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COMMISSION STAFF WORKING DOCUMENT

IMPACT ASSESSMENT REPORT

Accompanying the document

Proposal for a
DIRECTIVE OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

amending Directive 2003/87/EC as regards aviation's contribution to the Union's economy-wide emission reduction target and appropriately implementing a global market-based measure

{COM(2021) 552 final} - {SEC(2021) 552 final} - {SWD(2021) 555 final} - {SWD(2021) 604 final}

TABLE OF CONTENTS

List of Acronyms

CAEP	Committee on Aviation Environmental Protection
CDM	Clean Development Mechanism
CNG2020	Carbon Neutral Growth from 2020
CO_2	Carbon Dioxide
CO_2 eq.	Carbon Dioxide equivalent
CORSIA	Carbon Offset and Reduction Scheme for International Aviation
EAG	Environment Advisory Group
EEA	European Economic Area
EU	European Union
ETS	Emissions Trading System
EUA	EU Allowance
EUAA	EU Aviation Allowance
EUC	Emissions Unit Criteria
Extra-EEA	Flights between aerdromes within the European Economic Area and aerodromes in a third countries
GHG	Greenhouse Gas
GMBM	Global Market-Based Measure
GMTF	Global Market-Based Measure Technical Task Force
HLG	High Level Group
IATA	International Air Transport Association
ICAO	International Civil Aviation Organization
Intra-EEA	Flights between aerodromes within the European Economic Area
LDC	Least Developing Country
LLDC	Land-locked Developing Country
MBM	Market-Based Measure
MRV	Monitoring, Reporting and Verification
MT	Million Tonnes
RTK	Revenue Tonne-Kilometre
SARPs	Standards and Recommended Practices
SIDS	Small Island Developing States
UNFCCC	United Nations Framework Convention on Climate Change

1. INTRODUCTION: POLITICAL AND LEGAL CONTEXT

Tackling climate change and reaching the objectives of the Paris Agreement and other environmental issues (including addressing air pollution and energy demand) are at the core of the European Green Deal[1]. The necessity and value of the European Green Deal have only grown in light of the very severe effects of the COVID-19 pandemic on our health and economic well-being. Unprecedented near term investments are needed[2] to overcome the negative impact of the COVID-19 crisis on jobs, incomes and businesses, including in the sectors covered by the EU Emissions Trading System (ETS). The European Green Deal is a response to these challenges. It is a new growth strategy that aims to transform the EU into a fair and prosperous society, with a modern, resource-efficient and competitive economy where there are no net emissions of greenhouse gases in 2050 and where economic growth is decoupled from resource use. It also aims to protect, conserve and enhance the EU's natural capital, and protect the health and well-being of citizens from environment-related risks and impacts. At the same time, this transition must be just and inclusive.

The climate neutrality objective, which the Commission proposed in 2018[3] and the European Council[4] and Parliament[5] endorsed, is at the core of this transformation. The Commission has proposed to enshrine climate neutrality into EU law[6]. In order to set the EU on a sustainable path to achieve climate neutrality by 2050, and with the Communication on stepping up Europe's 2030 climate ambition[7] (2030 Communication) the Commission has proposed an EU-wide, economy-wide net greenhouse gas emissions (GHG) reduction target by 2030 compared to 1990 of at least 55% that will set the Union onto the path to climate neutrality.

The Commission is reviewing all relevant climate and energy policies. This includes increasing the environmental contribution of the Emissions Trading System (ETS) in a manner commensurate with the overall target.

1.1. Aviation and climate change

Aviation accounts for 2-3% of global CO_2 emissions[8], and is an important source of climate impacts from emissions other than CO_2[9]. Long-term projections of aviation activity show major increases in traffic. The CO_2 emitted in 2018 from all flights

[1] COM(2019)640 final.
[2] E.g. SWD/2020/98 final.
[3] COM(2018)773 final.
[4] European Council conclusions, 12 December 2019.
[5] European Parliament resolution of 14 March 2019 on climate change and resolution of 28 November. 2019 on the 2019 UN Climate Change Conference in Madrid, Spain (COP 25).
[6] COM (2020)80 final.
[7] COM (2020) 562 final.
[8] IPCC, 2018, IPCC special report on the impacts of global warming of 1.5°C.
[9] COM(2020)777 quantifies these impacts, while COM(2020)747 and associated documents analyse these effects in detail.

departing from the EU28+EFTA was at around 180 million tonnes of CO_2[10]. At EU-level, aviation made up 3.7% of total CO_2 emissions, or 15.7% of CO_2 transport emissions in 2018.

Despite significant technological development in the aviation sector, aviation emissions continued to rise up to 2019[11] and the prospect of impacts upon recovery from the COVID-19 crisis (see Section 2.1) represent an increasing challenge for reaching the EU's economy-wide greenhouse gas emission reduction target and commitments under the Paris Agreement[12], as well as the temperature goals under the Paris Agreement. Under the Paris Agreement, the EU and its Members States agreed on a long-term goal of keeping the increase in global average temperature to well below 2°C above pre-industrial levels and on pursuing efforts to limit the increase to 1.5% [13].

The European Green Deal[14] adopted by the Commission in December 2019, as well as the Climate Law[15] and the Climate Target Plan (CTP)[16], aim at enhancing the EU climate commitment under the Paris Agreement, consistent with its objective of reaching economy-wide climate neutrality in the EU by 2050. The EU is increasing its domestic economy-wide decarbonisation commitment, from 40% to at least 55% compared to 1990 levels by 2030, without using international credits. The updated Nationally Determined Contribution (NDC) of the EU reflecting the target of at least 55% domestic reduction compared to 1990 was communicated to the United Nations Framework Convention on Climate Change (UNFCCC) on 18 December 2020[17]. To reach the increased climate target, all sectors, including aviation, must adequately contribute to the required emission reduction efforts. The European Parliament has underlined that, as co-legislators, the European Parliament and the Council are the only institutions that can decide on any future amendment to the ETS Directive, and stressed that any amendment of the ETS Directive should only be undertaken if it is consistent with the EU's economy-wide GHG emission reduction commitment[18]. A key tool for addressing CO_2 emissions from aviation in Europe is the EU Emissions Trading System (EU ETS). It has allowed aviation to contribute to the 2020 climate objective, and this should be pursued for 2030, as fully recognized under the CTP.

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[10] EEA greenhouse gas - data viewer: https://www.eea.europa.eu/data-and-maps/data/data-viewers/greenhouse-gases-viewer

[11] Average fuel burn per passenger kilometre of aircrafts decreased by 24% between 1990 and 2016, resulting in huge amount of emissions avoided that would have happened without this technological development. However, growth in air traffic, aircraft size and increase of flight distances caused increased levels of emissions in absolute terms (see European Aviation Environmental Report 2019 of EASA, p22, https://ec.europa.eu/transport/sites/transport/files/2019-aviation-environmental-report.pdf).

[12] UNFCCC Paris Agreement (FCCC/CP/2015/10/Add.1), https://unfccc.int/resource/docs/2015/cop21/eng/l09r01.pdf

[13] UNFCCC Paris Agreement (FCCC/CP/2015/10/Add.1), https://unfccc.int/resource/docs/2015/cop21/eng/l09r01.pdf

[14] COM(2019)640 final.

[15] COM(2020)80 final.

[16] COM(2020)562 final.

[17] https://data.consilium.europa.eu/doc/document/ST-14222-2020-REV-1/en/pdf

[18] European Parliament resolution of 15 January 2020 on the European Green Deal https://www.europarl.europa.eu/doceo/document/TA-9-2020-0005_EN.pdf

While the political "mandate" to reinforce the EU ETS for aviation is clear, this is being examined in conjunction with other related and relevant initiatives, such as the revision of the Energy Taxation Directive and the Renewable Energy Directive, as well as the ReFuelEU Initiative, which are being assessed separately, with due account of the ETS dimension and impacts. As indicated in the European Green Deal, reducing CO_2 emissions from aviation relies on a mix of policy instruments, as there is no one single solution to decarbonise the sector. The revision of the EU ETS for aviation is therefore part of the so-called "basket of measures", which includes market-based measures like the EU ETS and CORSIA, the boosting of the production and uptake of sustainable aviation fuels ("SAF"), aircraft technology improvements and operational improvements through e.g. the Single European Sky initiative.

Globally as well, countries have to take increased action in respect of aviation to contribute to achieving the objectives of the Paris Agreement. While the EU ETS currently regulates intra-European aviation, and the Korean ETS, New Zealand ETS, and the Shanghai ETS within China have covered domestic aviation, broader and stronger action is essential.

In the public consultation on updated rules for aviation ETS, 91 % of respondents agree that the aviation sector should contribute more to climate actions. 88% of respondents believe that market-based measures can be effective to tackle aviation emissions in line with the climate objectives.

1.2. EU action and relevant international fora: the Paris Agreement and the International Civil Aviation Organization (CORSIA)

The International Civil Aviation Organisation (ICAO) Assembly set an objective to stabilise global net CO_2 emissions from international aviation[19] at 2020 levels through 'carbon neutral growth' (CNG 2020)[20], i.e. compensating emission growth above 2020 levels by purchasing carbon credits, and of improving fuel efficiency by 2% annually through 2050. These current objectives are to be attained by a 'basket of measures' that consists of measures in four different areas: aircraft technology and standards; air traffic management and operations; sustainable aviation fuels and the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA). The initial CNG 2020 objective is recognized as largely insufficient to bring the necessary contribution from the aviation

[19] Around 65% of aviation emissions are considered by ICAO to be 'international', while 35% are 'domestic', according to the 2020 UNEP gap report (https://www.unep.org/emissions-gap-report-2020, pages). As stated by ICAO in its submission to the 4th conference of the Parties of the UNFCCC, ICAO has no jurisdiction in respect of domestic aviation, see https://web.archive.org/web/20200608064440/https://www.icao.int/environmental-protection/Documents/STATEMENTS/cop4.PDF.

[20] 2010 ICAO Assembly Resolution A37-19, available at: http://www.icao.int/publications/Documents/9958_en.pdf

sector to the achievement of the Paris temperature goals[21]. It has been suggested that aviation emissions should start decreasing no later than 2030[22].

The EU contributed significantly to, and supported the ICAO Assembly Resolution A40-18, whereby the ICAO Assembly decided to request the ICAO Council to explore "the feasibility of a long-term global aspirational goal for international aviation through conducting detailed studies assessing the attainability and impacts of any goals proposed, including the impact on growth as well as costs in all countries, especially developing countries, for the progress of the work to be presented to the 41st Session of the ICAO Assembly. Work is under way in view of the 41st Assembly in 2022. The EU has for long argued for moving beyond existing CO_2 objectives and establishing a common long-term goal in ICAO, consistent with science and the temperature goals under the Paris Agreement, to best guide and boost the development of adequate measures and spur the necessary research and deployment of new technologies.

In 2016, the 39th ICAO Assembly adopted a Resolution for a global market based measure for international aviation emissions (GMBM), known as the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA), despite reservations – on different accounts - from China, India, Saudi Arabia and the US[23].

By itself, CORSIA does not aim at reducing aviation emissions. CORSIA is an offsetting mechanism, which enables the aviation sector to continue to grow after 2020 in as far as collective international aviation emissions above a certain threshold (the baseline) are compensated through international offset credits (generated in non-aviation sectors mainly). The initial baseline, the average of international aviation emissions from CORSIA participating countries during 2019 and 2020, was deemed inappropriate by the ICAO Council in light of the COVID-19 crisis and was changed to 2019 emissions for the duration of pilot phase 2021-2023. The EU did not request such a change but accepted "*to ensure support for CORSIA under the circumstances created by the COVID-19 pandemic and avoid unravelling CORSIA design elements*"[24]. The consequence of such a baseline change is that CORSIA compliance is unlikely to require any emissions to be offset under the pilot phase.

States that voluntarily decide to participate in CORSIA offsetting may join the scheme from the beginning of a given year, and should notify ICAO of their decision to join by June 30 of the preceding year. As of 2021, 88 States decided to participate from the start of the pilot

[21] IEA, 2018. World Energy Balances 2018. https://www.oecd-ilibrary.org/energy/world-energy-balances-2018_world_energy_bal-2018-en

[22] Cames, Martin; Graichen, Jakob, Siemons, Anne; Cook, Vanessa 2015: Emission Reduction Targets for International Aviation and Shipping. Berlin. The study was commissioned by the European Parliament's Committee on Environment, Public Health and Food Safety ('ENVI') http://www.europarl.europa.eu/RegData/etudes/STUD/2015/569964/IPOL_STU(2015)569964_EN.pdf

[23] 2016 ICAO Assembly Resolution A39-3, available at: http://www.icao.int/environmental-protection/Documents/Resolution_A39_3.pdf

[24] COM(2020)219, https://ec.europa.eu/transparency/regdoc/?fuseaction=list&coteId=1&number=219&version=ALL&language=en

phase on 1 January 2021, including all G7 countries.[25] While the US has confirmed its participations, some important partners, such as China, India or Russia, are not participating. Unlike the voluntary participation of states in the CORSIA offsetting in the pilot and first phases from 2021 to 2026, the second phase of the CORSIA from 2027 to 2035 applies to all States. There are, however, two categories of exemptions based on aviation-related and socio-economic criteria.[26]

To be able to implement CORSIA, detailed rules on transparency, accounting, offsetting, registry and governance had to be adopted in the form of ICAO Standards and Recommended Practices (SARPs), which are binding on ICAO member states not filing differences to them. The actual implementation of CORSIA will depend on domestic legislation being developed, adopted and implemented by countries and regions participating in the scheme.

The EU and its Member States consistently argued in support of robust implementing rules and governance (e.g. the environmental integrity of eligible offsets, avoidance of double counting in line with the provisions still to be adopted under the Paris Agreement, robust sustainability criteria for sustainable alternative fuels), as well as adequate participation, in CORSIA's voluntary and mandatory phases all being key to ensure CORSIA's integrity and initial objective.

In 2018, the ICAO Council adopted the First Edition of the International Standards and Recommended Practices ('SARPs')[27].

The EU has actively contributed in the process on substance and has been amongst the first jurisdictions to adopt legally binding provisions for the purposes of implementing the monitoring, reporting and verification for ICAO's scheme[28], which is a key pillar for implementing CORSIA.

While strongly supporting CORSIA in ICAO, the EU Member States notified differences[29] to the ICAO SARPs, due to the presence of existing legislation in the EU addressing CO_2 emissions from international aviation. In the differences, they highlight the main governance difference between the EU ETS and CORSIA (route-based, versus State-based regulation). The objective was to maintain the legality of the EU ETS and to preserve the EU policy space and climate ambition, consistent with the EU ETS as last revised in 2017 and with strong calls by co-legislators not to prejudge any further EU action[30]. In the same spirit, the EU and its Member States, through the EU Presidency, re-

[25] https://www.icao.int/environmental-protection/CORSIA/Pages/state-pairs.aspx
[26] These criteria for the exemption of States from the CORSIA offsetting requirements in the second phase are defined in ICAO Resolution A40-19 paragraph 9e).
[27] https://www.icao.int/environmental-protection/CORSIA/Pages/SARPs-Annex-16-Volume-IV.aspx
[28] Commission Delegated Regulation (EU) 2019/1603 of 18 July 2019, see https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2019.250.01.0010.01.ENG
[29] Council Decision (EU) 2018/2027.
[30] European Parliament legislative resolution of 12 December 2017 on the proposal for a regulation of the European Parliament and of the Council amending Directive 2003/87/EC to continue current limitations of scope for aviation activities and to prepare to implement a global market-based measure from 2021. (COM(2017)0054 – C8-0028/2017 – 2017/0017(COD)) available at https://www.europarl.europa.eu/doceo/document/TA-8-2017-0477_EN.html

stated the above principles during the 40th ICAO Assembly in 2019 at the occasion of the adoption of a new Resolution on CORSIA, reiterating, and making it clear that in the EU's view CORSIA is not to be regarded as exclusive against other schemes and that it should not limit EU climate ambition[31].

Consistent with previous declarations, in June 2020, the EU and its Member States notified ICAO their participation in CORSIA from the start of the pilot phase on 1 January 2021 subject to differences filed (Council Decision 2020/954), by the ICAO deadline of 30 June 2020.

The ICAO Secretariat has not yet published the reservations of other States by that deadline, despite repeated calls from the EU to do so. The EU and its Member States have for long called for enhanced transparency in ICAO, as last reflected in an inter-institutional declaration agreed at the end of the last co-decision process on the EU ETS for aviation in 2017[32]. The lack of publication of differences, which is key to understand whether and how our international partners intend to participate to CORSIA, is problematic.

In terms of other major partners, there are public reservations to the 2013, 2016 and 2019 Assembly Resolutions made by the US, China, Brazil, Russia, Saudi Arabia, India and Venezuela (see Annex 10).

While the US has issued reservations it made the following public statement: "*The United States supported the decision to adopt the CORSIA SARPS based on the understanding that CORSIA is the exclusive market-based measure applying to international aviation, and that CORSIA will ensure fair and reciprocal commercial competition by avoiding a patchwork of country- or regionally-based regulatory measures that are inconsistently applied, bureaucratically costly, and economically damaging. Furthermore, continued U.S. support for CORSIA assumes a high level of participation by other countries, particularly by countries with significant aviation activity, as well as a final CORSIA package that is acceptable to, and implementable by, the United States*."[33]. The US is collecting emissions data from US airlines on an expressly voluntary basis, with the FAA ensuring compliance with CORSIA monitoring, reporting and verification rules by filling data gaps from the limited airlines not providing data on a voluntary basis, and it has been noted that "*the State Department will need to work with FAA to secure the implementing legislation necessary for further U.S. participation*"[34].

As regards the Chinese Government, it has publicly stated that: "*China opposes any scheme that strays from realities faced by States and goes at the expense of the legitimate*

[31] https://www.icao.int/Meetings/a40/Documents/10132_corr1_en.pdf
[32] Statement by the European Parliament, the Council and the Commission, annexed to the European Parliament legislative resolution A8-0258/2017 available at https://www.europarl.europa.eu/doceo/document/TA-8-2017-0477_EN.html#title3
[33] US Federal Aviation Administration (FAA), Department of Transport, Notice of 14 March 2019, available at https://www.faa.gov/about/office_org/headquarters_offices/apl/research/environmental_policy/media/corsia_mrv_program_statement.pdf
[34] https://climate21.org/documents/C21_State.pdf memo

rights to development of developing countries and emerging market countries. ... China has notified differences according to Article 38 of Chicago Convention."[35]

1.3. Integration of CO_2 aviation emissions in the EU's Emissions Trading System

The EU led the way in implementing a carbon market mechanism for CO_2 aviation emissions by including all flights to and from aerodromes in the European Economic Area in the EU's Emissions Trading System (EU ETS) in 2008 (see Annex 8). The European Court of Justice confirmed the EU's right to regulate airlines based outside the EU on a route basis, which is necessary to provide equal treatment on routes, i.e. to apply the principle of non-discrimination enshrined in Article 11 of the Chicago Convention[36].

