoring system for non-CO_2 effects. This would be a first step for future regulations and would also improve the data basis for CO_2-eq metrics.

For inclusion in the EU ETS, the comparability of non-CO_2 effects with the traded commodity, allowances in tons of CO_2-eq, would be necessary. EASA (2020, p. 82) proposes the inclusion of NO_x emissions via the GWP100 metric that is already used in the EU ETS for other gases (Art. 3j ETS Directive). It notes that such an inclusion of NO_x emissions is not uncritical, given the existing uncertainties regarding the climate impact of NO_x emissions and the limits of the GWP for aggregating GHGs with effects over different time frames (EASA 2020, p. 32). In addition, there are alternative instruments for reducing NO_x emissions, e.g. the introduction of a charge.

A number of measures could be taken to reduce non-CO_2 effects overall. In addition to a NO_x levy or charge, these measures include spatial and temporal no-fly zones (climate-restricted areas) or a standard for the aromatics content[30] of kerosene (EASA 2020). Such alternative measures have the advantage of building on existing regulations, standards and charges and could be implemented quickly and easily. It also avoids the difficulty of converting non-CO_2 effects to CO_2-eq.

Another option for including non-CO_2 effects in the EU ETS would be to introduce a simple multiplier for CO_2 emissions. This would mean that airlines would have to submit more allowances to cover their verified CO_2 emissions. The factor should be based on the radiative forcing of non-CO_2 effects and should be between 3 and 5 (Oeko-Institut 2020a, p. 5). This could apply either to all EUAAs or only to EUAs. The price for CO_2 emissions (and deposited non-CO_2 effects) would increase accordingly depending on the multiplier for aviation. Since such a mechanism does not currently exist in the EU ETS, its implementation is more difficult than, for example, the abolition of free allocation.

Thus, the inclusion of all non-CO_2 effects in the ETS continues to be difficult; calculation methods and the introduction of a mandatory monitoring system should be further pursued. Regarding NO_x emissions, a NO_x charge is a better option in view of trade-offs and possible negative net climate effects of NO_x emissions. In the medium term, the overall climate impact of flights should be subject to strict regulation.

2.5 CORSIA

2.5.1 Current regulatory framework

It was agreed in 1997 under the Kyoto Protocol that greenhouse gas emissions from international aviation and maritime transport would not be included in the national climate targets of industrialised

[30] Aromatics are chemical compounds in fuel. Fuels with a lower share of aromatic compounds burn more cleanly and emit fewer soot particles.

countries (Annex I countries). Instead, the Kyoto Protocol mandated the ICAO and the International Maritime Organization (IMO) to address these emissions.

In contrast to the Kyoto Protocol, all greenhouse gas emissions are covered under the Paris Agreement. However, countries can determine for themselves which emission sources and greenhouse gases are included in their national inventories. With the exception of the EU, no country has yet included international flights in its initial national inventories. Measures to reduce greenhouse gas emissions from international flights have, therefore, been discussed primarily under the ICAO in recent decades.

After years of negotiations, ICAO Contracting States adopted an instrument in 2016 to limit CO_2 emissions from aviation: the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA). It was intended that CORSIA would implement "carbon-neutral growth" after 2020. The increase in CO_2 emissions beyond 2020 is to be avoided or offset by means of technical and operational measures, the use of alternative fuels, and the purchase of offsets in the period from 2021 to 2035.

However, the climate impact of CORSIA is very limited in practice for a number of reasons:

- CORSIA only regulates CO_2 emissions and thus only about one third of the actual climate impact of flights (see chapter 1).
- The obligations under CORSIA only apply to flights between countries that participate in CORSIA. Participation is voluntary in the period from 2021 to 2026. Current participation covers approx. 50% of CO_2 emissions from international aviation. From 2027, participation will be mandatory for many – but not all – countries. It is expected that its coverage will then be around 80%.
- Due to the Covid-19 pandemic, the Parties decided in June 2020 to adjust the base year for the first phase of CORSIA from 2021 to 2023. While the original versions of CORSIA envisaged using the average of 2019 and 2020 as the base level, the emissions level of 2019 (i.e. prior to the effects of the pandemic) is now taken as the basis for calculating the offsetting requirement. According to calculations by Oeko-Institut, air operators no longer have to make any mitigation efforts in this phase now. For the subsequent phases, it is still unclear what base levels will be used. If the average for 2019 and 2020 is retained, mitigation efforts could be reduced by between 25% and 75%, depending on how quickly the industry recovers from the pandemic and emissions correspondingly increase (Oeko-Institut 2020b).
- The requirements for the quality of offsets are low and the quality of the currently approved offsets is questionable in part. For example, under the rules of CORSIA, the continued existence of a forest project must be ensured only for the duration of CORSIA. If the carbon is released at a later date, it does not necessarily have to be offset (Schneider et al. 2019). In addition, projects from the Clean Development Mechanism (CDM) of the Kyoto Protocol are eligible. Most of these projects continue to operate regardless of whether they can still sell their credits (NewClimate Institute; Oeko-Institut 2017; Schneider et al. 2017). Therefore, the purchase of these old credits does not have a mitigation effect (Warnecke et al. 2019). It is also expected that many projects for avoiding deforestation will be used under CORSIA. These involve numerous problems – in particular high uncertainties in determining the reference level and the risk of carbon leakage (Schneider et al. 2018). Finally, there are currently no rules for the use of international carbon markets under Article 6 of the Paris Agreement. This does not yet ensure that double counting

of emission reductions between CORSIA and nationally determined contributions under the Paris Agreement is avoided. Overall, it is therefore anticipated that the purchase of offsets under the current rules of CORSIA will barely have a mitigation effect.

- CORSIA enables airlines to meet their obligations by using alternative fuels. This includes fossil fuels that emit fewer greenhouse gases during extraction and production. However, such emissions reductions are also counted toward meeting national climate targets. Furthermore, it is unclear to what extent all upstream chains of biogenic alternative fuels are sufficiently accounted.

- In the light of the objectives of the Paris Agreement, the current overarching goal of "carbon-neutral growth" must be regarded as insufficient overall.

This makes it clear that CORSIA is only a first step toward global cooperation to reduce emissions from the aviation sector. Based on past experience, the extent to which the political will exists to make the instrument significantly more ambitious on an international level seems questionable. Some stakeholders are therefore calling on the EU in particular to use its own climate policy instruments instead of CORSIA. A crucial question here is on which international flights the EU will regulate air traffic through the EU ETS (e.g. only intra-European flights) and on which flights CORSIA will apply exclusively or additionally (e.g. flights between the EU and third countries) (see also section 2.4).

2.5.2 Options for action

CORSIA is scheduled to be reviewed by the contracting states for the first time in 2022. This provides an opportunity to reshape CORSIA's objectives and key rules. In the context of these international negotiations, the German government could advocate the following to increase the climate protection impact of CORSIA:

- **Target for 2050:** A long-term target for 2050 is very likely to be an important point of discussion during the review. An increasing number of airlines and Member States have already set zero emissions targets for this period. CORSIA could set a corresponding overarching target for all Parties.

- **Adjustment of the target path for the medium term:** With a long-term zero emissions target, the target path up to 2035 (the current time frame of the instrument) should also be adjusted. A linear reduction path to the zero emissions target would be more consistent with the goals of the Paris Agreement than "carbon-neutral growth." The base year should also be chosen carefully. The original average of 2019 and 2020 (rather than 2019 or 2020 levels on their own) may be a fair compromise to account for the impact of the Covid-19 pandemic without diluting the ambition of the mechanism.

- **Blending quota for synthetic fuels**: In the long term, hydrogen produced from green electricity or synthetic kerosene (also known as "e-fuels") will have to play an important role in limiting the climate impact of aviation. The timely start of synthetic fuel production can pave the way for this. CORSIA could therefore also break new ground and introduce a blending quota for synthetic fuels. This would require airlines to meet part of their mitigation obligations by using synthetic fuels. If implemented under CORSIA, there would be no distortion of competition, as the quota would apply equally to all airlines on routes between participating countries.

- **Improving the quality requirements for offsets:** The minimum requirements currently in force do not ensure a high quality of offset credits. A number of rules could improve their quality. These include, above all, the exclusion of project types that have a low probability of additionality and an obligation to ensure the permanence of emission reductions from forest and peatland projects over 100 years, as some standards, such as Climate Action Reserve (CAR), have already implemented**.**

- **Use of carbon credits from emission trading systems:** Another option is to use allowances from emissions trading systems instead of projects to offset emissions under CORSIA. In the case of ambitious emissions trading systems, it presumably leads to a more reliable offsetting of emissions than using carbon credits from projects (Doda et al. 2021). However, there is also a risk that emissions trading systems with overallocation could be permitted under CORSIA for political reasons.

In discussions on an EU level on the implementation of CORSIA, Germany should advocate that the aviation ETS remains in place for intra-European flights and that CORSIA is applied only to international flights between the EU and third countries.

With respect to the negotiations under Article 6 of the Paris Agreement, it is important that the use of carbon credits under CORSIA is considered an international transfer under Article 6 and accounted accordingly by Parties in fulfilling their commitments under the Paris Agreement. This is provided for in the draft negotiating texts for COP25 in Madrid but has been repeatedly challenged by some countries such as Saudi Arabia and Brazil.