According to Directive 2003/87/EC, all aircraft operators carrying out aviation activities covered by the EU ETS have to annually report their emissions corresponding to the previous year. They have an obligation to surrender as many allowances as the emissions they have reported. Every year, a number of aviation allowances is issued. The total amount is defined by the allowed "cap", which was 95% of the average 2004-2006 emissions. Starting from 2021, allocations to aviation are reduced by the linear reduction factor (currently of 2.2%) now applicable to all ETS sectors (Annex 9 provides more information on the EU ETS for aviation).

Allowances are distributed through two mechanisms: auctioning and free allocation. Currently, 82% of aviation allowances are distributed through free allocation, 3% are part of a special reserve for new entrants and fast growers, and 15% are auctioned. In 2009, the co-legislators noted that '*auctioning should therefore be the basic principle for allocation, as it is the simplest, and generally considered to be the most economically efficient, system*'[37].

The total number of allowances for aviation was based on average emissions in 2004-2006, while the allocation to each operator was based on activity data from 2010. The reason for including free allocation in the distribution of allowances was that the "no allocation" option would have treated the aviation sector differently from those sectors already covered by the EU ETS and it would have increased the demand for allowances towards other sectors. In addition, the share of auctioning for other sectors under the EU ETS has increased, leading to calls from some stakeholders and Member States[38] to move away from free allocation for the aviation sector. The European Green Deal and 2030 Climate Target Plan clearly set out the Commission's intention to propose to reduce the EU ETS allowances allocated for free to airlines.

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[35] https://www.icao.int/Meetings/a40/Documents/Resolutions/china_EN.pdf

[36] Case C‑366/10, http://curia.europa.eu/juris/document/document.jsf?text=&docid=117193&pageIndex=0&doclang=EN&mode=req&dir=&occ=first&part=1&cid=211542

[37] Recital 13 of Directive 2009/29/EC, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32009L0029

[38] Council meeting (Environment) of 5 March 2020. Outcome of the Council meeting available at https://www.consilium.europa.eu/media/47923/st06577-en20.pdf.

The EU ETS has delivered 200 million tonnes of reductions/offsets over 8 years[39], being applicable to all operators, EU and non-EU alike, on the same routes. The compliance rate is extremely high, as reported last in the recent Carbon Market Report issued by the Commission[40]. This provides the aviation contribution to the 2020 EU climate objective and, as foreseen in the CTP, this will continue for 2030.

The EU and its Member States' strong support of international action complementary to domestic or regional action to address climate change, including in the field of international aviation at ICAO, is underlined by the fact that the European Parliament and Council have amended the EU ETS three times to reduce its initial geographical scope and thereby facilitate progress in ICAO on CORSIA.

First in 2012, when the ICAO Council decided to begin developing guidance for a GMBM for international aviation emissions, EU ETS scope was temporary limited, allowing airlines to choose either full coverage or pan-European coverage. Following the 2013 ICAO Assembly Resolution A38-18 to develop a GMBM to offset international aviation emissions, the EU further limited the scope to intra-EEA flights only during the period 2013-2016 while maintaining equal treatment on routes. Pending the development of the CORSIA implementing rules and modalities (SARPs), the EU ETS Directive was last revised in 2017 to extend the most recent scope derogation until the end of 2023, while indicating the conditions under which the EU would consider implementing CORSIA, namely that its implementation is "consistent with the Union economy-wide greenhouse gas emission reduction commitment for 2030 with the aim of preserving the environmental integrity and effectiveness of Union climate action". This was intended to provide continued momentum to the international process in the light of the political commitment made by the EU and its Member States to take part in CORSIA from its "pilot phase" (as of 1 January 2021), subject to certain conditions[41].

The Commission has again recently recognised[42] that international cooperation on aviation is desirable and that international instruments such as CORSIA should promote effective action in this context.

In 2020, the EU ETS was extended to all departing flights from the EEA to Switzerland[43]. As a result, Switzerland applies its ETS to all departing flights to EEA airports, ensuring a level playing field on both directions of routes, as a result of the EU/Switzerland Agreement on the linking of their respective emission trading systems. In the EU-UK Trade and Cooperation Agreement reached in December 2020, the EU

[39] See the 2019 European aviation environmental report: "Between 2013 and 2020, an estimated net saving of 193.4 Mt CO2 (twice Belgium's annual emissions) will be achieved by aviation via the EU ETS through funding of emissions reduction in other sectors.", https://www.eurocontrol.int/publication/european-aviation-environmental-report-2019

[40] COM(2020)740, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52020DC0740

[41] Through the 2016 Bratislava declaration of Directors General of Civil Aviation, see https://www.icao.int/environmental-protection/documents/2016-bratislava_declaration.pdf , https://www.icao.int/Meetings/a40/Documents/WP/wp_102_en.pdf (see Section 1.4)

[42] COM(2020) 562 final.

[43] Commission Delegated Decision (EU) 2020/1071 of 18 May 2020, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32020D1071

ETS shall continue to apply to departing flights from the EEA to the UK, while a UK ETS will apply effective carbon pricing on flights departing from the UK to the EEA.

(Annex 8 sets out the chronological development of the EU ETS)

Comparing the EU ETS and CORSIA

Both CORSIA and the EU ETS are market-based measures to address CO_2 emissions. However, there are important differences between them, which have been studied extensively in advance of preparing this Impact Assessment and were already looked at in the previous Impact Assessment[44].

The first important difference is in the nature of the two measures: the EU ETS is a legally binding cap and trade system setting a limit on the total GHG emissions of the participating sectors so as to reduce them in absolute terms within the EU (use of international credits to a limited extent was allowed in the EU ETS until 2020, but since the start of the fourth trading period, i.e. 2021, not any more). CORSIA is essentially a carbon-offsetting scheme, which allows emissions from the aviation sector to continue increasing above the baseline (now 2019 emissions for the pilot and 2019-2020 for future phases unless changed), and foresees offsetting with credits from reductions in other sectors worldwide (international offsetting).

Secondly, the scope of EU ETS is route-based (applying to all operators, EU and non-EU alike) whereas the scope of CORSIA is state-based (applying to aircraft operators from each state only). All nationalities of companies operating in the European market have complied with the EU ETS across the economy, EU and non-EU alike. Under the ICAO State-based system, the SARPs do not foresee any State enforcing on "other State's" airlines: No State shall '*delegate enforcement ...towards ICAO, [or] to another State*.' (section 1.3.2 of the SARPs).

The EU ETS is also binding in Union law, and has been enforced effectively by Member States. The Commission studied the means by which an effective global market-based measure could be developed, and the "*downsides of [ICAO] Standards pertain to the uncertain legal status of such Standards which also affects their enforceability*"[45]. As ICAO is using the approach of a standard for CORSIA, no enforcement is possible by ICAO, and domestic implementation by States is key.

Through the EU ETS, aviation has contributed to almost 200 million tonnes of reductions of CO_2 emissions over the past 8 years. While the in-sector aviation emissions for intra-EEA flights kept growing, from 53.5 million tonnes CO_2 in 2013 to 69 million in 2019, the flexibility of the EU ETS, whereby aircraft operators may use any allowances to cover their emissions, meant that the CO_2 impacts from these flights did not lead to overall greater climate change.

CORSIA is expected to generate significantly lower reductions than the EU ETS when comparing GHG emission reductions achieved in the geographical scope of the EU, as all the emissions credits will be purchased from programmes administrating projects outside the EU[46]. However, on a global scale, CO_2 emission reductions through CORSIA may be higher (as far as international aviation is concerned).

[44] SWD(2017) 31 final.

[45] https://ec.europa.eu/clima/sites/clima/files/transport/aviation/docs/gmbm_legal_study_en.pdf

[46] Currently only programmes outside the EU are accepted under the CORSIA eligible emission units: https://www.icao.int/environmental-protection/CORSIA/Pages/CORSIA-Emissions-Units.aspx.

CORSIA relies on international offsets. The quality of international offsets is harder to control and this may raise concerns over additionality, permanence, net harm and the applicable accounting rules to avoid double counting[47]. In addition, it should be recalled that the EU 2030 climate objective under UNFCCC should be met through domestic reduction efforts, i.e. without the use of international credits. This was reflected in the European Council conclusions from October 2014[48] and accordingly communicated by the EU under the Paris Agreement[49].

The CORSIA baseline for the pilot phase has been changed to "2019 only" in the course of 2020, whereas the EU ETS is based on a 2004/2006 average. The change of baseline in CORSIA is likely to mean that no offsets will be required for compliance purposes during the pilot phase of CORSIA.

Under the EU ETS, allowances must be surrendered for each tonne of emitted CO_2 by flights covered by the EU ETS. These allowances are currently worth around €30/tonne. Up to 2020, certain types of international credits were allowed for surrendering but limited to 1.5% of emissions. In the light of the EU's experience with international credits and in line with the EU contribution to the Paris Agreement, no international credits can be used after 2020 in the EU ETS.

Finally, the geographic scope is different: CORSIA applies to international flights between participating States, whereas the EU ETS currently applies to domestic and international flights within the EEA.

More information on the EU ETS features on Annex 9. The main features of CORSIA can be found on ICAO Resolution A40-19, in Annex 6.

2. PROBLEMS DEFINITION

2.1. What is/are the problems?

2.1.1. Problem 1: Aviation sector must contribute to economy-wide emission reductions necessary to achieve the increased level of climate ambition and to avoid the risk of global aviation emissions undermining the global temperature goals of the Paris Agreement

Aviation emissions account for 2-3% of global CO2 emissions and have significantly increased since 1990 both at EU-level but also globally. At EU-level, CO_2 emissions from aviation made up 3.7% of the economy-wide total or 15.7% of CO_2 transport emissions in 2018[50]. Aviation's emissions in Europe increased an average of 5% year-on-year between 2013 and 2018[51]. In 2018, the EU was responsible for 15% of the global

[47] See CORSIA emissions unit eligibility criteria that seek to address such concerns: https://www.icao.int/environmental-protection/CORSIA/Documents/ICAO_Document_09.pdf
[48] https://www.consilium.europa.eu/media/24561/145397.pdf
[49] https://data.consilium.europa.eu/doc/document/ST-14222-2020-REV-1/en/pdf
[50] As indicated by the greenhouse data viewer of the European Environment Agency, https://www.eea.europa.eu/data-and-maps/data/data-viewers/greenhouse-gases-viewer
[51] Those emissions covered by the EU ETS, not including flights to/from outermost regions, dependencies and territories.

aviation CO_2 emissions[52]. Moreover, non-CO_2 climate impacts are estimated to be at least as important in total as those of CO_2 alone[53].

Notwithstanding the recent reduction in traffic as a consequence of the COVID-19 pandemic, aviation climate impacts are projected to grow further given the sector's historical growth of above the average of other economic sectors. Before the COVID-19 pandemic, Eurocontrol had projected an annual increase in European aviation emissions by 53% by 2040 compared to 2017[54]. Before the COVID-19 crisis, ICAO had estimated that, by 2040, international aviation emissions could rise by up to 150% compared to 2020[55]. However, given the impact of the pandemic, the airline industry does not expect air travel demand to return to pre-COVID-19 levels before 2024; however, this does not seem to impact significantly the dominant upward trend.

Considering current and projected emissions from the aviation sector, and in the context of an enhanced climate ambition of the EU for 2030, the contribution from aviation to the achievement of the EU objective will need to be significantly strengthened, therefore, also with a view to allow for the necessary contribution to the EU climate neutrality by 2050. The 2019 European Aviation Environment Report also highlighted this need[56].

Growing aviation emissions are not only an issue within the EEA but also at the global level. The latest UNEP gap report[57], recently issued, recalls the growing importance and urgency of reducing aviation emissions (CO_2 and non-CO_2 emissions having a climate impact) generated by aviation activities, against the temperature goals of the Paris Agreement and climate science.

Since the last review of the EU ETS for aviation, the European political context has evolved with President Von der Leyen's Political Guidelines[58], which emphasize that "*carbon emissions must have a price, and every person and every sector will have to contribute*". Beyond the increase in EU 2030 ambition to achieve domestic EU-wide economy-wide greenhouse gas emissions reductions of at least 55% compared to 1990, the 2030 Climate Target Plan communication underlines that "*in accordance with its international commitment to economy-wide action under the Paris Agreement, the EU should continue to regulate at least intra-EU aviation emissions in the EU ETS*". In its conclusions of 11 December 2020, the European Council "*invites the Commission to assess how all economic sectors can best contribute to the 2030 target and to make the necessary proposals, accompanied by an in-depth examination of the environmental,*

[52] Intra-EEA aviation represented 7.5% and departing flights to third countries another 7.5%. All departing flights are covered in the EU's NDC under the Paris Agreement and in the aviation industry's Destination 2050 initiative.
[53] COM(2020)777 quantifies these impacts, while COM(2020)747 and associated documents analyse these effects in detail.
[54] Eurocontrol (2018), European Aviation in 2040.
[55] ICAO, 2019. See https://www.icao.int/environmental-protection/Pages/ClimateChange_Trends.aspx
[56] See: https://www.easa.europa.eu/eaer/
[57] See pages 52-61at https://www.unep.org/emissions-gap-report-2020
[58] President Von der Leyen's Political Guidelines, https://ec.europa.eu/info/sites/info/files/political-guidelines-next-commission_en_0.pdf

economic and social impact at Member State level"[59]. Outgoing flights are in the scope of the EU 2020 target of -20% GHG emissions reduction[60], and have been included in the legislation enacting the EU's -40% GHG emissions reduction commitment[61] and now a -55% NDC[62].

For aviation to contribute to the goals of the Paris Agreement, broader global action is required. CORSIA is a step in this direction. Additional measures will in any event be needed to enhance the international aviation contribution to the fight against climate change. The Commission is also working with third countries to promote carbon pricing: co-operation with China has been underway for the last eight years, and China's national ETS begins operating this year, but does not include (domestic) aviation in its scope for the time being. As part of a new trans-Atlantic agenda[63], the Commission has emphasized that the EU and US "*should work closely together on emissions trading, carbon pricing and taxation*".

The decarbonisation of the aviation sector requires an enhanced carbon price signal, including in view of the significant investments needed in Sustainable Aviation Fuels (SAF), improved air traffic management infrastructure, as well as further research and deployment of advanced and breakthrough technologies (such as open rotor engines, carbon-free synfuels, hydrogen or electrically-propelled aircrafts). The use of price instruments to decarbonise the sector is considered to have less-adverse distributional effects, and to be potentially socially progressive[64]. The EU ETS' current price incentive of approximately €115 per tonne for zero emission jet fuel, is by itself insufficient to bridge the price gap with conventional kerosene. However, by investing auctioning revenues through the Innovation Fund, the EU ETS can also support deployment of breakthrough technologies and drive the price gap down. EU Member States have reported using more than €46 billion or 77% of their ETS revenues for climate action over the last 8 years. Last, the need to further internalize environmental costs and allow for a level playing field among modes of transport is also recognised as an important element of the decarbonisation strategy of the sector. In that respect, the review of energy taxation is also considered as one of the initiatives that would contribute to achieving the 55% net reduction target presented under the 'Fit for 55' package of the European Green Deal[65].

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[59] https://www.consilium.europa.eu/media/47296/1011-12-20-euco-conclusions-en.pdf
[60] See https://www4.unfccc.int/sites/SubmissionsStaging/NationalReports/Documents/045612387_European%20Union-BR4-1-European%20Union-BR4_C_2019_8832_and_SWD_2019_432.pdf
[61] See Commission presentation to Council at https://www.transportenvironment.org/sites/te/files/WK_2310_2017_INIT_2.pdf
[62] https://data.consilium.europa.eu/doc/document/ST-14222-2020-REV-1/en/pdf
[63] Joint Communication of the Commission and EEAS of 2 December 2020, JOIN(2020)22.
[64] See SWD/2020/176 final and https://www.bruegel.org/2018/11/distributional-effects-of-climate-policies/
[65] European Commission. (2020). Commission Work Programme 2021: Annex I outlines all the instruments to be proposed which includes among others the revision of the EU ETS, the review of energy taxation, the revision of the Directive on the deployment of alternative fuels infrastructure.

2.1.2. Problem 2: Promote broad and effective participation by States in CORSIA and ensure effective implementation of CORSIA through the EU ETS in a manner that is fully compatible with the EU 2030 climate objectives and the EU's commitment under the Paris Agreement

2.1.2.1. The effectiveness of CORSIA

Effective implementation of CORSIA worldwide will depend on the baseline (beyond the pilot phase), the quality of required offsets, level of participation, how CORSIA is being implemented domestically, the avoidance of double counting, fuels framework and enforcement by states. Whether CORSIA will work depends on all these factors.

Favoured by the design of CORSIA and its implementing elements, and significantly amplified by the new baseline adapted at the request of international partners as a result of the COVID-19 pandemic, the available supply of units exceeds the likely demand in the short-term (if any demand at all materializes during the pilot phase as a result of the new baseline). This in turn means that, as long as demand is low, CORSIA will not act in practice as an incentive towards emission reductions from the sector.

Indeed, in comparison to current carbon price of around €30 per tonne CO2, international credits trade at far lower prices. For example, the CDM credit price is currently around €0.33 per tonne CO2. Added to this the uncertainty of any significant credit demand in the next years, the steering effect of CORSIA remains doubtful. Where supply exceeds demand, the price for credits will go towards zero.

Notwithstanding the need for robust rules to be implemented by ICAO and participating States, broad/full participation from strategic partners in CORSIA is key if it is to deliver on its initial objective.

The EU has demonstrated its determination to play its part and will continue to do so, but it should also be clear that, for CORSIA to work and to be effective, all strategic partners need to be on board and undertake domestic implementation. 88 countries are listed on the official ICAO Secretariat website[66], including all EU Member States and all G7 countries, but key States are still missing at this juncture e.g. China, India, Russia, Brazil.