3 Recommendations

In order to eliminate the existing preferential treatment of aviation and provide increased incentives for emissions reduction, Germany should advocate the implementation of a range of regulatory options:

- **Energy taxes:** Germany should advocate EU-wide taxation of kerosene as part of the reform of the EU Energy Tax Directive in order to eliminate the unequal tax treatment of the various modes of transport as effectively as possible. If no corresponding reform of the EU Energy Tax Directive has taken place by 2022, Germany should introduce a kerosene tax at national level and seek taxation with other EU Member States within the framework of enhanced cooperation or through bilateral agreements (see chapter 2.1).

- **Value added tax:** Germany should work at European and (and international) level to ensure that value added tax is also levied on international air travel. For intra-European flights, the EU Member States would have to agree on an option as part of the reform of the VAT Directive. Either VAT could be levied on the entire flight in the country of departure or a notional revenue share could be applied to the domestic leg of international flights or to the entire journey except for the portion in the destination country. One option for action that Germany could implement within the current legal framework without the need to amend the EU's VAT Directive would be to levy VAT on the domestic portion of international flights (see chapter 2.2).

- **Air ticket tax**: The current air ticket tax should be reformed in several respects. Firstly, EU-wide minimum rates for an air ticket tax should be established to avoid evasive action. Secondly, the German air ticket tax should be increased. As long as no agreement can be reached at European

(and international) level on the levying of a value added tax, Germany should increase the air ticket tax in such a way that it more or less balances the uncollected VAT on international flights. A distinction should also be made between economy and business class. In addition, the tax for short-haul flights could be increased significantly to create more incentives for a shift to more environmentally-friendly modes of transport. Thirdly, the cap and the linking of the air ticket tax rate to the revenues from the auctioning of carbon credits should be abolished. Fourthly, the levying of the air ticket tax on inbound flights should also be considered. Fifthly, the inclusion of freight transport using moderate tax rates should be implemented in the short term. In parallel, an EU regulation with higher tax rates should be pursued as the risk of relocation to neighbouring countries is greater in freight traffic than in passenger traffic (see chapter 2.3).

- **EU Emissions Trading System:** The upcoming revision of the ETS Directive in 2021 and 2022 offers good opportunities for strengthening the aviation ETS. In this context, Germany should commit to ending the free allocation of allowances and to the auctioning of all allowances instead. The inclusion of non-CO_2 effects should be initiated in parallel (see chapter 2.4).

- **CORSIA**: As regards the first review of CORSIA, which is set to take place in 2022, Germany should work to ensure that the instrument is made more effective. To this end, Germany should advocate setting a zero emissions target for 2050, increasing the target path for 2035, setting blending quotas for e-fuels, tightening the requirements for offset credits and, if necessary, enabling the use of carbon credits from emissions trading systems under CORSIA. On an EU level, Germany should work to ensure that the EU ETS remains in place for intra-European flights and that CORSIA is only applied to international flights between the EU and third countries (see chapter 2.5).

To implement climate protection in aviation, uniform regulations at EU and international levels are desirable because they have the greatest impact and can send stronger political signals. On an EU level, some Member States support stronger aviation taxation: in 2019, a coalition of 9 EU Member States (BE, BG, DK, FR, DE, IT, LU, NL, SE) approached the EU Commission and suggested an EU-wide aviation taxation initiative (Euractiv 2019). Several leading candidates in the European Parliament elections (EPP, S&D, ALDE, Greens/EFA, and GUE/NGL) also advocated the levying of a kerosene tax. However, at an international conference with government representatives organized by the Netherlands in 2019, discussions about regulatory options showed that there is no broad consensus among Member States about reforming aviation taxation (Netherlands government 2019; Reuters 2019). Unless stronger regulation can be implemented on an EU level, Germany should take national policy action. By doing so, Germany would also provide impetus for broader European and international initiatives.

In addition to the economic instruments examined here, the German Travel Expenses Act should also be amended. For example, it could be stipulated that, as a matter of principle, environmentally-friendly modes of transport are to be used as a matter of priority and travelling by plane is only permissible in exceptional cases. Short-haul flights in particular could be addressed accordingly. Finally, subsidies for regional airports should be reviewed and reduced.

4 Outlook

The long-term transformation of the aviation sector to climate neutrality is a climate policy challenge, especially against the backdrop of increasing mobility, growing freight traffic, limited opportunities to shift medium- and long-haul flights, long investment cycles in the development of new aircraft and

propulsion technologies, high costs and the limited availability of alternative fuels, and the challenges of containing non-CO_2 effects.

To make aviation climate-neutral, it will be necessary to combine a variety of measures:

- **Avoiding flights:** The simplest and most effective way of making aviation climate-neutral is the avoidance of flights. For example, digitisation offers great opportunities for reducing the number of business trips. But the frequency of private long-distance travel must also be critically reflected.
- **Shift of flights to rail:** Another important element is shifting short-haul flights to rail. This is possible on short-haul journeys in particular. For this, an expansion of rail infrastructure with a reduction in travel times is important.

In addition, the use of new technologies can reduce the climate impact of unavoidable flights. However, the technologies that are currently available or being developed are not expected to be available on a large scale in the next two decades, and thus can only make a limited contribution during this period:

- **Improved energy efficiency:** This includes operational measures such as improved airspace management or improved flight profiles, more efficient aircraft engines or more efficient aircraft construction, e.g. by means of new types of aerodynamically optimised aircraft. The latter is of particular interest for aircraft with new propulsion systems such as hydrogen. However, considerable efficiency gains in the past have not been able to compensate the growth in the sector, with the result that the emissions have increased in absolute terms. The target set by the ICAO to reduce fuel consumption per passenger kilometre by 2% per year is unlikely to be achieved in 2020. Currently, efficiency gains are approx. 1-1.5% per year.
- **Biofuels:** Biofuels are currently being tested and used by various airlines as so-called "drop-in" fuels. These have the advantage that they can be blended with kerosene and can, therefore, also be used in the existing fleet. Biofuels can also count toward offset obligations under CORSIA. However, biofuels have very different carbon footprints and production can lead to indirect land use changes, including deforestation. There is also competition with other uses of the land, especially for food production. The potential for truly sustainable biofuels is therefore limited. In the long term, therefore, biofuels can play at best a niche role and not a supporting role in the aviation sector.
- **Synthetic kerosene:** Synthetic kerosene – also known as e-fuels or power-to-liquid (PtL) – is similar in composition to fossil kerosene but is produced from CO_2 and climate-neutral hydrogen. The CO_2 can be obtained from various sources such as biogas or by capturing it from the air. However, the production of synthetic kerosene requires a significant expansion of renewable energies and large areas for carbon capture. According to calculations by Oeko-Institut, roughly all of Germany's renewable electricity generation would have to be used to produce the kerosene fuelled in Germany from renewable energies. For the carbon footprint of synthetic kerosene, the most important factors are the purchase of electricity from additional renewable energy capacities and its integration into the electricity system. This is because if the electricity is generated using fossil fuels, the production of synthetic kerosene can cause more emissions. In addition, the source of the CO_2 and other social and environmental criteria play a major role. The extent to which green hydrogen can be imported is also uncertain. In addition, synthetic fuels can only address the climate impact of aviation to a limited extent, since not all non-CO_2 effects

can be reduced by the cleaner combustion of synthetic kerosene. Overall, it is estimated that the climate impact of aviation can be reduced by about 30-60% by using synthetic jet fuel.

- **Hydrogen:** Aircraft powered by hydrogen could also be a long-term option. The hydrogen could either be burned in turbines on board or converted into electricity in a fuel cell that powers propellers. Hybrid systems are also conceivable. A key challenge is storing the hydrogen, which takes up significantly more space and requires comparatively heavy tanks. Taking into account the non-CO_2 effects, it is assumed that hydrogen can reduce the climate impact by between 50% and 75% when used as a fuel. In the case of use in fuel cells, a reduction of even 75% to 90 % is expected. However, the use of hydrogen is a technically complex solution which is not expected to be available for use in relevant applications before 2035. Furthermore, from today's perspective, it is unclear how large the potentials for sustainable green hydrogen are in the medium term.

- **Electric aircraft:** In this type of aircraft, electric engines are powered by batteries. In flight operations, battery-electric propulsion systems could represent the most climate-friendly option in aviation: no CO_2 emissions are produced, nor do non-CO_2 effects occur – in contrast to biofuels, synthetic kerosene and hydrogen-powered aircraft. Norway announced in 2018 that all short-haul domestic flights will be electric by 2040. The main disadvantage of battery electric propulsion compared to kerosene is the low energy density and thus the high weight of lithium-ion batteries. From today's perspective, it seems likely that their use will therefore be limited to smaller aircraft and short distances of no more than 500 to 1,000 kilometres – a distance for which rail transport is often well suited. Using battery-electric aircraft for this purpose only makes sense, therefore, where no rail infrastructure can be built, e.g. on islands.

Overall, it is clear that the aviation sector must undergo a fundamental transformation in order to significantly reduce its climate impact. In doing so, the focus should not only be on technological options, but also on the avoidance of flights and the shift from air transport to more environmentally-friendly modes of transport. Price signals that take into account the actual environmental costs can play an important role in this context.

List of references

BBC (2019): Introduce frequent flyer levy to fight emissions, government told. Online available at https://www.bbc.com/news/business-49808258, last accessed on 18 Jan 2021.

BDL - Bundesverband der Deutschen Luftverkehrswirtschaft (2018): BDL - Bundesverband der Deutschen Luftverkehrswirtschaft. Was bedeutet Luftfracht für Deutschland? Eine Analyse der volkswirtschaftlichen Bedeutung, der Funktionsweise, der Prozesse sowie des Wettbewerbs im Luftfrachtverkehr. Bundesverband der Deutschen Luftverkehrswirtschaft. Berlin, 2018. Online available at https://www.bdl.aero/wp-content/uploads/2018/10/was-bedeutet-luftfracht-fur-deutschland.pdf, last accessed on 10 Dec 2020.