Against this backdrop, the EU will continue to support efforts, multilaterally in ICAO and bilaterally with strategic partners, to secure adequate participation and implementation, as well as to make sure that CORSIA delivers on its initial objective and is further strengthened, avoiding any backsliding at the occasion of the first review planned for 2022.

2.1.2.2. The implementation of CORSIA through the EU ETS in a manner that is fully compatible with the EU 2030 climate objectives and the EU's commitment under the Paris Agreement

Article 28b of the EU ETS Directive 2003/87/EC requires the Commission to present a report to the Council and the European Parliament in which it shall consider ways for

[66] https://www.icao.int/environmental-protection/CORSIA/Pages/state-pairs.aspx

CORSIA instruments to be implemented in Union law through a revision of this Directive. It shall also examine the ambition and overall environmental integrity of CORSIA, including its general ambition in relation to targets under the Paris Agreement, the level of participation, its enforceability, transparency, the penalties for non-compliance, the processes for public input, the quality of offset credits, monitoring, reporting and verification of emissions, registries, accountability as well as rules on the use of biofuels. In addition, the report shall consider whether the provisions adopted under Article 28c(2) need to be revised. Article 28b of the EU ETS Directive foresees the Commission accompanying the report with "*a proposal, where appropriate, to amend, delete, extend or replace*" the derogations provided for in Article 28a (which limit the scope of EU ETS to intra-EEA flights from 2017-23), that is "*consistent with the Union economy-wide greenhouse gas emission reduction commitment for 2030 with the aim of preserving the environmental integrity and effectiveness of Union climate action*".

The review of the EU ETS for aviation should ensure that CORSIA is implemented as appropriate through the EU ETS. Any amendment of the EU ETS Directive must be consistent with EU's ambition to become climate neutral by 2050, the Union's economy-wide greenhouse gas emission reduction commitment for 2030 and with the aim of preserving the environmental integrity and effectiveness of Union climate action. At the same time, Union legislation must ensure equal treatment for airlines operating on the same routes.

Based on the ICAO definition of *"international flights",* implementing the CORSIA SARPs for the offsetting would mean that airlines based in an EU Member State should offset CO_2 emissions generated by international flights between states participating in CORSIA, above the baseline level, irrespective of the ETS in place in the EU and its higher level of climate ambition.

Thus, all international emissions of flights between EU Member States could potentially be subject to both the EU ETS and CORSIA regimes in as far as intra-EEA flights are concerned. However, the EU policy space and level of climate ambition have been safeguarded as a result of the differences agreed at the EU level and filed by EU MSs in ICAO, recalled in a formal EU statement delivered at 2019 ICAO Assembly at the occasion of the adoption of a CORSIA Resolution. This was considered crucial in order not to prejudge the review of the EU ETS in the light of CORSIA and to fully preserve the integrity of EU climate objectives.

This also means that the validity of EU law (ETS) is fully preserved, with airlines being responsible to surrender allowances for their intra-European emissions (and in respect of departing flights to Switzerland) through the EU ETS.

Ultimately, however, the issue is how to apply CORSIA while making sure that it does not allow for any backsliding in terms of climate ambition compared to what the EU has committed to for 2030, does not bring any undue administrative burden compared to the benefits expected and is fully consistent with the spirit and "mandate" of the last ETS review in 2017.

2.1.3. Problem 3: The current high proportion of free allocation of aviation allowances, in the absence of carbon leakage, undermines the price signal and risks future windfall profits.

When the first proposal to include aviation in the EU ETS was issued, free allocation was provided to align with other sectors that received free allocation in the early phases of the EU ETS, also as a way to facilitate the initial acceptability of the new system. Under the ETS more generally, free allocation is now targeted at sectors at significant risk of carbon leakage, while auctioning is recognised as the basic principle for allocation, as it is the simplest, and generally considered the most economically efficient, system.

While a significant risk for carbon leakage for aviation due to the ETS has not been substantiated due to its very nature (difficulties or even impossibility to change/divert route due to the very nature of the traffic), 85% of aviation allowances are nevertheless allocated for free which undermines the effectiveness of the carbon price signal thereby removing incentives for aircraft operators to decarbonise their activities. In 2019, aircraft operators received free allocation of 31.3 million allowances, covering 46% of the total emissions. In contrast, the majority of rail activity in Europe has been covered by the EU ETS since 2005, because of its use of electricity, and it has not received free allocation.

The total number of allowances for aviation was based on average emissions in 2004-2006, while the allocation to each operator was based on activity data from 2010. However, the individual emissions of airlines have taken differing trajectories since 2010. This system has created unfair and unjustified treatment among operators, which now need to be rectified to allow for a better level playing field, also for new entrants. No action by the EU would perpetuate a free allocation scheme, which mirrors the market configuration of 2010.

Taking into consideration the impact of COVID-19 on air traffic, and the likelihood that 2019 levels will not be reached before 2024, a continuation of the current allocation levels would generate not costs, but windfall profits for operators (i.e. a large proportion of the opportunity cost of using allowances received for free has been passed on to consumers/customers), and would create downwards pressure on the prices of ETS allowances. The price signal would not only be insufficient to generate emission reductions in line with the 2030 climate targets but would act in the opposite direction than that required by those targets.

A transition to a higher or full auctioning share, whether immediate or staggered, would eliminate windfall profits and put new entrants on the same competitive footing as existing operators[67].

Free allocation of aviation allowances does not take into account cost pass through from producers/service providers to customers and consumers, a behaviour which is much better understood now. The issue had been raised for a while by the EP and, as a result of the last co-decision, the EU ETS Directive requires the Commission to "*study the ability*

[67] Foonote 15 of Directive 2009/29/EC, https://eur-lex.europa.eu/legalcontent/EN/TXT/?uri=CELEX:32009L0029

of the aviation sector to pass on the cost of CO_2 to its customers in both the EU ETS and ICAO's market-based measure, comparing this to industries and to the power sector, and with the intention to propose to increase the percentage of auctioning pursuant to the review referred to in Article 28b(2)"[68]. The Commission study on auctioning and cost-pass through[69] shows that the majority of the opportunity cost of emission allowances is passed through to customers. Whether allowances are received free of charge or against payment would not be expected to make any difference to this cost pass-through decision. Consequently, full auctioning would not imply unreasonable costs on aircraft operators. Recently, in 2020 the European Court of Auditors found that "*the number of free allowances allocated to the industry and aviation sectors in phase 3 was not based on their ability to pass through costs (see paragraphs 29 to 31) and that, while carbon leakage has the potential to affect EU carbon markets, and thus the evolution of the greenhouse gas emissions worldwide, there is limited targeting of the free allocation of allowances (see paragraphs 32 to 38)*"[70].

The Communication on a European Green Deal[71] states that there will be a proposal to reduce the free allowances allocated to airlines. This is re-stated in the Communication on Stepping up Europe's 2030 climate ambition: "For aviation, the Commission will propose to reduce the free allocation of allowances, increasing the effectiveness of the carbon price signal in this sector, while taking into account other policy measures such as energy taxation and the ReFuelEU initiatives".

In this context, the revision of the EU ETS for aviation should ensure that the allocation of allowances is aligned with the reinforced EU climate objective and is economically efficient.

80% of the public consultation respondents, half of which private sector stakeholders and including most of respondents from the aviation sector, believe that reducing or removing the free allocation of allowances to airlines would increase the cost of flying for operators and consumers. At the same time, 69% of respondents, gathering mostly NGOs and EU citizens, agreed that a reduction or removal of the free allocation of allowances to airlines would increase the climate change mitigation impact by the EU.

3. WHY SHOULD THE EU ACT?

3.1. Legal basis

The legal basis for the EU ETS Directive 2003/87/EC, as well as all subsequent legislation amending it or other legislation regulating GHG emissions, is Article 192 of the Treaty on the Functioning of the European Union. This should remain the legal basis

[68] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32017R2392
[69] https://ec.europa.eu/clima/sites/clima/files/ets/revision/docs/cost_pass_through_en.pdf
[70] Special Report, the EU's emissions Trading System: free allocation of allowances needed better targeting 2020, https://www.eca.europa.eu/Lists/ECADocuments/SR20_18/SR_EU-ETS_EN.pdf (see paragraphs 32 to 38).
[71] COM(2019)640 final.

for any new legislation addressing climate impacts of aviation, as the principal objective of the measure is the protection of the environment through the reduction of GHG emissions.

3.2. Subsidiarity: Necessity of EU action

As recalled in chapter 1, the EU has committed to economy-wide climate neutrality by 2050, and the Commission has proposed an EU-wide net greenhouse gas emissions reduction target by 2030 compared to 1990 of at least 55%, which has been endorsed by the European Council. To reach the target, all sectors need to contribute. The projected continued growth of aviation emissions represents a challenge to reaching the EU's target and its commitments under the Paris Agreement.

Article 28b of the EU ETS Directive, as amended by Regulation 2017/2392, requests the Commission to present a report to the European Parliament and to the Council in which it shall consider ways for CORSIA to be implemented as appropriate in Union law through a revision of the EU ETS Directive. Furthermore, Article 3d requires the Commission to undertake a study on the cost pass-through of the aviation sector with the intention of making a proposal to increase the percentage of auctioning of aviation allowances, pursuant to the review referred to above.

Any amendment to the ETS Directive can only be brought about by the EU. An EU legal act is required for Member States to apply CORSIA for the flights covered by the geographical scope of application of Directive 2003/87/EC as set out in its Annex I, i.e. flights departing from airports in the EEA and arriving to other airports in EEA or to third countries and, incoming flights to airports in the EEA from third countries.

To ensure a joint effort of EU Member States towards meeting the EU's climate objectives and to ensure a level playing-field on the EU single market, it is essential for the EU to continue to act to ensure a harmonised approach to appropriate implementation of CORSIA across all Member States.

3.3. Subsidiarity: Added value of EU action

Acting at EU level is more efficient than acting at the Member State level, in terms of scale – the larger an emission trading system is, the more cost-efficient the emission reductions. It also prevents distortion of competition in the internal market by ensuring that the environmental requirements are harmonised across the EU. In order to avoid distortions of competition in comparable circumstances, it is important that all flights on the same route be treated in the same way. This harmonized approach through an EU emission reduction tool (cap and trade system) has allowed for aviation's contribution to the EU 2020 climate objective and is set to ensure consistency with the 2030 target.

Specifically, as regards the implementation of CORSIA, EU action ensures the participation of all Member States (effectiveness) while also ensuring a level playing-field on the EU single market and administrative simplification for operators concerned.

4. OBJECTIVES: WHAT IS TO BE ACHIEVED?

4.1. General Objectives

4.1.1. Ensure achievement of increased EU climate targets for 2030 and 2050 and fulfil international commitments under the Paris Agreement

Through the 2030 Climate Target Plan, the Commission proposed to raise the level of ambition on climate action and to cut greenhouse gas emissions by at least 55% by 2030 in order to set Europe on a responsible path to becoming climate neutral by 2050. It states that mobility will still have to be made substantially cleaner and that transport, including aviation, will have to substantially reduce emissions in particular in sectors that so far have been hard to decarbonise such as aviation. This means enhanced emission reductions from all sectors of the EU economy, including aviation, consistent also with the EU's economy-wide commitment under the Paris Agreement.

As recently stated in the CTP, the EU ETS will remain a key tool to achieve reductions of CO_2 emissions from aviation by 2030 (directly or indirectly).

The EU ETS is a system designed to drive CO_2 emission reductions first in the sectors covered and in the locations where it is cheapest to achieve. Given the rapid growth in aviation activities, the EU ETS has not yet led to aviation sector reductions in absolute terms. This state of play might change if

- the cheapest reductions have already been achieved (reducing emissions in the aviation sector is considered generally more expensive than in other sectors);
- the cost of allowances increases, to a level leading to investment into new technology, operational improvements and sustainable aviation fuels and this, combined with EU initiatives like RefuelEU, leads to direct emission savings;
- the carbon cost (through ETS, removal of tax exemption, removal of VAT exemption or other financial measures or through the ReFuelEU initiative) increases the air fares, potentially reducing demand and incentivising shift to other means of transport;
- demand for air travel is reduced due to rising awareness of the impact of aviation and more online conferencing replacing business travels.

Therefore, strengthening the ETS is considered as an important part of the solution to achieve both emission reductions while reinforcing the price signal to incentivise necessary investments in decarbonisation. At the same time, other EU measures are also needed to further reinforce the price signal, outside the scope of this impact assessment (in accordance with the concept of a "basket of measures"), as also indicated by the fact that a growing number of Member States feel the need to adopt passenger duties. The concept is further supported by the fact that 82 % of respondents to the public consultation agreed that market-based measures such as the EU ETS and CORSIA should be combined with other policies such as support for innovative aviation technologies, operational improvements, taxation, and the production and use of sustainable aviation fuels.

Enhanced action for both domestic and international emissions is needed to significantly reduce climate impacts from international aviation, consistent with the Paris Agreement, the commitments under ICAO and climate science.

The objective of CORSIA, i.e. essentially to compensate for the growth of international aviation CO_2 emissions beyond 2019 levels through international credits, is expected to lead to CO_2 emission reductions on a global scale, and may even have a positive effect on domestic aviation emissions all over the world, but is in itself far from being sufficient to duly contribute to the EU's objective of climate neutrality by 2050.

CORSIA – as the first international sectorial agreement on CO_2 emissions following the conclusion of the Paris Agreement – should in particular deliver CO_2 emissions reductions compared to 'business as usual' on the global scale. In case it will ensure contribution from all major international aviation states, thereby leading to world-wide collective action on a non-discriminatory basis, it should be considered as a complement to the EU ETS.

Assuming adequate environmental integrity of offsets[72] and avoidance of double counting, CORSIA offsetting would be transitionally helpful pending the deployment of breakthrough technologies such as electrification, hydrogen or synthetic fuels produced from renewable energy sources. CORSIA relies on airlines purchasing and cancelling offset units that certify reductions achieved in other sectors. The Paris Agreement covers all anthropogenic emissions, from all sectors of the economies, with developed countries being required to undertake economy-wide action while developing countries are expected to move towards economy-wide action over time.

4.2. Specific objectives

4.2.1. Lead international efforts, build alliances with the like-minded and maintain competitiveness

In order for the EU to lead international climate efforts, it should encourage other countries to follow. In 2018, the EU-27 accounted for around 22.5% of total global aviation CO_2 emissions (7.5% intra-EU and 15% from flights that either depart or land in the EU to/from a non-EEA third country). The need for the EU to also spur on ICAO states to take action to contribute to achieving the temperature goals of the Paris Agreement is self-evident against this backdrop. In this context, it is encouraging that China has put a national ETS into operation, which may be extended to aviation, and that Korea and New Zealand have ETSs, which cover some emissions from aviation.

[72] https://ec.europa.eu/clima/sites/clima/files/ets/docs/clean_dev_mechanism_en.pdf

4.2.2. Increase carbon price signal, while avoiding carbon leakage and ensuring a level playing field and fairness

As in other areas of climate action, it is important to ensure that the options selected to reduce emissions do not lead to an increase in climate impacts elsewhere, the so-called carbon leakage. There is no evidence of carbon leakage at present for aviation, because there is equal treatment of all airlines on flight routes covered by the ETS. On the other hand, the issue of 'hub leakage' (aviation activity could theoretically be somewhat displaced to hub airports where carbon pricing is not applied), should be examined. Another aspect worth examining is substitution of air travel by other means of transport, such as trains.

Ensuring that operators on the same route are treated equally remains a key specific objective, to avoid any discrimination on grounds of nationality. This includes examining the situation of flights to and from outermost regions in addition to impacts on outermost regions in general. It should also be taken into account that EU carriers have a relatively large share of their emissions covered by the EU ETS compared to their non-EU competitors.

5. WHAT ARE THE AVAILABLE POLICY OPTIONS?

5.1. What is the baseline from which options are assessed?

Baseline

For CORSIA implementation, options are assessed against option C1BASE (as described below), the current ETS scope, where the application of the EU ETS legislation is limited to intra-European flights. This is the situation under the current scope derogation, which applies to emissions until end 2023.

The baseline against which all other options for auctioning of allowances are assessed is option A0BASE, the 'do-nothing' option, under which 15% of allowances for aviation are auctioned as under the current legal situation until 2030.

These are the baselines for the assessment of policy options modelled using the Aviation Integrated Model (AIM) for aviation sector impacts as described in Annex 4.2. As for other impact assessments for the *Fit for 55* proposals, we use values from the REF scenario modelled under PRIMES (as described in the common methodological annex 4.1), the common baseline, as inputs for the AIM modelling. The baselines C1BASE and A0BASE use values from the REF scenario to ensure consistency.

Modelling approach and assumptions

The quantitative analysis of impacts of each option and combinations is based on modelling of the aviation sector using the AIM global aviation systems model and of the wider economy using the E3ME global macro-economic model. The full results are

presented in the study by ICF commissioned by the Commission[73]. The modelling also relied on information from the assessment of CORSIA, the assumption that a large number of countries apply CORSIA through domestic regulation and maintain their participation, the price of CORSIA eligible credits, and from the study of cost pass through under the EU ETS.

The modelling was carried out both for a set of 'most likely' trajectories for input variables (oil price, carbon price, demand growth, CORSIA participation and changes in technology), which give the nominal values for which the results are presented here, unless otherwise stated, and across a series or grid of different ranges or scenarios for these input variables. Uncertainty is examined by using in most cases a high, central and low value for each input variable. This allows highlighting of the cases where a variable is particularly important. The impact of some variables that do not require model runs were also tested and are presented here, such as the extent to which offsets under CORSIA are real and additional.

The model runs were first undertaken in 2020, but were updated by new model runs in January 2021 to reflect the latest information on the impact of COVID-19 and revised Commission projections of aviation demand. The results presented here are those updated to reflect the impacts of COVID-19.

Table 5.1: *Broad categorisation of AIM model inputs which may lead to differences in outputs (as assessed by total aviation sector CO_2 up to 2050 on a global/extra-EEA/intra-EEA basis)*

Potential impact on outcomes	Level of uncertainty		
	Low	Mid	High
Low		– Biofuel characteristics[74] – Carbon intensity of electricity generation	– Electricity price
Mid	– Coverage of flights to/ from UK and Switzerland – Allowance allocation methods – Urbanisation	– EUA/CER prices	– Cost pass-through assumptions

[73] ICF Consulting et al. (2020), Assessment of ICAO's global market-based measure (CORSIA) pursuant to Article 28b and for studying cost pass-through pursuant to Article 3d of the EU ETS Directive. (hereafter "ICF Study").