BDL (2017): Was wird eigentlich per Luftfracht transportiert? Online available at https://www.bdl.aero/wp-content/uploads/2018/09/bdl-luftfahrtaktuell-2017-4.pdf, last accessed on 9 Oct 2020.

BMF (o.D.): Luftverkehrsteuer. Online available at https://www.bundesfinanzministerium.de/Content/DE/Glossareintraege/L/001_Luftverkehrsteuer.html?view=renderHelp, last accessed on 11 Aug 2020.

BMVI (2019): Verkehr in Zahlen 2019/2020, 2019. Online available at https://www.bmvi.de/SharedDocs/DE/Publikationen/G/verkehr-in-zahlen-2019-pdf.pdf?__blob=publicationFile, last accessed on 29 Sep 2020.

Boeing (2019). Commercial Market Outlook 2019–2038. Boeing, 2019. Online available at https://www.boeing.com/resources/boeingdotcom/commercial/market/commercial-market-outlook/assets/downloads/cmo-2019-report-final.pdf, last accessed on 16 Dec 2020.

Britische Regierung (2020): Rates for Air Passenger Duty. Online available at https://www.gov.uk/guidance/rates-and-allowances-for-air-passenger-duty, last accessed on 25 Jan 2021.

Bundesregierung (2003): Antwort der Bundesregierung auf die Kleine Anfrage der Abgeordneten Klaus Brähmig, Ernst Hinsken, Edeltraud Töpfer, weiterer Abgeordneter und der Fraktion der CDU/SCU - Drucksache 15/325 - Auswirkungen der geplanten Besteuerung grenzüberschreitender Flüge auf die Tourismuswirtschaft (Drucksache 15/398), 2003. Online available at http://dipbt.bundestag.de/dip21/btd/15/003/1500398.pdf, last accessed on 14 Jan 2021.

CE Delft (2019a). Taxes in the Field of Aviation and their impact, Final report. CE Delft. European Commission (ed.), 2019. Online available at https://op.europa.eu/en/publication-detail/-/publication/0b1c6cdd-88d3-11e9-9369-01aa75ed71a1, last accessed on 30 Dec 2019.

CE Delft (2019b): Schroten, A. e. a. Transport taxes and charges in Europe, An overview study of economic internalisation measures applied in Europe. CE Delft, 2019. Online available at https://www.cedelft.eu/en/publications/2312/transport-taxes-and-charges-in-europe-an-overview-of-economic-internalisation-measures-applied-in-europe, last accessed on 30 Nov 2020.

CEC - Council of the European Union (2020). Submission to the UNFCCC on behalf of the European Union and its Member States on the update of the nationally determined contribution of the European Union and its Member States (Doc 14222/1/20 REV1). Council of the European Union. Brussels, 18 Dec 2020. Online available at https://data.consilium.europa.eu/doc/document/ST-14222-2020-REV-1/en/pdf, last accessed on 17 Feb 2021.

Destatis - Statistisches Bundesamt (2020a): Finanzen und Steuern: Luftverkehrsteuer 2019, Fachserie 14 Reihe 9.6. Statistisches Bundesamt (ed.). Online available at https://www.destatis.de/DE/Themen/Staat/Steuern/Weitere-Steuern/Publikationen/Downloads-weitere-Steuern/luftverkehrsteuer-2140960197004.pdf?__blob=publicationFile, last accessed on 18 Jan 2021.

Destatis (2019). Luftverkehr auf allen Flugplätzen - Fachserie 8 Reihe 6.2 - 2018. Destatis, 2019. Online available at https://www.destatis.de/DE/Themen/Branchen-Unternehmen/Transport-Verkehr/Personenverkehr/Publikationen/Downloads-Luftverkehr/luftverkehr-alle-flugplaetze-2080620187004.pdf;jsessionid=7FC34911572B5ABD8E70FA281E00D4CD.internet8742?__blob=publicationFile., last accessed on 17 Nov 2020.

Destatis (2020b): 1,2 Milliarden Euro Luftverkehrsteuer im Jahr 2019 angemeldet. Online available at https://www.destatis.de/DE/Themen/Staat/Steuern/Weitere-Steuern/luftverkehrsteuer.html, last accessed on 15 Jan 2021.

Deutscher Bundestag: Gesetz zur Änderung des Luftverkehrsteuergesetzes. In: Bundesgesetzblatt Teil I Nr 48. Online available at http://www.bgbl.de/xaver/bgbl/start.xav?startbk=Bundesanzeiger_BGBl&jumpTo=bgbl119s2492.pdf, last accessed on 10 Aug 2020.