[74] Biofuel characteristics include price, fuel lifecycle CO_2 as compared to fossil-derived Jet A, any limits on blending ratio, and supply available to aviation. To a year-2035 timescale these are likely to have only low impact on outcomes because use of aviation biofuels over this timescale likely represents only a small fraction of total fuel, as discussed in Section 1.1.2.6; impacts in the case that biofuel take-up is much higher than anticipated are discussed in Section 1.2.14.

Potential impact on outcomes	Level of uncertainty		
	Low	Mid	High
High	– Population growth	– CORSIA participation – Future aircraft technology characteristics – Rules on quality of CORSIA credits	– GDP/capita – Oil price

The variables to which results are most sensitive include CORSIA implementation by states and continued participation, technology assumptions and demand.

Participation

CORSIA coverage will vary substantially depending on its implementation and continued participation by states. CORSIA only covers emissions from international flights when both origin and destination countries are participants. In other words, if a country does not implement or decides not to continue participating in CORSIA, none of the flights to and from that country are covered. In addition, CORSIA foresees that no state should regulate airlines based in any third country. This would pose challenges to ensuring equal treatment on routes, which is important for any economic measure to be effective. As a result, emissions coverage decreases rapidly with reduction in participation.

As the ICAO Secretariat has not published the responses which were required by 30 June 2020 to a State letter, these responses and any conditions attached are not public. The analysis in this impact assessment is based on what the ICAO Secretariat has published on its website. The analysis looks at the following CORSIA participation scenarios:

- Initial assumed implementation: the level assumed for the results presented (nominal) values, assumes implementation and continued participation throughout the period 2021-2035 of the 88 States listed by the ICAO Secretariat on its website in December 2020 (which includes the US), but that none of the larger countries which have opposed CORSIA (China, Russia, India, Brazil or Vietnam) participate in any of its phases.
- High implementation and continued participation: assumes implementation throughout the period 2021-2035 of all of the 88 States listed by ICAO Secretariat on its website in December 2020, plus starting in 2027, participation of the currently five additional States - China, Russia, India, Brazil and Vietnam - which are not exempt from CORSIA's second phase.

Technology

Technology developments are modelled by specifying individual characteristics of candidate technologies for nine aircraft size class. However the characteristics of future technologies (e.g. new aircraft models, retrofits, operational measures or alternative fuels) can be highly uncertain. In many cases, estimates of the benefits of technologies depend on engineering breakthroughs that have still to be made.

Therefore, the technology adoption model uses scenarios to assess the impact of uncertainty in technology parameters. This assessment is based on three scenarios using technology parameters, including changes in aircraft operating costs by cost type and changes in fuel burn, as derived from Schäfer et al. (2016)[75] and Dray et al. (2018). For example, the 'pessimistic' technology scenario used in this study describes a future in which it is particularly hard to reduce aviation emissions through technology; this assumes the reduction in fuel use from new technologies is at the low end of available estimates, costs are at the high end of available estimates, and the date from which the technology is available is at the late end of available estimates. The central scenario assumes all technology parameters are at central/'most likely' values from available estimates, and in the 'optimistic' scenario reductions in fuel use from new technologies are at the high end of available estimates, costs are at the low end of available estimates, and the date from which the technology is available is at the early end of available estimates. In all cases, consistency with ICAO's CO_2 standard is assumed. Measures are adopted based on their cost-effectiveness. This means that high fuel and/or carbon prices can affect which technologies, retrofits and operational strategies are adopted.

The results also depend on a number of other input assumptions, for example the scale of supply of cellulosic biomass-derived drop-in aviation fuel. Projections of how much biofuel might be in use in aviation up to 2050 vary widely and are dependent on the costs, sustainability and supply of biomass assumed, as well as the characteristics of and demand from other sectors and policies. Most recent multi-sectoral analyses project relatively low aviation biomass use to 2035.

Electrofuels (or power-to-liquid fuels) also have potential to contribute to climate neutrality. However, given the current costs at 3-6 times that of untaxed kerosene and uncertainties about uptake, electrofuels are not included in the modelling for this impact

Carbon prices

The following carbon price scenarios are used in this impact assessment for EU allowances and CORSIA eligible offsets (adjusted for the impacts of COVID-19).

Table 5.2: Carbon price assumptions by scenario and allowance type, corrected for the impacts of COVID-19.

[75] Schäfer, A., Evans, A. D., Reynolds, T. and Dray, L. M. Costs of Mitigating CO_2 Emissions from Passenger Aircraft. *Nature Climate Change*, Vol. 6, 2016, pp. 412-417.

Scenario	*Carbon price €/tCO2, year 2020 euros*			
	2015	**2020**	**2025**	**2030**
EUA (EU ETS) Base COVID-19 (nominal)	7.8	26.5	27.5	32
EUA (EU ETS) IIb COVID-19 (high)	7.8	26.5	47.8	84.5
CORSIA Sc1 (nominal)	0.20	1.02	1.02	1.02
CORSIA Sc2 (high)	0.20	1.02	5.09	13.2

The nominal values in table 5.2 above are those used for the results presented in this impact assessment, unless stated otherwise. The nominal case uses the REF scenario EU ETS price, as inthe Impact Assessment for the EU ETS and other proposals. The ETS carbon price in REF only reflects currently adopted policies, with 2030 price at €32 and average prices at €29 for the period 2021 to 2030. Currently observed carbon market prices do already respond to the increased GHG target and vary between €40 and €55. The policy scenarios modelled under the ETS revision Impact Assessment project average carbon price ranges between €45 and €70 for the period 2026 to 2030, with projected carbon prices in the year 2030 ranging between €50 and €85. This is broadly in line with external analyses, for which the average of price forecasts for 2030 is €71, with a large range between €42 and €89 (with all prices adjusted to 2020 Euros). Both this and the ETS impact assessment recognise that an increase in GHG reduction ambition would lead to higher carbon prices. In addition, the broader EU ETS revision impact assessment also uses the following rounded central carbon price assumptions, based on these and other sources, for the assessment of some impacts, such as auctioning revenues, (in €2020): €50 as average for the whole period 2021 to 2030.

Higher carbon cost scenarios for both EU ETS allowance and CORSIA were also used in sensitivity testing for this aviation ETS impact assessment. These were defined before the finalisation of the modelling exercises for the general ETS impact assessment and are given in table 5.2 above (see the 'high' scenarios). The 2030 carbon price assumptions for the ETS high price scenario (EUA (EU ETS) IIb COVID-19 (high)) are however consistent with the upper range of the above price projections, so that the full range of carbon prices is covered by the scenarios modelled. Also, when expressed as averages, the high cost scenario for EU allowances under the EU ETS are above the above mentioned levels used in the broader ETS impact assessment with (in €2018): €51.7 as average for the whole period 2021 to 2030

To ensure consistency in the calculation of revenues, the assumptions of the general ETS impact assessment have been used just for revenues.

5.2. Description of the policy options

5.2.1. CORSIA implementation

5.2.1.1. Option C0WIDE: Return to full scope EU ETS

This option proposes applying the EU ETS legal scope of departing flights to third countries (other than Switzerland and the UK), and incoming flights from third countries (unless exempted), if no amendment to the ETS Directive was adopted before surrender requirements apply to emissions as of 2024[76]. Currently, the flights exempted from this scope are those incoming from Switzerland, while a delegated act is being prepared to exempt incoming flights from the UK, which are in the scope of the ETS of the UK. Incoming flights could also be exempted to provide for optimal interaction between the EU ETS and third countries' measures for reducing the climate change impact of flights. This would maintain the equal treatment of aircraft operators on routes, with the EU regulating departing flights to countries applying CORSIA, while these countries would be responsible for flights to the EEA[77]. This would also be consistent with the EU's NDC that covers outgoing flights.

In this option, EU allowances are required to be surrendered by airlines for these emissions, while CORSIA is not applied at all by any EU or EEA member state.

Table 5.3: Key features of Option C0WIDE

Features	Assumptions
EU ETS Scope	Flights to, from, within EEA, including domestic (from 2024)
CORSIA Scope	International flights between participating non-EEA countries; to/from/within EEA not covered
EU ETS cap	95% of average full scope year 2004-2006 aviation CO2; LRF of 2.2% per year from 2021
EU ETS allocation	Existing situation
Modelling CORSIA CO_2 eligibility	N/A
Outermost regions coverage	Flights to, from and within any given OMR are included.

5.2.1.2. Option C1BASE: Intra-EEA scope

This option is the baseline. It mirrors the current application of the EU ETS. The EU ETS would be applied in line with the scope of the system as currently applied[78]: allowance surrendering obligations for aircraft operators would be based solely on emissions from

[76] The first surrender requirements that, under existing law, would apply to extra-European flights apply on 30 April 2025.
[77] This approach has been noted as a practical way to solve the issue of Common but Differentiated Responsibilities and Capabilities, which has been a longstanding challenge in the UNFCCC context. See, for example, http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1952554 .
[78] Flights within the EEA, and departing flights to Switzerland and to the UK.

flights between aerodromes located in the EEA, and for departing flights to Switzerland and the UK. In this option, CORSIA is not applied to any intra-EEA routes, nor on flights to and from the EEA.

Table 5.4: Key features of Option C1BASE

Features	Assumptions
EU ETS Scope	Flights within EEA, including domestic; departing flights to CH and UK
CORSIA Scope	International flights between participating non-EEA countries; to/from/within EEA not covered
EU ETS cap	As option 0 but reduced to reflect reduced scope; LRF of 2.2% per year from 2021
EU ETS allocation	Existing situation
Modelling CORSIA CO_2 eligibility	N/A
Outermost regions coverage	Flights within any given OMR are included. Flights to and from OMRs are exempt.

5.2.1.3. Option C2CONLY: CORSIA only

In this option, only CORSIA would be applied to all international flights (as commonly defined by ICAO): flights between EEA states and flights between EEA states and third countries. The EU ETS would no longer apply to aviation in this option.

Table 5.5: Key features of Option C2CONLY

Features	Assumptions
EU ETS Scope	N/A
CORSIA Scope	All international and intra-EEA (non-domestic) flights (excluding to/from CORSIA non-participating States)
EU ETS cap	N/A
EU ETS allocation	N/A
Modelling CORSIA CO_2 eligibility	Emissions above CORSIA baseline
Outermost regions coverage	International flights to and from OMRs are included, domestic flights within OMRs are exempt

5.2.1.4. Option C3CLEAN: Clean

The EU ETS would continue to apply to the current intra-EEA scope, as in Option C1BASE, and CORSIA would be introduced for extra-EEA flights, i.e. flights between EEA States and third countries (other than to Switzerland and the UK). In this option, the EU ETS would be applied as at present and CORSIA would be applied to flights to and from third countries which participate in the scheme, provided that a level playing field is maintained on routes. Any emissions above CORSIA's baseline on routes to and from those third countries would be offset by airlines based in Europe using CORSIA eligible offsets.

A variation of this option is that the EU operators use a sub-set of the ICAO CORSIA Implementation Element listing eligible units, or use ETS allowances if they choose to do so[79]. The EU might decide that units should originate from reductions in countries which are Party to the Paris Agreement, to encourage participation in the global agreement to tackle climate change. The EU might also decide that units should originate in countries which participate in CORSIA[80], so as to incentivise participation in ICAO's scheme and discourage free-riding. It could also be ensured that double-counting is avoided with Paris commitments. The EU could also decide to extend the list of eligible offsets to project types not on ICAO's list.

The option would continue to keep the currently applicable scope of the EU ETS and would potentially strengthen it by application of CORSIA on extra-EEA flights, which could generate additional emissions reductions compared to the current situation, when international aviation emissions as a whole exceed 2019 levels (the current CORSIA baseline).

Table 5.6: Key features of option C3CLEAN

Features	Assumptions
EU ETS Scope	Flights within EEA, including domestic; departing flights to CH and UK
CORSIA Scope	International flights (excluding to/from CORSIA non-participating States), intra-EEA excluded
EU ETS cap	Same as in C1BASE
EU ETS allocation	Existing situation
Modelling CORSIA CO_2 eligibility	Emissions above CORSIA baseline
Outermost regions coverage	Flights within any given OMR included under the EU ETS. International flights to and from OMRs included under CORSIA.

5.2.1.5. Option C4MIX: Mix

In this option, the EU ETS would continue to cover the emissions from domestic flights within each EEA state. For flights between EEA states, which are covered by the EU ETS at present[81], the ETS would continue to apply for emissions up to the CORSIA baseline (bearing in mind that no CORSIA obligation to offset emissions arises as long as emissions are below that baseline). For emissions above the baseline, CORSIA would then apply.

In practical terms, given that CORSIA has a later timeline than the ETS, the EU ETS would apply in a way that any CORSIA offsetting that actually takes place could simply be deducted from the next EU ETS emissions surrender obligation, thereby avoiding an

[79] As allowances are currently valued at around €30, while CDM credits trade at €0.30, airlines are likely to use the cheaper units.
[80] Possibly with the exception of landlocked developing countries and less developed small island States.
[81] Flights within the EEA, and departing flights to Switzerland and to the UK.

airline paying both the ETS carbon price and for offsets under CORSIA, for the same emissions. Accordingly, to ensure the environmental integrity of the EU ETS, the emissions covered by CORSIA offsetting would be deducted from the available amount of allowances (the cap).

For extra-EEA flights between EEA states and third countries, only CORSIA would apply.

Same as for Option C3CLEAN, a variation also of this option would be that the EU applies some specific conditions to the choice of offsets to be used for CROSIA by operators administered by an EEA member state.

De facto, this option would retain the applicability of the EU ETS within the currently applied scope, as long as aviation emissions on all routes worldwide covered by CORSIA do not exceed 2019 levels[82]. Afterwards, intra-EEA emissions would be offset with international credits to the extent required by CORSIA[83] (with the consequence that they could represent reductions achieved potentially outside the territory of the EEA).

Table 5.7: Key features of Option C4MIX

Features	Assumptions
EU ETS Scope	EEA domestic flights. Intra-EEA flights up to CORSIA baseline
CORSIA Scope	All international flights and intra-EEA (non domestic) flights (excluding to/from CORSIA non-participating States), intra-EEA excluded
EU ETS cap	Same as in Option C1BASE, CORSIA offsetting deducted
EU ETS allocation	Existing situation
Modelling CORSIA CO_2 eligibility	Emissions above CORSIA baseline
Outermost regions coverage	International flights to/from OMRs included in CORSIA. Flights within any given OMR are fully subject to EU ETS (i.e. inc. emissions above CORSIA baseline)

5.2.1.6. Option C5MIX2: Mix bis

In this option, for operators with licences issued by EEA States, the EU ETS would apply to non-domestic intra-EEA flights (for all emissions generated by these flights, independently from the level). CORSIA would apply to flights by these operators to and from third countries participating in the scheme. For operators with licences issued by third countries, the EU would no longer be able to ensure that there is a level-playing field on routes as CORSIA would also apply on those non-domestic intra-EEA flights, in addition to flights between EEA States and third countries participating in CORSIA. The EU ETS would not be applicable to third country operators. This option would not cover domestic flights at all.

[82] Application of CORSIA before 2030 means that the baseline and the calculated offsetting are based on the emissions on all CORSIA routes worldwide.
[83] The calculation of CORSIA offsetting of individual airlines depend on the increase of emissions on all CORSIA routes worldwide, not on the increase of emissions of the individual airline.

Table 5.8: Key features of Option C5MIX2

Features	Assumptions
EU ETS Scope	Flights within EEA, excluding domestic, if operator licence issued by an EEA State
CORSIA Scope	International flights to/from EEA. Flights within EEA, if operator licence issued by a non-EEA state
EU ETS cap	As Option C1BASE but reduced further to reflect reduced coverage; LRF of 2.2% per year from 2021.
EU ETS allocation	Existing situation
Modelling CORSIA CO_2 eligibility	Eligible operator emissions above CORSIA baseline
Outermost regions coverage	For aircraft operators with licences not issued by EU Member States, non-domestic flights to and from OMRs are included under CORSIA.

Table 5.9: Summary of CORSIA implementation options

Policy option	Domestic flights	Intra-EEA flights (including departing to CH, UK)	Extra-EEA flights
C0WIDE	ETS	ETS	ETS
C1BASE	ETS	ETS	-
C2CONLY	-	CORSIA	CORSIA
C3CLEAN	ETS	ETS	CORSIA
C4MIX	ETS	ETS/ CORSIA (above CORSIA baseline)	CORSIA
C5MIX2	-	EEA airlines: ETS non-EEA airlines: CORSIA	CORSIA

5.2.2. *Auctioning share increase*

5.2.2.1. Option A0BASE: "Do nothing"

Article 3d paragraph 2 of the EU ETS Directive provides that 15% of allowances for aviation shall be auctioned and that the Commission shall study cost-pass through by airlines "*with the intention of making a proposal to increase the percentage of auctioning*" in the current review. In the absence of any amendment, this level would continue under a revised ETS as well. This option is the baseline against which the other policy options will be assessed.

The aviation cap would be subject to the linear reduction factor, which is currently 2,2%, yearly, and which will be subject to revision in the upcoming ETS legislative proposal[84]. The total number of corresponding allowances would be distributed through free allocation (82%), special reserve (3%) and auctioning (15%).

5.2.2.2. Option A1FULL: Immediate full auctioning

In this option, 100% of the allowances for aviation would be auctioned from the entry into force of the revision (assumption for the assessment: 2023). The aviation cap, as calculated before starting full auctioning, would be decreased by the (revised) linear reduction factor each year up to 2030.

In case the scope of the EU ETS were to change as a consequence of the application of one of the options in section 5.1.1, which differs from the intra-EEA scope, the aviation cap would have to be recalculated proportionally.

5.2.2.3. Option A2SWIFT: Swift phase out

The application of this option would lead to full auctioning of allowances for aviation by 2025. It would start with an auctioning share of 60% in 2023, and then a share of 80% in 2024. The method of distribution between operators would continue the current situation, based on 2010 traffic.

5.2.2.4. Option A3SLOW: Slow phase out

This option would entail a slower movement to full auctioning by 2030. It would start from 20% of auctioning of allowances for aviation in 2023 and would increase in a linear manner to full auctioning by 2030. The method of distribution between operators would continue the current situation.

5.2.2.5. Option A4RED: Slow reduction

Under this option, the auctioning share of 20% of allowances for aviation would also be set in 2023. It would increase in a linear manner to end at 55% at least until 2030 (and afterwards, in the absence of future revisions of the ETS). This option would maintain a number of free allowances for aviation at least until 2030 (and afterwards in the absence of future revisions of the ETS). The method of distribution between operators would continue the current situation.

A mix of business associations and NGOs made suggestions to revise options listed in the questionnaire or to introduce new options. The top three reasons for such suggestions were the importance of creating a level playing-field between EEA airlines and non-EEA airlines; avoiding market distortions on certain routes and avoiding hub leakage; and the impact of COVID-19. The concrete suggestions included aligning policy reference year

[84] As stated in the Inception Impact Assessment of the general ETS review, "general improvements proposed to the EU ETS may be applied across the whole system", which includes the linear reduction factor as well. See https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12660-Updating-the-EU-Emissions-Trading-System

with CORSIA baseline year 2019; ensuring no double counting; and four new options varying in their coverage of EU ETS.

5.2.3. Cross-cutting issues

In combination with the options on the main parameters above, there are some issues which need to be addressed by the proposal:

5.2.3.1. Exemptions for outermost territories

Currently, the EU ETS temporarily exempts flights to and from outermost regions[85] (e.g. Tenerife – Madrid; Berlin – Tenerife), as well as flights between two different outermost regions (Madeira - Azores) from 2013-2023[86]. However, flights within the same outermost region are covered by the EU ETS (Lanzarote – Tenerife), the exception to that being Public Service Obligation (PSO) flights, which are excluded.

From an environmental perspective, this exemption covers about 14% of the EU ETS aviation emissions. The share of flights to/from outermost regions considered as domestic (to their respective Member State) represents about 6% of the aviation emissions currently covered by the EU ETS[87]. CORSIA does not foresee any special status and exemptions for remote or outermost regions.

The flights to and from outermost regions could:

- Continue to be exempted from the EU ETS, and seek to apply CORSIA
- Be included in EU ETS and CORSIA
- Be exempted from any obligation

5.2.3.2. SAF implementation

EU ETS incentivises operators to use Sustainable Aviation Fuels (SAF) at a level of around EUR 115/tonne, but this incentive is insufficient for large-scale use of fuels that are more expensive. The EU ETS considers a tonne of SAF, which fulfils all the sustainability criteria of RED II to count as zero emissions.

Whereas the EU will continue to rely on the RED II framework for the definition of Sustainable Aviation Fuels, there are different options for dealing with the incentives to use SAF:

- Continue to consider SAF as zero-emissions in EU ETS and consider it zero-emissions for CORSIA too;

[85] Within the meaning of Article 349 of the Treaty on the Functioning of the European Union.
[86] Flights to and from these areas were covered by the EU ETS in respect of the year 2012.
[87] In 2019, the aviation emissions in the scope of the EU ETS was 68 million tonnes, the emissions from flights to/from outermost regions (currently exempted) was 9.9 million tonnes and emissions from flights to/from outermost regions from/to their respective Member State (considered as domestic) was 4.3 million tonnes.

- Consider it zero-emissions for EU ETS, but use the life-cycle emissions value from the CORSIA SARPs for purposes of reductions of offsetting requirements to CORSIA;
- Adopt the proportional emissions reduction for the EU ETS too.

The ReFuelEU Aviation initiative would also aim at incentivising operators to use SAF, through obligations on both the supply and demand sides. On the supply side, the ReFuelEU Aviation initiative could introduce an obligation for fuel suppliers to supply only SAF-blended fuels at EU airports. On the demand side, the ReFuelEU Aviation initiative could oblige airlines departing from an EU airport to use a share of SAF. In order to prevent fuel tankering (i.e. a practice whereby an airline refuels with more jet fuel than necessary at an airport outside the EU with less strict SAF obligations and thus cheaper fuel), the ReFuelEU Aviation initiative could foresee an obligation for airlines to refuel before departure at an EU airport with an amount of jet fuel corresponding to that necessary to operate the next flight. Therefore, if adopted, the ReFuelEU Aviation initiative would share the same objectives as the revision of the EU ETS for aviation, namely reducing CO_2 in the aviation sector and supporting the uptake of SAF.

5.2.3.3. Exemptions for business aviation

Currently the EU ETS provides for an exemption for aircraft with a total mass below 5700 kg; for flights of non-commercial aircraft operators with annual emissions less than 1000 tonnes; and for flights of commercial aircraft operators with a yearly emission less than 10000 tonnes or less than 243 flights in a year. The effect is that the majority of business aviation is *de facto* exempted from any obligation of reporting or surrendering allowances. Business aviation flights which are exempted from the EU ETS amounted to 1,1% of emissions of the intra-EEA scope in 2019.

The proposal should examine whether this exemption is still justified or no longer warranted.

5.3. Options discarded at an early stage

Variations of option C4MIX could be maintaining the EU ETS for intra-EEA flights, and also apply CORSIA for the emissions above the 2019 CORSIA baseline. The operators which, having surrendered EU allowances, then cancel ICAO offset units for the same emissions, would receive free allocation proportional to the costs of those offsets (noting that allowances are currently worth around €30, and CDM credits are currently worth around €0.30). This option would create double compliance obligation for the same emissions, implying increased complexity and additional burden both on aircraft operators and competent authorities. Furthermore, this would require continuing free allocation, unless auction revenue were used to purchase any such credits. Therefore, this possibility was not further assessed.

Option C5MIX2 was not further analysed as it would add high level of complexity to the system without significant additional benefit compared to other options and introducing concerns for equal treatment of airlines on routes. In the public consultation, this option received no support, it was the second least favoured option of the respondents.

5.4. Overview of problems, objectives and policy options

The policy options above, to a different extent, directly contribute to the achievement of the objectives defined in Chapter 4. Table 5-8 shows how the policy options are meant to contribute to the solution of the problems described in Chapter 2.

Table 5.10: Overview of intervention logic

Problem	Objective	Policy options
Increased climate ambition	General objective: ensure aviation's contribution to achieve the increased targets	All
Implementation of CORSIA	Specific objective: Lead international effort 4.2.1	C options 5.2.1
Carbon price signal is weak	Specific objective: Increase price signal while avoiding carbon leakage and ensuring level playing field 4.2.2	A options 5.2.2

6. WHAT ARE THE IMPACTS OF THE POLICY OPTIONS?

This section assesses the environmental, economic and social impacts of each option, for the aviation sector and more generally.

6.1. Environmental impacts

The policy options assessed involve the use of flexible, market-based measures, where airlines can choose either to reduce their own emissions or to buy and surrender allowances under the EU ETS or offsets under CORSIA to comply, which can lead to emissions reductions outside the aviation sector. As a result, the assessment looks both at the direct impact on CO_2 emissions from aviation and the net impact on greenhouse gas emissions both for intra-European and global aviation. The net impacts are those which are most important in terms of aviation's contribution to meeting 2030 emissions reduction targets. In-depth analysis considers that aviation emissions are currently

warming the climate at approximately three times the rate of that associated with aviation CO_2 emissions alone[88]. These impacts are reflected in the narrative but not in the tables presenting results for direct and net CO_2 emissions.

This section goes on to look at the external costs for other environmental impacts associated with each policy option.

6.1.1. Impacts on aviation emissions

This section assesses the impact of the different policy options on direct aviation emissions- CO_2 emitted by aircrafts.

It is worth noting that the price for international credits today is less than €1, as compared with the price of ETS allowances, which is above €35. Therefore, the options C2CONLY and C4MIX would simply consist in relaxing the current mitigation policies in place for limiting intra-EEA aviation emissions which have proven effective.

Direct emissions from aviation grow in all options between 2015 and 2030. As shown in Table 6.1 below, direct global aviation emissions are projected to be 1079 Million tonnes (Mt) in 2030 for the baseline option C1BASE and options C2CONLY to C4MIX, up from 769 Mt in 2015. This is down from the growth in projected direct global emissions in the pre-COVID-19 model runs of 1138 Mt in 2030, a drop of about 5% in global aviation emissions taking into account the expected impacts of the pandemic. Option C0WIDE, full scope, is estimated to lead to 1077 Mt in 2030 (down from 1135 Mt in pre-COVID-19 modelling). Direct emissions from Extra-EEA flights (to and from the EEA) show a similar pattern, with options to C4MIX projected to have CO_2 emissions of 174 Mt in 2030. Option C0WIDE has emissions of 172 Mt. For intra-EEA emissions in 2030 Options C1BASE 1 and C3ONLY and C4MIX are projected to emit 52.5 Mt CO2, C0WIDE 52.4 Mt and Option C2CONLY 52.7 Mt. The results in the last row of the table below show that when ETS rather than CORSIA is used for extra EEA flights, there is a difference in emissions of 60 Mt (154-94) in C3CLEAN vs C0WIDE scenario and 67 (151 -94) in C4MIX vs C0WIDE, all in 2030.

[88] SWD(2020)277, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=SWD:2020:277:FIN.

Table 6.1: Comparison of direct and net aviation CO_2 by policy option. Direct CO_2 includes all CO_2 emitted by aircraft engines. Net CO_2 totals take into account the emission reductions taking place in other sectors due to aviation sector's demand for offsets, allowances and use of alternative fuels. The table also shows how allowance and offset use is distributed between CORSIA offsets and EU allowances. The calculations assume CORSIA offsets are of high quality and fully additional. Due to the functioning of the model, EU-EFTA totals include Switzerland and exclude the UK as EU ETS coverage of departing flights to UK was not agreed at the time of modelling.

Policy option	Global aviation CO_2 emissions, Absolute, in Mt				Aviation sector (Direct) global CO_2 in 2030 in Mt that are offset under:		Intra-EU/EFTA aviation CO_2 emissions, Absolute, in Mt				Extra-EU/EFTA CO2 emissions, Absolute, in Mt			
	Aviation sector emissions (Direct) 2015	Aviation sector emissions (Direct) 2030	Emissions after accounting for reductions in other sectors from use of CORSIA offsets and EU ETS allowances (Net) 2030		CORSIA	EU ETS	Aviation sector emissions (Direct) 2015	Aviation sector emissions (Direct) 2030	Emissions after accounting for reductions in other sectors from use of CORSIA offsets and EU ETS allowances (Net) 2030		Aviation sector emissions (Direct) 2015	Aviation sector emissions (Direct) 2030	Emissions after accounting for reductions in other sectors from use of CORSIA offsets and EU ETS allowances (Net) 2030	
			Total	Compared to Baseline					Total	Compared to Baseline			Total	Compared to Baseline
C0WIDE	789	1077	918	**-74**	61	98	52	52.4	29.5	**-2.5**	151	172	94	**-76**
C1BASE	789	1079	992	**-**	61	25	52	52.5	27.0	**-**	151	174	170	**-**
C2CONLY	789	1079	1047	**55**	32	0	52	52.7	49.2	**22.2**	151	174	161	**-9**
C3CLEAN	789	1079	1003	**11**	50	25	52	52.5	27.0	**0**	151	174	154	**-16**
C4MIX	789	1079	1022	**30**	32	25	52	52.5	23.9*	**-3.1**	151	174	161	**-9**

6.1.2. Impacts on emissions from other sectors

This section looks at the net impact of the different policy options on emissions, including the reductions brought about in other sectors through the use of EU allowances from stationary installations or eligible offsets under CORSIA for compliance.

6.1.2.1. CORSIA Options

Net aviation emissions are presented alongside the direct emissions in Table 6.1 above. Under the baseline (Option C1BASE), which maintains the EU ETS for aviation at its current, reduced scope, global net aviation emissions are projected to be 992 Mt CO_2 in 2030, an increase of 29% from 2015 levels. Intra-EEA net aviation emissions are projected to be 27 Mt CO_2 in 2030, a reduction of 27% between 2015 and 2030.

Looking at net global aviation emissions under other options, the reduction in emissions when taking account of reductions under CORSIA and ETS ranges from 15% for option C0WIDE to 3% for C2CONLY.

The greatest impact is for emissions from flights between EEA States, where all options with an EU ETS component lead to a reduction in impacts relative to direct emissions of 43% (for C0WIDE) to 55% (C4MIX), though the impact of the latter is inflated by operators of intra-EEA flights offsetting a share of CORSIA emissions that exceeds their own growth in emissions (see text box 7.1).

For emissions to and from the EEA, the biggest impact on emissions, when emissions reductions under CORSIA and EU ETS are taken into account, is also for C0WIDE with a 45% reduction in CO_2 emissions while C2CONLY and C4MIX show a 7% reduction and C3CLEAN a 27% reduction.

The detailed results are in Table 6.1, and the implications in terms of comparison of options are elaborated further in chapter 7. Two messages emerge from this table on net emissions: first is that net emissions intra EU-EFTA are of the same order on all options except for C2CONLY and secondly that all the options under extra EU-EFTA showed a similar scale except for C0WIDE.

The results are sensitive to assumptions about CORSIA participation, as set out in Chapter 5. The results presented in the report are based on the initial assumed participation. Table 6.2 below shows the proportion of global aviation emissions that fall under CORSIA under this scenario as well as under the high CORSIA participation scenario. Note that the values in Table 6.2 below are all emissions that fall under the CORSIA remit, not the proportion of global aviation CO_2 that is offset under CORSIA. It includes emissions below the CORSIA baseline that are not offset and biofuel-related direct CO_2 emissions which are exempt. For Option C4MIX, it includes intra-EEA emissions below the CORSIA baseline (not offset), which are also covered by the EU ETS. The proportion of global aviation CO_2, offset under CORSIA is therefore

significantly below the proportion of international emissions covered shown in the table below.

It should be noted that ICAO has no jurisdiction in respect of domestic aviation emissions, which comprise more than 40% of total emissions from aviation[89]. So the table excludes domestic aviation emissions

Table 6.2: CORSIA percentage coverage of international aviation CO_2 emissions in 2025, 2030 and 2035, by participation scenario, with the COVID-19-adjusted demand scenario and all other input variables set to nominal values[90].

Policy option	CORSIA coverage of global international CO_2, Initial Assumed Participation, %			CORSIA coverage of global international CO_2, High Participation, %		
	2025	2030	2035	2025	2030	2035
C0WIDE	31.2	30.8	30.8	31.2	48.2	48.4
C1BASE	31.1	30.7	30.6	31.1	48.0	48.2
C2CONLY	53.6	51.5	50.2	53.6	73.0	71.8
C3CLEAN	47.5)	45.9	45.1	47.5	67.4	66.7
C4MIX	53.6	51.4	50.2	53.6	73.0 (72.8-73.2)	71.8

A better measure of emissions potentially covered by CORSIA is given by looking at the potential demand for CORSIA offsets, Table 6.3 below.

Table 6.3: Potential demand for CORSIA offsets in the pilot, first and second phases, showing the total demand for each full period (the Pilot and 1st Phase the total over 3 years for each and the 2nd Phase, the total of 9 years), under COVID-19-adjusted nominal scenario assumptions

Policy option	CORSIA offset demand at Initial Assumed Participation, million			CORSIA offset demand at High Participation, million		
	Cumulative demand over the period:			Cumulative demand over the period:		
	Pilot 2021-2023	First 2024-2026	Second 2027-2035	Pilot 2021-2023	First 2024-2026	Second 2027-2035
C0WIDE	51 (24-62)	113 (53-155)	547 (303-880)	51 (24-62)	113 (53-155)	941 (546-1450)
C1BASE	51 (24-62)	113 (53-155)	548 (310-882)	51 (24-62)	113 (53-155)	942 (558-1450)

[89] Graver, Zhang, and Rutherford, "CO2 Emissions from Commercial Aviation, 2018.".
[90] Nominal values are those from most likely trajectories for all uncertain scenario variables (including demand growth, oil prices, carbon prices, CORSIA participation and the rate of improvement of new technology).

Policy option	CORSIA offset demand at Initial Assumed Participation, million			CORSIA offset demand at High Participation, million		
	Cumulative demand over the period:			Cumulative demand over the period:		
	Pilot 2021-2023	First 2024-2026	Second 2027-2035	Pilot 2021-2023	First 2024-2026	Second 2027-2035
C2CONLY	0.0 (0.0-3.4)	9.9 (0.0-76)	375 (79- 867)	0.0 (0.0-3.4)	9.9 (0.0-76)	783 (275-1500)
C3CLEAN	12 (0.0-25)	63 (0.0-127)	494 (173-962)	12 (0.0-25)	63 (0.0-127)	902 (409-1590)
C4MIX	0.0 (0.0-3.1)	9.6 (0.0-75)	373 (78- 865)	0.0 (0.0-3.1)	9.6 (0.0-75)	781 (271-1492)

Under current CORSIA provisions, until 2030, the baseline and the offsetting required for each operator under CORSIA are based on the **collective** emissions in the baseline year, 2019 for the pilot, and 2019-2020 for future phases, and the growth in emissions above the baseline level for all routes included in CORSIA. For the purpose of modelling only, the assumption made is that the 2019 baseline applies to the pilot phase and future phases.

The impact of these collective provisions is that including or excluding a country changes the collective effort. A decision by a large, emerging economy (such as China or India) with a faster growing aviation sector than in Europe to implement and continue to participate in CORSIA would for example lead to Europe offsetting a larger share of emissions.

For comparison reasons, global aviation demand in 2030 would be around 1 bn Mt in 2030. Tables 6.2 and 6.3 above show, for example, that under Option C1BASE (Intra-EEA), CORSIA coverage, which is projected to be 30.7% of global international aviation CO_2 under the initial assumed implementation and continued participation, could rise to 48.0% of global international emissions in 2030 under high participation. In terms of offset demand looking for example at the pilot phase and Option C1BASE, this implies a total offset demand under CORSIA of around 51 Mt for the initial assumed and high participation scenarios. For the first phase running from 2024 to 2026, total offsets demand could be around 113 Mt for the initial assumed and high participation scenarios. For the second phase, 2027-2035, it could go up to 942 Mt under high participation. The impact of participation on other options is shown in the tables. Uncertainty about implementation and continued participation in CORSIA and its enforcement by participating states has a larger impact than oil or carbon price uncertainty on the outcomes of the options[91].

[91] ICF Study, p.56.

Note that all the net results presented in Table 6.1 assume that CORSIA is implemented by all 88 countries in the initial participation scenario and that offsets are of high quality and fully additional. The risk of higher CO_2 emissions if CORSIA offsets are not additional has also been modelled. Other risks such as double counting have not been modelled but are discussed in chapter 7. The results show that the modelled outcomes, especially for global and extra-EEA flights, are sensitive to assumptions about CORSIA offset quality. Table 6.4 below looks at the extreme case where none of the CORSIA offsets are additional. In this case, net global emissions are 32 to 61 Mt CO_2 higher across the options in 2030. There is also an impact on some net intra-Europe emissions outcomes (see Table 6.4 below).