Doda, B.; La Hoz Theuer, S.; Cames, M.; Healy, S.; Schneider, L. (2021): Voluntary offsetting: credits and allowances (UBA Climate Change, 04/2021), 2021. Online available at https://www.umweltbundesamt.de/sites/default/files/medien/5750/publikationen/2021_01_11_cc_04-2020_voluntary_offsetting_credits_and_allowances_1.pdf, last accessed on 29 Jan 2021.

EASA (2020). Updated analysis of the non-CO2 climate impacts of aviation and potential policy measures pursuant to the EU Emissions Trading System Directive Article 30(4). EASA. Eurpean Commission (ed.), 2020. Online available at https://ec.europa.eu/clima/news/updated-analysis-non-co2-effects-aviation_en, last accessed on 2 Dec 2020.

EC - European Commission (2020a). Impact Assessment Accompanying the document Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions Stepping up Europe's 2030 climate ambition. Investing in a climate-neutral future for the benefit of our people. Commission Staff Working Document (SWD(2020) 176 final Part 1/2). European Commission. Brussels, 17 Sep 2020. Online available at https://eur-lex.europa.eu/resource.html?uri=cellar:749e04bb-f8c5-11ea-991b-01aa75ed71a1.0001.02/DOC_1&format=PDF, last accessed on 17 Feb 2021.

EC - European Commission (ed.) (2020b): EC - European Commission. Sustainable and Smart Mobility Strategy – putting European transport on track for the future, SWD(2020) 331 final (COM(2020) 789 final). Brussels, 2020. Online available at https://ec.europa.eu/transport/sites/transport/files/legislation/com20200789.pdf, last accessed on 26 Jan 2021.

EEA - European Environment Agency (2020): EEA. EEA greenhouse gas data viewer. European Environment Agency, 2020. Online available at http://www.eea.europa.eu/data-and-maps/data/data-viewers/greenhouse-gases-viewer, last accessed on 14 Oct 2020.

Euractiv (2019): Nine EU countries urge new Commission to tax aviation more. Online available at https://www.euractiv.com/section/aviation/news/nine-eu-countries-urge-new-commission-to-tax-aviation-more/, last accessed on 11 Aug 2020.

FÖS - Forum ökologisch-soziale Marktwirtschaft (2020): Ann-Cathrin Beermann, Swantje Fiedler, Mario Meyer. Zehn klimaschädliche Subventionen im Fokus, Wie ein Subventionsabbau den Klimaschutz voranbringt und den Bundeshaushalt entlastet. Forum ökologisch-soziale

Marktwirtschaft. Greenpeace (ed.), 2020. Online available at https://www.greenpeace.de/presse/publikationen/studie-10-klimaschaedliche-subventionen-im-fokus.

FÖS - Forum ökologisch-soziale Marktwirtschaft (2021): Beermann, A.; Fiedler, S.; Runkel, M.; Schrems, I.; Zerzawy, F.; Meyer, M. Zehn klimaschädliche Subventionen sozial gerecht abbauen - ein Zeitplan. Forum ökologisch-soziale Marktwirtschaft, 2021. Online available at https://foes.de/publikationen/2021/2021-02_FOES_Klimaschaedliche_Subventionen_sozial_gerecht_abbauen.pdf, last accessed on 26 Feb 2021.

FreightHub (n.d.): Luftfracht. Online available at https://freighthub.com/de/luftfracht/, last accessed on 28 Nov 2019.

Gössling, S.; Ceron, J.-P.; Dubois, G.; Hall, M. C. (2009): Hypermobile travellers. In: Gössling, S. and Upham, P. (ed.): Climate change and aviation: Issues, challenges and solutions. London: Earthscan, pp. 131–150.

Gouvernement Francais (2020): Taxe sur les nuisances sonores aériennes. Online available at https://www.ecologie.gouv.fr/taxes-aeronautiques#e4, last accessed on 16 Dec 2020.

Government of the Netherlands (2019): Dutch government tables national flight tax bill. Online available at https://www.government.nl/topics/environmental-taxes/news/2019/05/14/dutch-government-tables-national-flight-tax-bill, last accessed on 18 Jan 2021.

IATA (2019): IATA. Economic performance of the airline industry. IATA, 2019. Online available at https://www.iata.org/en/iata-repository/publications/economic-reports/airline-industry-economic-performance---december-2019---report/, last accessed on 25 Jan 2021.

IATA (o. D.): Value Added Tax: Tax exemption must be maintained for international travel. Online available at https://www.iata.org/contentassets/a72d8d3cfaf84529bcdef6b2dc59f224/value-added-tax.pdf, last accessed on 13 Jan 2021.

ICAO - International Civil Aviation Organization (2018). ICAO long-term traffic forecasts. Passenger and cargo. International Civil Aviation Organization, 2018. Online available at https://www.icao.int/sustainability/documents/ltf_charts-results_2018edition.pdf, last accessed on 16 Oct 2020.