Table 6.4: Year-2030 and 2035 net aviation CO_2 after offsets and EU ETS allowances are subtracted, for different levels of CORSIA offset additionality. Central values shown are for all scenario variables at nominal values[92], including demand growth.

Policy option	Direct annual CO_2 emissions, Mt	Net annual CO_2 emissions, Mt (0% additional CORSIA offsets)		Net annual CO_2 emissions, Mt (100% additional CORSIA offsets)	
	2030	2030		2030	
Global					
		Emissions	**Compared to baseline**	**Emissions**	**Compared to baseline**
C0WIDE	1077	979	-74	918	-74
C1BASE	1079	1053	-	992	-
C2CONLY	1079	1079	26	1047	55
C3CLEAN	1079	1053	0	1003	11
C4MIX	1079	1054	1	1022	30
Extra-Europe (to/from EEA, excluding UK, including OMRs)					
		Emissions	**Compared to baseline**	**Emissions**	**Compared to baseline**
C0WIDE	172	94	-76	94	-76

[92] Nominal values are those from most likely trajectories for all uncertain scenario variables (including demand growth, oil prices, carbon prices, CORSIA participation and the rate of improvement of new technology).

Policy option	Direct annual CO_2 emissions, Mt	Net annual CO_2 emissions, Mt (0% additional CORSIA offsets)		Net annual CO_2 emissions, Mt (100% additional CORSIA offsets)	
	2030	2030		2030	
C1BASE	174	170	-	170	-
C2CONLY	174	170	0	161	-9
C3CLEAN	174	170	0	154	-16
C4MIX	174	170	0	161	-9
Intra-Europe (EEA, excluding UK, including OMRs)					
		Emissions	Compared to baseline	Emissions	Compared to baseline
C0WIDE	52.4	29.5	2.5	29.5	2.5
C1BASE	52.5	27.0	-	27.0	-
C2CONLY	52.7	52.6	25.6	49.2	22,2
C3CLEAN	52.5	27.0	0	27.0	0
C4MIX	52.5	27.3	0.3	23.9	-3.1

The EU ETS requires the tonnes of direct CO_2 emissions covered to be reported and an equivalent number of allowances to be surrendered each year. The coverage of direct CO_2 emissions by policy option is shown in Table 6.5 below. This shows that 45 million tonnes of aviation CO_2 emissions are projected to be covered by the EU ETS in the year 2030 under Option C1BASE (Intra-EEA), up from 44 Mt in 2025. At the upper end, Option C0WIDE (return to full scope) leads to 224 Mt under the EU ETS in 2030, while Options C3CLEAN (clean cut) and C4MIX (mix) both lead to 45 Mt under the EU ETS in 2030.

Table 6.5: Modelled direct CO_2 emissions from routes under the EU ETS, by policy option at nominal values for uncertain input variables in the years 2015, 2025, 2030 and 2035

Policy option	Direct CO_2 emissions under the EU ETS scope, Mt, for nominal scenario inputs and uncertainty range				
	2015	2025		2030	
			Compared to baseline		Compared to baseline
C0WIDE	58	213	169	224	179
C1BASE	58	44	-	45	-
C2CONLY	58	0	-44	0	-45
C3CLEAN	58	44	0	45	0
C4MIX	58	44	0	45	0

As aviation emissions continue to grow, and as the overall EU ETS cap declines according to Linear Reduction Factor (with the LRF assumed here to be 2.2%), airlines will use EU allowances from other sectors under the EU ETS for compliance. Additional demand for allowances from aviation will increase emission reduction incentives and scarcity in the EU ETS and therefore result in greater emissions reductions in other sectors. The estimated number of allowances (each equivalent to 1 tonne of CO_2) demanded by the aviation sector under each option is shown in the table below. Option C0WIDE leads to a demand of 98 Mt from other sectors, C1BASE, C3CLEAN (clean cut) and C4MIX (mix) to 25 Mt of demand for EUAs from other sectors.

Table 6.6: Annual demand for EUAs from other sectors from aviation in the EU ETS, and projected revenues, in 2030 by policy option at nominal values for uncertain input variables (numbers in larger font) and range due to variations in uncertain input variables (numbers in brackets).

Policy option	Estimated demand for EUAs by aviation from stationary sectors, million		
	2015	2030	
			Compared to baseline
C0WIDE	20	98	73
C1BASE	20	25	-
C2CONLY	20	0	-25
C3CLEAN	20	25	0
C4MIX	20	25	0

The results presented in this impact assessment include the impact of the decision to change the COVID-19 baseline to emissions in 2019 (instead of 2019 and 2020). The change in CORSIA baseline is expected to delay the need for airlines to provide offsets to cover emissions growth by several years. It is very likely that there will be no need for offsets in the pilot phase or even the first phase due to COVID-19 effects[93].

In terms of cumulative impacts the RefuelEU and options described here, a higher SAF uptake in 2030 would be expected to lead to a small net increase in net CO_2 on routes covered by the EU ETS (C0WIDE, C1BASE, C3 CLEAN and C4MIX) as SAF is zero rated under the EU ETS but is associated with some emissions. It would lead to a decrease in net CO_2 on non-ETS routes. ReFuelEU is likely to lead to a reduction in demand for offsets under CORSIA. For example, by ReFuelEU applying on extra-EEA routes, there is a potential for a 40-70% reduction in CORSIA offsetting costs on these routes by 2035.

The different options are associated with other environmental impacts, beyond the impacts of CO_2 emissions. The assessment looks at the total EEA external costs of aviation for the period 2021 to 2035, when CORSIA is due to end. It focuses on the external/environmental costs associated with passenger air travel, but the broad impacts of freight aviation are likely to be similar. It covers the external costs from accidents, local NOx and PM2.5 air pollution, noise and habitat destruction as well as climate externalities. The climate costs presented are those associated with the direct CO_2 emissions from planes, not the net costs that take account of CO_2 reductions in other sectors or the non-CO_2 climate impacts. The approach used to estimating the external costs follow the approach set out in the Commission Handbook on the External Costs of Transport, which includes the impacts of non-CO2 aviation impacts and use of a marginal cost of carbon of €100/ tonne CO2 eq. External costs, shown in Table 6.7 below, show a similar pattern across options, with externalities driven by demand. The total external costs assessed amount to €667.5 billion for Option C1BASE with a range from the lowest externality cost for C0WIDE at €662.3 billion to the highest of €669.2 billion for Option C2CONLY. The direct CO2 emissions are doubled to give the CO2 and non-CO2 impacts of aviation. The non-CO2 impacts are more uncertain. If non CO2 impacts are not taken into account in estimating the external costs of climate impacts, the total external cost ranges from €346 billion to €350 billion for the options considered. These are dominated by the externality costs associated with climate impacts, which range from €631.9 billion for Option C0WIDE to €638.6 for Option C2CONLY. The externality associated with local NO_x pollution, the next largest cost amounts to

[93] Lambert Schneider and Jakob Graichen, Should CORSIA be changed due to the COVID-19 crisis?, May 2020.

€14.94 billion in the baseline, €14.90billion for Option C0WIDE and €15.00 billion for Option C2CONLY.

Table 6.7: Total estimated EEA aviation externality costs by category, cumulative costs for 2021-2035, at nominal values for all uncertain scenario variables.[94]

Policy option	Accident costs, billion €2018	Local NOx costs, billion €2018	PM2.5 costs, billion €2018	Noise costs, billion €2018	Habitat destr'n costs, billion €2018	Climate costs, billion €2018	Total, billion €2018
C0WIDE	2,236	14,900	0,535	11,250	1,490	631,900	662,300
C1BASE (baseline)	2,239	14,940	0,536	11,270	1,494	637,000	667,500
C2CONLY	2,250	15,000	0,537	11,320	1,501	638,600	669,200
C3CLEAN	2,239	14,940	0,536	11,270	1,494	637,000	667,500
C4MIX	2,239	14,940	0,536	11,270	1,494	637,000	667,500
Compared to baseline							
C0WIDE	-0,003	-0,040	-0,001	-0,020	-0,004	-5,100	-5,200
C1BASE (baseline)	-	-	-	-	-	-	-
C2CONLY	0,011	0,060	0,001	0,050	0,007	1,600	1,700
C3CLEAN	0	0	0	0	0	0	0
C4MIX	0	0	0	0	0	0	0

6.1.2.2. Auctioning share increase options

From 2021 onwards, the total amount of aviation allowances issued will decrease over time consistently with the LRF applied to all ETS sectors[95], and the ratio of free to

[94] ICF Study COVID-19 Update, Table 1.18, p. 40, using values from the handbook commissioned by DG MOVE on the external costs of transport Version 2019 – 1.1: https://op.europa.eu/de/publication-detail/-/publication/9781f65f-8448-11ea-bf12-01aa75ed71a1

[95] On the level of the linear reduction factor see the impact assessment on the general ETS.

auctioned allowances is a policy decision. Fixing the total amount of aviation allowances and applying LRF to the amount will strengthen the steering effect of ETS on the sector.

All modelling scenarios in the ICF Study, including the scenarios with low growth and high ambition, suggest that aviation emissions will exceed the aviation cap. However, increasing the share of auctioned allowances would further reinforce a clear price signal. Airline operators would pay for a larger share of their allowances and have a greater incentive to reduce emissions. This effect will remain limited due to airlines' ability to pass through the carbon cost to consumer prices, as discussed in section 2.1.3.

Different options for increase of auctioning share may have different impacts on carbon leakage or perceived risk thereof. Due to the nature of aviation (geographical determination of routes), moving the same activity outside Europe has limited possibilities.

The intention of free allocation is to prevent emitters from avoiding carbon costs by moving the location of emissions outside the policy area. For aviation, this carbon leakage could only occur via airline decisions (e.g. choosing to develop non policy-affected routes) or passenger decisions (e.g. choosing an itinerary that hubs via a non-policy-affected country), with the balance of the two depending on rates of cost pass-through and modal shift, whereby shift from plane to rail is the main risk, as switch to road transport is not a viable option for the majority of air travel.

Leakage mechanisms due to carbon pricing can be positive or negative. When leakage is *positive*, emissions increase outside the policy area. Passengers on a stopping itinerary who could hub via an airport in the policy area may choose instead to hub via a (cheaper) airport outside the policy area. When leakage is *negative*, emissions may decrease both inside and outside the policy area. Passengers may decide not to travel due to increased costs. Passengers may also choose an alternative, likely less polluting, mode of transport. Because positive leakage is typically less when the policy area is larger (as fewer alternative non-policy hubs are available which do not involve a large detour), even greater auctioning percentages are unlikely to lead to significant positive leakage.

The ICF Study checked whether carbon leakage occurred due to the impact of auctioning share increase on airline cost per RPK, ticket prices and demand (in RPK) by route group. The modelling found that immediate full auctioning option (A1FULL) resulted in lower emissions combined with those CORSIA options where ETS coverage is wider than for options with smaller coverage. This is due to negative leakage, ie. passengers choosing not to fly. For example, comparing option C3CLEAN and C2CONLY combined with immediate full auctioning option, the leakage is negative with around 0.6 Mt reduction in direct emissions in 2035 on non-ETS routes in option C3CLEAN.

In general, the results suggest there is a low risk of (positive) carbon leakage when switching to a higher auctioning percentage, and that changes in cost associated with auctioning changes are still well within the range of cost variability due to fluctuations in fuel price.

6.2. Competitiveness and economic impacts

When looking at economic impacts, it is important to assess the policy options' implications on operating costs, ticket prices and demand, as well as auction revenues as presented below. These are then used to assess whether there is potential for options to distort competition, between airlines, airports and tourist destinations. This section also considers the cumulative impacts of this and other 'Fit for 55' initiatives, in particular of RefuelEU and the review of the Energy Taxation Directive, on costs and competitiveness of airlines and EU airport hubs to the extent possible given the timetables for the different impact assessments and availability of data. The section ends with an evaluation of the administrative effort for the different options.

6.2.1. Impacts on operating costs, prices and demand

The options vary in their coverage of CO_2 emissions from aviation and in the policy tools used to cover different segments of emissions. The two policy tools, EU ETS and CORSIA, lead to different prices for each tonne of CO_2 emissions covered. As a result, the different options have different impacts on the operating costs of airlines. The extent to which changes in operating costs lead to changes in ticket prices depends on the extent to which airlines can pass extra costs on to customers. Higher fares may change passengers' and freight operators' demand for air transport, or transport on the routes affected, depending both on the size of the change in fare and on airline customers' price sensitivity. However, the ICF study finds the impact of the carbon price for all policy options (except C0WIDE) negligible compared to differences in other sources of airline costs (e.g. fuel).

6.2.1.1. CORSIA implementation options

For intra-EEA flights, the baseline leads to a projected increase in carbon costs from 0.2% of total operating costs in 2015 to 1% in 2030. This represents an increase in carbon costs from 1.2% to 7 % of fuel costs from 2015 to 2030. The impact of the carbon price on the operating costs is very small for all other options. In Option C2CONLY, CORSIA only, this impact, a rise of 0.005%, is negligible. For all other options, also, the impact is very limited (between 0.8% and 1% for the central or nominal scenario presented and at most rising to 3% of operating costs under the high cost scenario).

For extra-EEA flights, the costs of all options, except C0WIDE, full scope, are negligible in 2030, under the nominal and high cost scenarios. For C0WIDE, the cost rises to 1.8% of total operating costs in 2030, rising to a maximum of 5.6% of operating costs for the high cost scenario.

Table 6.8: Estimated intra-EEA carbon costs when all scenario variables , including carbon prices for EU ETS allowances and CORSIA, are at COVID-19- adjusted nominal values, as a percentage of fuel costs and total operating costs, by policy option, 2015 and 2030.

Policy option	Carbon costs as % of fuel costs (exc. carbon)			Carbon costs as % of total operating costs		
	2015	2030		2015	2030	
			Compared to baseline			Compared to baseline
C0WIDE	1.2	6.8	-0.2	0.2	0.9	-0.1
C1BASE (baseline)	1.2	7.0	-	0.2	1.0	-
C2CONLY	1.2	0.04	-6.96	0.2	0.005	-0.995
C3CLEAN	1.2	7.0	0	0.2	1.0	0
C4MIX	1.2	7.0	0	0.2	0.9	-0.1

Table 6.9: Estimated extra-EEA carbon costs when all scenario variables, including carbon prices for EU ETS allowances and CORSIA, are at COVID-19-adjusted nominal values , as a percentage of fuel costs and total operating costs, 2015 and 2030

Policy option	Carbon costs as % of fuel costs			Carbon costs as % of total operating costs		
	2015	2030		2015	2030	
			Compared to baseline			Compared to baseline
C0WIDE	0.2	8.1	8.1	0.04	1.8	1.8
C1BASE (baseline)	0.2	0.0	-	0.04	0.0	-
C2CONLY	0.2	0.04	0.04	0.04	0.01	0.01
C3CLEAN	0.2	0.06	0.06	0.04	0.01	0.01
C4MIX	0.2	0.04	0.04	0.04	0.01	0.01

Note carbon costs are non-zero in 2015 as routes to/from the UK are included in extra-EEA throughout.

In terms of impact of carbon costs on ticket prices or fares, the calculated initial average carbon cost pass through rates (for EU ETS and CORSIA costs) is around:

- 74% for intra-EEA flights
- 75-82% for extra-EEA flights
- And 77% for other routes (flights not within, or to or from the EEA)

As can be seen in Table 6.10, the resulting impact on fares is small. By 2030, for C1BASE, the baseline, the average one-way fare for intra EEA flights is projected to be €148.10 (€150.2 under the high price scenario), up from €143.47 in 2015. For extra-EEA the 2030 projected price is € 330.16 (or €330.4 under the high price scenario), up from 311.41 in 2015 and for other routes €188.38 in 2030 down from € 193.31 in 2015. Other

options are projected to have very similar fares. One-way intra-EEA fares vary by less than €1 between the different policy options (or €3 under the high cost scenario). For extra-EU/EFTA fares, the largest difference is between Option C0WIDE and other options, amounting to around €2 for one-way, less than 1% of the total ticket price or fare. Under the high carbon price scenario, this rises to €6 difference, less than 2% of the total fare.

Table 6.10: Average fare in 2030 and 2035 by region and policy option, for all uncertain scenario values set to COVID-19-adjusted nominal values).

Policy option	Avg. one-way fare, intra-EEA, €2018			Avg. one-way fare, extra-EEA, €2018			Avg. one-way fare, other routes, €2018		
	2015	2030		2015	2030		2015	2030	
			Compared to baseline €			Compared to baseline €			Compared to baseline €
C0WIDE	143.47	148.00	-0.10	311.41	332.17	2.01	193.31	188.39	0.01
C1BASE (baseline)	143.47	148.10	-	311.41	330.16	-	193.31	188.38	-
C2CONLY	143.47	147.14	-0.96	311.41	330.07	-0.09	193.31	188.38	0
C3CLEAN	143.47	148.10	0	311.41	330.19	0.03	193.31	188.38	0
C4MIX	143.47	148.10	0	311.41	330.18	0.02	193.31	188.38	0

With minimal ticket price differences between the options in 2030, the assessment also predicts small differences in demand, measured in Revenue Passenger Kilometres and Revenue Tonne Kilometres (RTK), for all policy options. Table 6.11 shows that for extra-EEA flights, all options are projected to have the same demand with 1.87 trillion RPK and 90.3 trillion RTK in 2030, except Option C0WIDE, which leads to RPK of 1.85 trillion, and RTK of 88.5 billion just 1% and 2% lower than other options. For intra-EEA flights all options lead to the same passenger demand projection of 0.78 trillion RPK in 2030. For freight, there is also little difference, with C2CONLY leading to the highest demand with 2.26 trillion FTK and all other options at 2.23 trillion RTK in 2030.