ICAO (1944): Convention on International Civil Aviation done at Chicago on the 7th day of December 1944, 1944. Online available at https://www.icao.int/publications/documents/7300_orig.pdf, last accessed on 14 Jan 2021.

ICAO (2000): ICAO's policies on taxation in the field of international air transport. Online available at https://www.icao.int/publications/Documents/8632_3ed_en.pdf, last accessed on 13 Jan 2021.

ICAO (2019): Destination Green: The next chapter. 2019 Environmental Report Aviation and Environment, 2019. Online available at https://www.icao.int/environmental-protection/Pages/envrep2019.aspx, last accessed on 5 Jun 2020.

infras (2016): Auswirkungen eines EHS-Linking für den Bereich Luftfahrt – Aktualisierung für die Schweiz, Schlussbericht, 21 Jul 2016. Online available at https://www.bafu.admin.ch/dam/bafu/de/dokumente/klima/externe-studien-berichte/auswirkungen_einesehs-linkingfuerdenbereichluftfahrtaktualisieru.pdf.download.pdf/auswirkungen_einesehs-linkingfuerdenbereichluftfahrtaktualisieru.pdf, last accessed on 13 Nov 2019.

Klinski/Keimeyer (2019): Zur verfassungsrechtlichen Zulässigkeit eines CO2-Zuschlags zur Energiesteuer - Rechtswissenschaftliches Gutachten. Berlin, 2019. Online available at https://www.oeko.de/fileadmin/oekodoc/CO2-Zuschlag-zur-Energiesteuer.pdf, last accessed on 8 Dec 2020.

Lassen, C. (2016): Aeromobility and Work. In: *Environment and Planning A* 38 (2), pp. 301–312. DOI: 10.1068/a37278.

Lee, D. S.; Fahey, D. W.; Skowron, A.; Allen, M. R.; Burkhardt, U.; Chen, Q.; Doherty, S. J.; Freeman, S.; Forster, P. M.; Fuglestvedt, J.; Gettelman, A.; León, R. R. de; Lim, L. L. et al. (2020): The contribution of global aviation to anthropogenic climate forcing for 2000 to 2018. Atmospheric Environment, 117834. DOI: 10.1016/J.ATMOSENV.2020.117834.

Ministère de la Transition Écologique (2020): Aeronautical taxes. Online available at https://www.ecologie.gouv.fr/en/aeronautical-taxes, last accessed on 18 Jan 2021.

NEE - Netzwerk Europäischer Eisenbahnen e.V. (ed.) (2017): Böttger, C. Abschätzung der Kosten der Verkehrsträger im Vergleich, 2017. Online available at https://www.netzwerk-bahnen.de/assets/files/news/2017/studie-abschaetzung-der-kosten-der-verkehrstraeger-im-vergleich.pdf, last accessed on 3 Feb 2021.

New economics Foundation (2015): Devlin, S.; Bernick, S. Managing aviation passenger demand with a frequent flyer levy. New economics Foundation, 2015. Online available at https://neweconomics.org/uploads/files/58e9fad2705500ed8d_hzm6yx1zf.pdf, last accessed on 18 Jan 2021.

NewClimate Institute; Oeko-Institut (2017): Warnecke, C.; Day, T.; Schneider, L.; Cames, M.; Healy, S.; Harthan, R.; Tewari, R.; Höhne, N. Vulnerability of CDM projects for Discontinuation of Mitigation Activities: Assessment of Project Vulnerability and Options to Support Continued Mitigation. NewClimate Institute; Oeko-Institut. DEHSt (ed.). Berlin, 2017. Online available at https://www.dehst.de/SharedDocs/downloads/EN/project-mechanisms/vulnerability-of-CDM.pdf?__blob=publicationFile&v=3, last accessed on 6 Nov 2020.

Niederländische Regierung (2019): International conference on carbon pricing and aviation taxes is starting. Online available at https://www.government.nl/latest/news/2019/06/20/international-conference-on-carbon-pricing-and-aviation-taxes-is-starting, last accessed on 25 Jan 2021.

Oeko-Institut (2020a): Graichen, J.; Graichen, V. Analysis of potential reforms of aviation's inclusion in the EU ETS. Oeko-Institut. Transport & Environment (ed.), 2020. Online available at https://www.transportenvironment.org/sites/te/files/publications/2020_11_Oko_Institute_analysis_potential_reforms_aviation_inclusion_ETS.pdf.

Oeko-Institut (2020b): Schneider, L.; Graichen, J. Should CORSIA be changed due to the COVID-19 crisis?. Oeko-Institut. Berlin, 2020. Online available at https://www.oeko.de/fileadmin/oekodoc/Should-CORSIA-be-changed-due-to-the-COVID-19-crisis.pdf, last accessed on 4 Nov 2020.

Oeko-Institut; FÖS; FFU Berlin (i.E.): Schumacher, K.; Siemons, A.; Keimeyer, F.; Bär, H.; Beermann, A.; Jacob, K.; Postpischil, R. Ökologische Finanzreform: Produktbezogene Anreize als Treiber umweltfreundlicher Produktions- und Konsumweisen. Endbericht zu Verbrauchsteuern und weiteren produktbezogene ökonomische Instrumente (UBA Texte, xx/2021). Oeko-Institut; FÖS; FFU Berlin, i.E.

Pache, E. (2005): Möglichkeiten der Einführung einer Kerosinsteuer auf innerdeutschen Flügen. herausgegeben vom Umweltbundesamt (Texte 12/05), 2005. Online available at

https://www.umweltbundesamt.de/sites/default/files/medien/publikation/long/2853.pdf, last accessed on 4 Mar 2019.

Regierung der Niederlande (2019): Dutch govenrment tables national flight tax bill. Online available at https://www.government.nl/latest/news/2019/05/14/dutch-government-tables-national-flight-tax-bill, last accessed on 28 Nov 2019.

Reuters (2019): EU nations aim high with plan to tax air travel. Online available at https://www.reuters.com/article/us-climate-change-eu-airlines/eu-nations-aim-high-with-plan-to-tax-air-travel-idUSKCN1TL1I7, last accessed on 25 Jan 2021.

Ritchie, H. (2020): Climate change and flying: what share of global CO2 emissions come from aviation?, OurWorldInData.org. Online available at https://ourworldindata.org/co2-emissions-from-aviation, last accessed on 12 Jan 2021.

Schneider, L.; Conway, D.; Kachi, A.; Hermann, B. (2018): Crediting Forest-related Mitigation under International Carbon Market Mechanisms: A Synthesis of Environmental Integrity Risks and Options to Address Them. Online available at https://newclimate.org/2018/09/19/crediting-forest-related-mitigation-under-international-carbon-market-mechanisms/.

Schneider, L.; Day, T.; La Hoz Theuer, S.; Warnecke, C. (2017): CDM supply potential up to 2020: Umweltbundesamt. In: *20457634*. Online available at https://www.dehst.de/SharedDocs/downloads/EN/project-mechanisms/CDM-Supply-Potential-up-to-2020.pdf?__blob=publicationFile&v=2.

Schneider, L.; Michaelowa, A.; Broekhoff, D.; Espelage, A.; Siemons, A. (2019): Lessons learned from the first round of applications by carbon-offsetting programs for eligibility under CORSIA. Berlin / Zurich / Seattle: Oeko-Institut. Online available at https://www.oeko.de/en/publications/p-details/lessons-learned-from-the-first-round-of-applications-by-carbon-offsetting-programs-for-eligibility-u/.

T&E - Transport & Environment (2020): Hemmings, B.; Pache, E.; Forsyth, P.; Mundaca, G.; Strand, J.; Kageson, P. Taxing Aviation Fuel in Europe. Back to the future?. Transport & Environment, 2020. Online available at https://www.transportenvironment.org/sites/te/files/publications/2020_06_Study_for_TE_Taxing_aviation_fuel_final.PDF.

TU Chemnitz (2020): Thießen, F. Die Subventionen des Luftverkehrs, Studie des Arbeitskreises Luftverkehr der TU Chemnitz. TU Chemnitz, 2020. Online available at https://www.rhein-main-institut.de/files/rmi/pro/20200518_Fuld_Thiessen_Subventionen.pdf, last accessed on 14 Jan 2021.

UBA - Umweltbundesamt (2016). Umweltschädliche Subventionen in Deutschland. Aktualisierte Ausgabe 2016. In collaboration with Köder, L. and Burger, A. Umweltbundesamt, 2016. Online available at https://www.umweltbundesamt.de/sites/default/files/medien/479/publikationen/uba_fachbroschuere_umweltschaedliche-subventionen_bf.pdf, last accessed on 27 Nov 2019.

UBA - Umweltbundesamt (2019). Umweltschonender Luftverkehr, lokal-national-international (UBA Texte, 130/2019). Umweltbundesamt, 2019. Online available at https://www.umweltbundesamt.de/publikationen/umweltschonender-luftverkehr, last accessed on 13 Dec 2019.

UK Committee on Climate Change (ed.) (2019): UK Net-Zero Advisory Group to the CCC. Chair's final report, 2019. Online available at https://www.theccc.org.uk/wp-

content/uploads/2019/05/UK-Net-Zero-Advisory-Group-Chair-Report.pdf, last accessed on 18 Jan 2021.

Warnecke, C.; Schneider, L.; Day, T.; La Hoz Theuer, S.; Fearnehough, H. (2019): Robust eligibility criteria essential for new global scheme to offset aviation emissions. In: *NATURE CLIMATE CHANGE* 9 (3), pp. 218–221. DOI: 10.1038/s41558-019-0415-y.