Table 6.11: Estimated global, extra-EEA and intra-EEA RPK and FTK by policy option, for all uncertain input variables at COVID-19-adjusted nominal values

Policy option	Estimated global annual RPK, trillion		Estimated global annual FTK, billion	
	2015	2030	2015	2030

			Compared to baseline			Compared to baseline
C0WIDE	6.88	12.22	-0.02	204	358.2	-1.8
C1BASE	6.88	12.24	-	204	360.0	-
C2CONLY	6.88	12.24	0	204	360.1	0.1
C3CLEAN	6.88	12.24	0	204	360.0	0
C4MIX	6.88	12.24	0	204	360.1	0.1
	Estimated extra-EEA annual RPK, trillion			**Estimated extra-EEA annual FTK, billion**		
	2015	**2030**		**2015**	**2030**	
			Compared to baseline			**Compared to baseline**
C0WIDE	1.30	1.85	-0.02	60.0	88.5	-1.8
C1BASE	1.30	1.87	-	60.0	90.3	-
C2CONLY	1.30	1.87	0	60.0	90.3	0
C3CLEAN	1.30	1.87	0	60.0	90.3	0
C4MIX	1.30	1.87	0	60.0	90.3	0
	Estimated intra-EEA annual RPK, trillion			**Estimated intra-EEA annual FTK, billion**		
	2015	**2030**		**2015**	**2030**	
			Compared to baseline			**Compared to baseline**
C0WIDE	0.54	0.78	0	1.70	2.23	0
C1BASE	0.54	0.78	-	1.70	2.23	-
C2CONLY	0.54	0.78	0	1.70	2.26	0.03
C3CLEAN	0.54	0.78	0	1.70	2.23	0
C4MIX	0.54	0.78	0	1.70	2.23	0

The results presented here assume base case carbon prices, also adjusted to reflect the impacts of COVID-19. For EU allowances this €26 /tonne in 2020 and €31 in 2030 and

€1/tonne in both 2020 and 2030 for CORSIA credits (all in year 2018 Euros). The ICF Study also looked at sensitivity to carbon prices if these follow the high carbon price scenario, with EU allowance prices rising to €83/ tonne in 2030 and CORSIA credits to €13 per tonne (see Table 6.12 below)

Table 6.12: Direct comparison of intra-EEA and extra-EEA RTK at different carbon price assumptions, under COVID 19-adjusted nominal scenario inputs for all other uncertain variables, by policy option.

Policy option	Intra-EEA annual RTK, 2030				Extra-EEA annual RTK, 2030			
	COVID-19-adjusted nominal scenario inputs		COVID-19-adjusted nominal scenario inputs + higher carbon price		COVID-19-adjusted nominal scenario inputs		COVID-19-adjusted nominal scenario inputs + higher carbon price	
		Compared to baseline		**Compared to baseline**		**Compared to baseline**		**Compared to baseline**
C0WIDE	79.9	-0.01	78.7	-0.03	273.8	-3.1	266.7	-10.1
C1BASE	80.0	-	79.0	-	276.9	-	276.8	-
C2CONLY	80.5	0.05	80.4	1.4	277.0	0.1	276.8	0
C3CLEAN	80.0	0	79.0	0	276.9	0	276.5	-0.3
C4MIX	80.0	0	79.0	0	276.9	0	276.6	-0.2

6.2.1.2. Auctioning share increase options

Aviation auctioning costs to airlines vary substantially depending on the auctioning option chosen, ranging from €41 billion[96] over the 2023-2030 period in the case of an immediate full auctioning and full scope EU ETS, to 0 euros in the case that only CORSIA is applied. It should be noted that in the case of CORSIA, airlines will have the obligation to finance private entities around the world through purchase and use of offset credits, instead of contributing to public finance in their own jurisdiction. Typically, global EU ETS-related airline costs exceed CORSIA-related costs unless the EU ETS for aviation is stopped completely (option C2CONLY). This is because EUA prices are assumed to be significantly higher than eligible unit prices for CORSIA.

For policy options where ETS and CORSIA do not apply on the same routes, the impact of different auctioning options on total CORSIA offset costs is under 0.5%. Under option C4MIX, the two schemes overlap, with CORSIA also covering intra-EEA slightly higher

[96] As for other estimation of auction costs/ revenues in the broader ETS impact assessment using carbon price assumptions of (in €2020): €40 as average for the whole period 2021 to 2030, €45 as average for the period 2026 to 2030 (drawing on the results of the PRIMES MIX and MIX-CP scenarios), €35 as average for the period 2021 to 2025.

CORSIA costs. However, offset costs still change by less than 1% between different auctioning options.

Around 75% of this cost will be passed through, given the characteristics of the routes operated in terms of competition, airport congestion and passenger demand sensitivity[97].

6.2.2. Impacts on level playing field

Generally, changes in operating costs, ticket prices and demand may affect the level playing field for example:

- If airlines pay different carbon costs when operating on the same route or if certain airlines bear a high proportion of costs because a larger share of their operations are in higher carbon cost routes;
- If a reduction in demand due to higher carbon costs affects some airlines, but not others with which they are in competition;
- If carbon costs lead to investment in airports outside higher carbon cost areas instead of within the higher cost area;
- If policies implemented equally across routes are not enforced equally by different states.

In the policy options regarding both CORSIA implementation and auctioning share increase assessed for this impact assessment, the costs and impacts on ticket prices and demand are too low to have a significant impact. With significant pass through of carbon costs to customers, European companies will not face significant disadvantage as result of carbon pricing in the EEA in terms of overall margin for manoeuvre when competing with airlines from jurisdictions without carbon pricing.

For example, the impact differences between the immediate full auctioning and swift phase-out options are small, and mainly concern years 2023 and 2024. Because this is part of the pandemic recovery period, all estimates of impact during this time period are uncertain**.** After this point, differences between the two options are basically negligible (for example, there is not an appreciable ongoing difference in airline fleets, operations or ticket prices for any of the policy options). The main difference between the two auctioning options is that the increase in airline costs and ticket prices from moving to full auctioning comes into effect in a single year in the immediate full auctioning scenario, and is phased in over the time period to 2025 in the swift phase-out scenario. This means that year 2023 and 2024 demand are slightly lower, and ticket prices higher (0.2%), for the immediate phase-out option.

[97] ICF Study pp. 249-250

6.2.2.1. Competition between airlines

Competitive distortions may arise when policies do not apply equally on routes, and where they are not enforced equally. Enforcement has been crucial for the success of the EU ETS to date[98]. Options apply uniformly to all airlines so do not create direct distortions.

There is also a risk that airlines that have a higher proportion of flights on high carbon cost routes than other airlines are less able to cross-subsidise them from lower carbon cost routes. Several studies nevertheless argue that such cross-subsidisation is minimal[99]. This is consistent with the 2017 Aviation ETS Impact Assessment[100], which considered the risk of indirect distortion of competition to be theoretical, mainly due to low extra allowance costs.

Airlines also compete with other transport sectors. With a small increase in ticket prices for the options considered, there may limited impact on choice of travel mode.

6.2.2.2. Competition between airports

For airports, the largest risk of competitive distortion is between EEA airports and major non-EEA airports close enough to the policy area to provide an alternative. Looking for example at London airports versus Paris or Amsterdam, Option C0WIDE, the option with the highest impact, leads to a 0.54% lower demand in million passenger movements per annum (mppa) when compared to the baseline C1BASE. All other options have a similar impact to option C1BASE or when compared to one another. For Paris and Amsterdam, the difference in impact on mppa varies from 1% to 1.4 % for the different options. A similar impact is seen when looking at Istanbul and Athens. The ICF Study suggests that higher intra-EU costs will reduce demand at both EEA and nearby non-EEA airports, with the latter marginally less affected.

In the longer-term, a risk is that airlines could move their operations to less-affected airports, for example in regions close to the EU with lower carbon costs (e.g. Istanbul).

The carbon costs associated with the options assessed are unlikely to have a significant impact on hub choice for passenger airlines, given the high costs of changing networks and hub location. Freight airlines are more likely to move cargo services for cost reasons, but do so primarily in the same catchment area[101], suggesting a limited impact on

[98] Following some airlines paying millions of euros of fines for non-compliance for their flights within the EU, all major airlines have maintained compliance with the system.
[99] CE Delft , 2005, Giving wings to emissions trading: inclusion of aviation under the European emissions trading scheme (ETS): design and impacts; CE Delft and MVA (2007). Implications of EU emissions trading scheme for competition between EU and non-EU airlines.
[100] https://ec.europa.eu/clima/sites/clima/files/swd_2017_31_en.pdf
[101] Uen A. Zhang A., Van Hui Y, Leung L and Fung M, 2017. Is developing air cargo airports in hinterland the way of the future? Journal of Air Transport Management , 61 155-25.

changes in freight hub. The carbon costs of the options considered are also typically not sufficient to lead to network changes for freight airlines. This is further made less likely due to bilateral air service agreements and ownership regulations. In any case, fluctuations in fuel price easily outweigh fluctuations in carbon costs both in the medium and longer term.

Only 25 % of the respondents to the open public consultation provided views on the hub leakage risk. According to some respondents, the EU should consider taking measures to mitigate the competitive distortions between feeder services of EEA-airlines that are subject to the EU ETS and feeder services from airlines from neighbouring non-EEA-countries related to these hubs. Concrete suggestions to address the competitive distortion included introduction of a carbon border adjustment mechanism, and alleviating the financial burden on EEA feeder flights by *inter alia* excluding them from EU ETS.

6.2.2.3. Competition between Tourist Destinations

When looking at whether tourist destinations subject to higher aviation carbon costs may lose market share, the ICF Study concluded that tourism demand has historically been relatively insensitive to cost changes. While there may be transport mode shift and changes in destination choice, any impacts are likely to be small at the carbon cost levels projected for the options considered.

6.2.3. Cumulative Impacts of Fit for 55 Initiatives

With all policy options (except C0WIDE) modelled to have no impact demand[102], and with modelling for other 'Fit for 55' initiatives of importance for aviation completed later than for this impact assessment, no cumulative impacts were modelled. However, a qualitative assessment has been undertaken, building on available information at the time of drafting and the sensitivity analysis undertaken on the modelling for this impact assessment. This also concludes that cumulative impacts are expected to be negligible or very small.

The Energy Taxation Directive Impact Assessment[103] suggests that the proposed aviation fuel tax will have a greater impact than the price signal resulting from any of the options considered in this impact assessment. Adding the small carbon cost impacts of ETS and

[102] For example in the ICF study 2030 carbon costs as a percentage of airline operating costs for intra-EU/EFTA were modelled as 0.006-1.1%, with a slightly wider range of 0.0%-2.1% for extra-EU/EFTA.
[103] Commission Staff Working Document, Impact Assessment Report accompanying the document 'Proposal for a Council Directive restructuring the Union framework for the taxation of energy products and electricity', Box 4 [to be published].

CORSIA options assessed here to the ETD impacts will not make a significant difference to the ETD costs as a proportion of operating costs, fares or competitiveness.

The cumulative impacts when considering the effect of ReFuelEU and the increased use of Sustainable Aviation Fuels (SAF) will also be limited. Higher use of SAFs should lead to a reduction demand for ETS allowances and CORSIA offsets (zero emission factor applies for sustainable fuels in the EU ETS and SAFs can be used for compliance under CORSIA). This will lead to a reduction in carbon costs though this reduction will be small compared to the fuel price increase, because the carbon costs, especially under CORSIA are small.

Though the fuel price increase will outweigh any change in carbon costs, the fuel price increase is estimated to be well within the fuel price sensitivities assessed for this impact assessment. Airline costs and ticket prices for the options in this impact assessment, along with RefuelEU preferred options are expected to be closer to the central or nominal scenario modelled for this study than the high fuel cost sensitivity analysis. While the effective fuel price for airlines would be higher, the impact is also small, the Impact Assessment for ReFuelEU foresees a 0.8% air ticket price increase by 2030 under its preferred scenarios. Therefore the overall cumulative impact on prices, demand and competitiveness is expected to be small.

6.2.4. Impact on auction revenues

In accordance with Article 3d(3) of the ETS Directive, the revenue from auctioning aviation allowances is proportionate to the share of the total attributed aviation emissions for all Member States for the reference year, which is the calendar year ending 24 months before the start of the trading period. For the fourth trading period of the ETS (which began on 1 January 2021) this means that the reference year for the distribution of aviation revenues is 2018. For the increased revenues from an increased share of auctions from the allocation of aviation allowances, the same rule would apply.

Following the inter-institutional agreement of 16 December 2020, the Commission committed to table in June 2021 proposals for new own resources based on the revision of the Emission Trading System, including its possible extension to aviation and maritime, a new Carbon Border Adjustment Mechanism and a new digital levy. The EU budget plays an increasingly important role for the EU to meet its commitment to become the first climate neutral continent by 2050. 30% of the expenditures under the MFF 2021-2027 and NextGenerationEU will be dedicated to climate-related projects.

The coverage of aviation ETS and in particular the speed of free allocation phase-out strongly affect aviation allowances auctioning revenue over the 2023-2030 time period. As the auctioning revenue is currently directed to Member States' budgets, the revenue

may enable lowering other taxes, such as income tax, or increasing government expenditure.

6.2.4.1. CORSIA implementation options

Option C2CONLY - CORSIA only - would remove all existing and future auction revenues to Member States or for other uses within the EU, including funding for innovation, modernisation and other support for transition to climate neutrality.

Option C0WIDE's larger coverage means that auctioning revenues from aviation are the highest. Options C3CLEAN and C4MIX have similar levels of impact on revenues.

When taking into account the effect of ETS revenue recycling to increase government expenditure or reduce taxes, extending the EU ETS to cover all flights (option C0WIDE) would have the greatest positive impact on EU27 employment and GVA. The full-scope CORSIA scheme (option C2CONLY) is associated with the lowest macro-economic outcome, whilst other options with a mix of CORSIA and ETS scopes are expected to have broadly similar, intermediate outcomes. However, the variation in expected macroeconomic effects between policy options is small.

6.2.4.2. Auctioning share increase options

Immediate full auctioning yields 50% more total revenue between 2023-2030 than a slow phase-out. In contrast, aviation demand for general EU allowances is only weakly affected by the chosen auctioning option, with typically only 1-3% difference in total year 2023-2030 EUA demand between the status quo and immediate phase-out options.

Table 6.13. : ETS revenue estimates including funds and solidarity for aviation (in bn EUR) [104]

Cap scenario	Sector	Annual average 2021-2025, 2020€ billions	Annual average 2026-2030, 2020€ billions
C0WIDE	Aviation	0.38 – 2.27	0.90 – 6.03

[104] Estimated range of revenues for CORSIA policy options, for different auctioning options, using price assumptions, as in the broader ETS impact assessment, of (in €2020): €40 as average for the whole period 2021 to 2030, €45 as average for the period 2026 to 2030 (drawing on the results of the PRIMES MIX and MIX-CP scenarios), €35 as average for the period 2021 to 2025. Note also that these values are approximate, produced by multiplying the number of auctioned allowances by given average allowance price (individual year values will likely differ from the 5-year average and different years have different auctioned allowance totals). This calculation assumes that CO2 emissions will be above the aviation cap level as modelled in all years.

C1BASE	Aviation	0.12 – 0.53	0.14 -0. 93
C2CONLY	Aviation	0 - 0	0 - 0
C3CLEAN	Aviation	0.12 – 0.53	0.14 -0. 96
C4MIX	Aviation	0.12 – 0.53	0.14 – 0.96

Table 6.14: Year 2021-2030 EU ETS allowance auctioning revenue, by ETS/CORSIA policy and auctioning option, using the assumptions of the general ETS impact assessment to ensure consistency in estimation of revenues (assuming an average carbon price of €35 for 2021-2030 and €45 for 2026-2030. see footnote [103]). These are presented as cumulative amounts or totals across all years for 2021-2022, 2023-2025 and 2026-2030.

Total Auctioning Revenue, billion €2020					
OPTIONS	A0BASE	A1FULL	A2SWIFT	A3SLOW	A4RED
C0WIDE					
Cumulative revenues 2021-2022	0,255	0,255	0,255	0,255	0,255
Cumulative revenues 2023-2025	1,663	11,084	9,714	3,965	2,985
Cumulative revenues 2026-2030	4,522	30,15	30,16	23,08	13,48
C1BASE					
Cumulative revenues 2021-2022	0,255	0,255	0,255	0,255	0,255
Cumulative revenues 2023-2025	0,363	2,413	1,923	0,754	0,601
Cumulative revenues 2026-2030	0,701	4,671	4,671	3,576	2,09
C2CONLY					
Cumulative revenues 2021-2022	0	0	0	0	0
Cumulative revenues 2023-2025	0	0	0	0	0
Cumulative revenues 2026-2030	0	0	0	0	0
C3CLEAN					
Cumulative revenues 2021-2022	0,255	0,255	0,255	0,255	0,255
Cumulative revenues 2023-2025	0,363	2,413	1,923	0,754	0,601
Cumulative revenues 2026-2030	0,701	4,671	4,781	3,576	2,09
C4MIX					
Cumulative revenues 2021-2022	0,255	0,255	0,255	0,255	0,255
Cumulative revenues 2023-2025	0,363	2,413	1,923	0,754	0,601
Cumulative revenues 2026-2030	0,701	4,671	4,781	3,576	2,09

6.2.5. Administrative effort

Administrative tasks related to the EU ETS and CORSIA are shared between the aircraft operators, national competent authorities and the European Commission. Operators face the costs of monitoring, reporting and verification of emissions and the effort needed for compliance, i.e. purchase and surrender of EU ETS allowances and CORSIA eligible

credits and their surrender. National authorities manage the system for reporting emissions, control free allocation, administer the accounts in the Union Registry, follow up and enforce compliance and are in direct contact with aircraft operators. The Commission provides for the Union Registry, approves free allocation, publishes the list of aircraft operators with the administering Member States and proposes/adopts legislation and provides for guidance documents in order to ensure harmonised implementation of the system.

6.2.5.1. CORSIA implementation options

The application of CORSIA requires aircraft operators to monitor and report their emissions from international flights covered by CORSIA. For routes where there are already EU ETS MRV requirements in place now (intra-EEA international flights), CORSIA may not present a particularly high additional administrative burden for aircraft operators. But for those routes that are not covered by MRV ETS requirements prior to 2019, complying with CORSIA requirements adds administrative effort and associated costs for data collection, reporting, quality assurance and verification[105]. In addition, aircraft operators engaging in routes covered by CORSIA will need to acquire and surrender eligible units for compliance, an activity that is likely to be outsourced at a cost.

The size of an aircraft operator is likely to have an effect on the relative scale of additional costs as a share of their overall costs. Whilst some costs, including emissions data collection, reporting and quality control, typically increase in-line with the number of flights, larger operators may be better placed to benefit from economies of scale by investing in automated IT solutions that reduce manual effort. Larger operators will tend to face relatively lower one-off costs as a share of their total costs, than smaller operators. These one-off costs include tasks such as setting up administrative systems and internal processes, understanding the detailed design and rules of CORSIA, as well as establishing knowledge of the carbon offset credit market in general and, specifically, the procurement of credits.

Option C0WIDE: increased administrative effort on aircraft operators as the geographical coverage is broader compared to the current situation, although this is a quantitative difference as airlines are subject to only one regulation. Increased effort for enforcing compliance can be expected for national authorities and the Commission.

Option C1BASE: no change in administrative costs as this is the continuation of the current system.

[105] Based on Article 28c of the ETS Directive, the Commission adopted Delegated Regulation 2019/1603, which defined the scope of CORSIA reporting. This Regulation is binding in its entirety and directly applicable. The purpose of this delegated act was to draw on existing rules and frameworks as far as possible in order to reduce the aircraft operators and verifiers' administrative burden and to specify how the relevant information will be transmitted to the ICAO's secretariat.

Option C2CONLY: airlines are subject only to one regulation, therefore the administrative costs are comparable to the current level, with additional one-off cost due to the change from EU ETS to CORSIA.

Option C3CLEAN: increased level of administrative costs as the aircraft operators are subject to two sets of rules. However, the EU ETS part is the continuation of the existing administrative procedures, and the separation of the two regimes is simple as the two regulations apply to different routes.

Option C4MIX: the level of administrative effort would be considerably higher for all players in the system compared to the current situation, as the same routes would be subject to two compliance obligations.

6.2.5.2. Auctioning share increase options

Full auctioning would reduce the administrative burden immediately and considerably. These administrative costs are mainly on competent authorities and the Commission. It would mean that all administrative procedures relating to the free allocation would be abolished. All other options maintain the current level of administrative burden, either until the end of the trading period (A0BASE and A4RED) or with a phase out time (A2SWIFT and A3SLOW), because the level of free allocation does not influence the level of administrative effort necessary for delivering it. The assessed options entail the condition that the free allocation is distributed on the current basis, namely based on 2010 traffic. Any other choice, i.e. changing the base year for distribution in order to reflect current market condition, would cause significant administrative burden both for the aircraft operators and for the regulators, because this would mean a new collection of tonne-kilometre data.

6.3. Social impacts

6.3.1. Impact on employment

The overall impacts on value added and employment of the different policy options are small: less than 0.05% in terms of both value added and employment in all cases at the EU27 level. This includes the impacts on the aviation and fuel supply sectors, their supply chain and multiplier effects, as well as the impact of recycling EU ETS revenues to increase government expenditure or reduce taxes. It should be noted however, that the impacts of different policy options on flight frequencies and capacities will affect the connectivity between regions and countries. These changes may have more substantial macroeconomic impacts than the changes concerning directly the aviation sector and associated supply changes, and have not been assessed in the modelling.

Most of the impacts of each option can be attributed to recycled EU ETS revenues. With increased auctioning revenues, for instance, governments could reduce taxes, which would result in increased spending across different sectors of the economy. Options with more positive outcomes on value added and employment are generally those with a larger volume of projected revenues from the EU ETS. Due to decrease of demand for air transport, a negative impact on employment in the sector is to be anticipated. However, the impact is estimated to be negligible (-0.13%) even in Option C0WIDE, where the impact is strongest.

The figure below shows the range of macroeconomic impacts (the relative difference between options with the strongest and weakest macroeconomic outcomes, Option C0WIDE and Option C2CONLY, respectively) for all current EU Member States under the assumption that additional government revenues are recycled in the economy. This range appears to be to be generally widest where the projected possible EU ETS revenues is largest relative to GDP. These examples include Cyprus, Malta and the Netherlands. The other policy options show broadly similar trends to Option C2CONLY. Without the effect of revenue recycling, the outcomes for individual Member States are much more uniform across policy options.

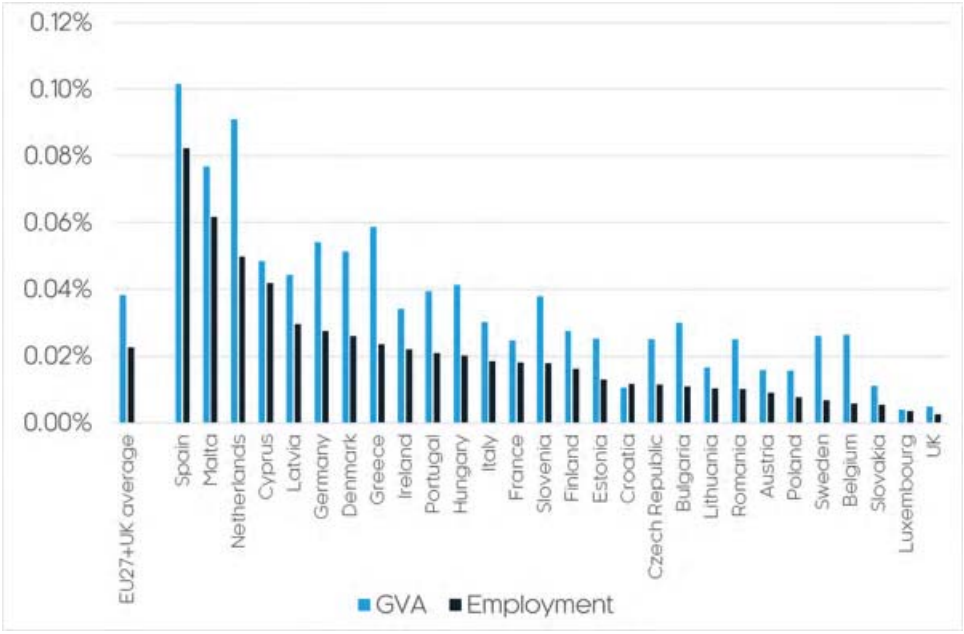


Figure 6.1. Differences in GVA and employment by 2035 between Options C0WIDE and C2CONLY, by country.[106]

6.3.2. Impact on households

Evidence suggests that carbon pricing on aviation is likely to be socially progressive, i.e the impact of carbon price is likely to be lower in respect of lower income households.

[106] ICF Study, Figure 49.

High-income households are more likely to fly and spend larger portions of their income on air travel, as air transport is in much higher demand in higher-income households, and therefore larger portion of its emissions can be attributed to higher-income households. Thus, increased carbon pricing on air travel is likely to be socially progressive as it primarily affects higher-income households, while increasing equal treatment with other modes of transport such as railways and road transport which are subject to taxation and VAT.

Citizens use air transport unevenly, with a small proportion flying very frequently, some occasionally, and most rarely (or not at all) in any particular year. It is still predominantly and disproportionally used by higher income groups. By way of example, a study representative of adults in Germany shows that 11% of respondents accounted for 29% of the flights in 2019. The highest income group reported three times higher average flight distances than the lowest income group.[107]. Results suggest that the share of the world's population travelling by air in 2018 was 11%, with at most 4% taking international flights. Global data also shows a similar pattern, suggesting that a minor share of air travellers is responsible for a large share of warming: The percentile of the most frequent fliers – at most 1% of the world population - likely accounts for more than half of the total emissions from passenger air travel[108].

6.4. Impacts on outermost regions (OMR)

In general, most flights to outermost regions are either domestic (e.g. Guadeloupe - Paris) or local short-haul flights with small aircraft, with the exception of the Canary Islands where flights are both domestic and international short haul flights (since the Canary Islands are a touristic destination). Therefore, it is likely that differences in how flights to and from outermost regions are handled will impact mainly the Canary Islands and, to a lesser extent, flights to and from Madeira.

Changes in the cost of flying or the frequency of available flights can affect the access by outermost region residents to education, training, goods and services to a much greater extent than for other, less-isolated regions. For outermost regions other than the Canary Islands, access costs to national capital cities, as a fraction of the local minimum wage, are 2-3 times greater than they are in other insular European regions. This means that the same level of cost increase in ticket prices for outermost region routes as for other routes can represent a significantly higher cost burden for residents of these regions. In turn, this

[107]Stefan Gössling, Andreas Humpe, Thomas Bausch, Does 'flight shame' affect social norms? Changing perspectives on the desirability of air travel in Germany, Journal of Cleaner Production, Volume 266, 2020, https://doi.org/10.1016/j.jclepro.2020.122015.

[108] Stefan Gössling, Andreas Humpe, The global scale, distribution and growth of aviation: Implications for climate change, Global Environmental Change, Volume 65, 2020, https://doi.org/10.1016/j.gloenvcha.2020.102194.

may affect the economic development of these regions. Flights within outermost regions that have been deemed socially necessary, however, are operated under Public Service Obligations (PSOs)[109]. As these flights are excluded from the Annex I activity in the ETS Directive, they may remain excluded from the EU ETS due to their PSO status even if the temporary exclusion of routes to and from outermost regions in Article 28a of the ETS Directive ends.

6.4.1. CORSIA implementation options

C0WIDE: includes EEA flights to/from and within the outermost regions, as well as flights between outermost regions and non-EEA destinations. This option would lead to EU ETS application for nearly all outermost region arriving and departing flights. This is the only option that has non-negligible impact on OMR. Because OMRs are typically geographically distant from mainland Europe, the impact of applying the EU ETS to flights to and from OMRs is similar to that of applying the EU ETS to extra-EEA flights, i.e., around €2.20 per one way flight or 1.2% of ticket price, for nominal values in 2035 (the central scenario) for uncertain variables. At the upper end of the uncertainty range impacts could be up to 4.8% of ticket price (€9 per one way flight) – see Table 6.15. This impact became smaller due to the COVID-19 crisis. If looking at the impact of the high carbon cost scenario alone, with other uncertain variable at nominal values, a high carbon cost leads to a difference of €4.68 per one way flight or 2.6% of the ticket price when applying the EU ETS to flights to and from OMRs.

C1BASE: this would continue the current situation (flights within a given outermost region included in the EU ETS, flights to and from outermost regions to both EEA and non-EEA destinations excluded). There would also be no change of status for UK-Canary Islands or Switzerland-Canary Islands flights.

C2CONLY: Flights between outermost regions and international destinations participating in CORSIA would be included (at CORSIA-appropriate carbon prices), but domestic flights, including flights within a given outermost region, would be excluded. The majority of flights to and from outermost regions other than Madeira and the Canary Islands are domestic. Because CORSIA carbon prices are projected to be low, and only apply to emissions above the CORSIA baseline, this option is likely to have only limited impacts. As far as EU outermost regions in the Caribbean are concerned, few Central and South American nations are likely to be CORSIA participants, so short and medium-haul flights for EU outermost regions in this region are unlikely to be covered.

[109] On public service obligations see Interpretative guidelines on Regulation (EC) No 1008/2008 of the European Parliament and of the Council; https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52017XC0617%2801%29

C3CLEAN: This option would be broadly similar to option C1BASE, but non-EEA non-domestic flights to and from outermost regions would be covered under CORSIA. Thus e.g. flights from the UK to the Canary Islands would have a small extra carbon cost.

C4MIX: This option would have a similar impact to option C3CLEAN (i.e. non-EEA non-domestic flights to and from outermost regions would be covered under CORSIA) .

Table 6.15. Projected carbon costs and numbers of flights on routes to and from outermost regions, 2030.

Policy option	Projected carbon costs as a percentage of total segment operating cost on routes to/from/within outermost regions in 2030		Projected number of flights to/from/within outermost regions, thousand in 2030	
		Compared to baseline	2030	Compared to baseline
C0WIDE	1.74	1.67	422	-4
C1BASE	0.07	-	426	-
C2CONLY	0.003	-0,067	427	1
C3CLEAN	0.07	0	426	0
C4MIX	0.07	0	426	0

Table 6.16. Average one-way fare for routes to/from/within EU outermost regions by policy option, 2015 and 2030 for all uncertain variables set to nominal values

Policy option	Avg. one-way fare, to/from/within OMRs, €2018		
	2015	2030	2030 Compared to baseline
C0WIDE	161.11	175.94	1.51
C1BASE	161.11	174.43	-
C2CONLY	161.11	174.27	-0.16
C3CLEAN	161.11	174.43	0
C4MIX	161.11	174.43	0

6.4.2. Auctioning share increase options

Changes in auctioning are also likely to have impacts on the outermost regions. This mainly affects option C0WIDE, because flights to and from outermost regions are

exempted in options C1BASE-C4MIX (though there is still a small impact via the coverage of flights within each outermost region).

Applying immediate full auctioning under option C0WIDE implies that ticket prices will increase by around 2% as cost pass through is expected (as for air passenger duties, which are often higher in comparison). Costs would normally be passed on, as the initial average pass-through rates on routes to and from EU outermost regions are estimated at 74-77%. If there were zero cost pass through, there would be an increase in operating costs per RPK for flights operating to/from or within OMRs in 2024 of around 4%. Depending on the operating margins of airlines running flights to and from the outermost regions, there may be a reduction of profits on these routes, noting that some are supported by other means (e.g. PSOs). However, most routes to/from OMRs and the continent are not supported by PSO as most PSO schemes apply to flights within one given outermost region (e.g. from one island of Azores to another island of Azores).

The other auctioning options, in combination with C0WIDE, take effect more gradually, but have similar impact by 2030. Impacts on passengers are likely to be limited, with cost increases for option C0WIDE and full auctioning of around €3 per one-way flight and demand reductions of 2-3% compared to scenarios where flights to and from outermost regions are exempted.

As a summary, the impact on outermost regions of the changes in auctioning are minimal for all options except C0WIDE, where these may be significant.

6.4.3. Conclusions

The impact on outermost regions of changing ETS eligibility is likely to consist of changes to air fares and flight frequency. Longer-term impacts might include decreases in the number of carriers operating on non-PSO routes if carbon costs substantially affect the operating margin on outermost region-associated routes. Changing flight costs and frequency may also affect the attractiveness of the outermost regions as tourist destinations.

Reducing flights by tourists would have an impact on local economies. Reducing flights by residents would affect residents' access to employment, education and other opportunities. This in turn may act to limit the economic development of these regions.

Changing flight costs and frequency may also affect air freight to the outermost regions. However, impacts on overall freight volume are likely to be limited, as the outermost regions depend primarily on shipping for the transport of goods.

Because of their remote locations, flights to and from outermost regions are typically long-haul flights for which fuel is a relatively high percentage of total costs. Airline cost and ticket price impacts for applying carbon prices on these flights are similar to those

for applying carbon prices on extra-EEA flights, and typically exceed impacts for intra-EEA flights.

The cost pass-through for these routes is estimated to be around 74-77%, which is similar to the level of pass-through on extra-EEA routes. Outermost regions typically have limited connectivity, meaning that a high percentage of destinations may only be reachable from outermost regions via a multi-segment journey. This means that also policy options, which exclude direct flights to and from OMRs, will have an impact on average ticket price to and from outermost regions. However, it is to be noted that price increase would be smaller than many air passenger duties which are applied. One means to help palliate the impact of lifting the exemption for OMRs would be that OMRs benefit from the revenues resulting from auctions, which was the case already in the past.

Overall, however, in spite of the considerations made in this section, impacts on fares show that the levels of change in ticket price are small compared to variations arising from changes in other variables, most notably fluctuations in fuel price.

6.5. Cross-cutting issues

6.5.1. Small emitters

As also stated in the impact assessment of 2017[110], the Commission published in 2014 a study by PWC et al.[111] that investigated the costs and benefits of the inclusion of small emitters in the EU ETS. It revealed amongst other things that the obligations with regard to MRV generate relatively higher administrative costs for small than large operators. Compared to the level of EU ETS revenues raised from a small emitter, the administrative cost can be up to 4 times higher. This study also showed that small emitters represent 90% of aircraft operators while contributing to 2.2% of emissions.

Regulation (EU) No 421/2014 introduced a number of simplifications for small emitters. Regulation 2017/2392 further simplified the MRV requirements for operators emitting less than 3 000 tonnes of CO_2 per year under the current geographic scope (intra-EEA) of the EU ETS, allowing the use of the small emitters tool underpinned by Eurocontrol and exempt them from verification. If aircraft operators meet the EU ETS thresholds for the use of Small Emitters Tool (SET) (<3 000 tonnes CO_2 full scope; <25 000 tonnes CO_2 reduced scope; for data gaps), then they can also use SET for their CORSIA related data.

Implementing Regulation 2018/2066 defines 'small emitters' as aircraft operators operating fewer than 243 flights per period for three consecutive four-month periods and aircraft operators operating flights with a total annual emission's lower than 25 000

[110] SWD(2017)31.
[111] https://ec.europa.eu/clima/sites/clima/files/transport/aviation/docs/report_ets_avaiation_small_en.pdf

tonnes CO_2. In this situation the aircraft operator is allowed to estimate the fuel consumption using tools implemented by Eurocontrol or another relevant organisation once their use is approved by the Commission. Delegated Regulation 2019/1603 requires commercial aircraft operators to report their CORSIA emissions even if they operate fewer than 243 flights departing in or arriving in an aerodrome situated in the territory of a Member State.

In addition, Regulation (EU) No 421/2014 introduced in Annex I (k) of the EU ETS Directive a *de-minimis* threshold to remove any obligations for small, non-commercial aircraft operators operating flights with total annual emissions lower than 1 000 tonnes per year. This exemption was extended until the end of 2030 by Regulation (EU) 2017/2392.

Business aviation belongs typically to small emitters. Any policy choice that re-introduces parts or all of them into the scope of the EU ETS would increase the administrative costs of these emitters, on top of the compliance costs.

6.5.2. Legal considerations and relationship with third countries, ICAO and UNFCCC

The legal considerations contained in Chapter 5.5.2 of the 2017 Impact Assessment are still valid and not repeated here.

Option C0WIDE: This option would avoid an overlap between the EU ETS and CORSIA, as their scopes of application would be distinct. Airlines, whether European or non-European, would be required to apply the same mechanism on the same routes, which avoids any distortion of competition. This option would amount to the EU's non-participation in CORSIA, which would differ from Council's notification to the ICAO Secretariat (while noting that the EU has reserved its full policy autonomy by filing differences to the CORSIA SARPs: they limit the scope of CORSIA application to be in accordance with whatever amendments are made to the EU ETS Directive).

Option C1BASE: This option would avoid an overlap between the implementation of the EU ETS and CORSIA as their scopes of application would be distinct. Airlines, whether European or non-European, would be required to apply the same mechanism on the same routes, which avoids any distortion of competition. In this option, however, flights to and from the EEA are not covered, either by the EU ETS, or by CORSIA. This option would amount to the EU's non-participation in CORSIA, which would differ from Council's notification to the ICAO Secretariat.

Option C2CONLY: Without considering domestic flights, this option would avoid the overlap in relation to implementation for intra EEA flights, as these flights would be covered only by CORSIA. However, domestic flights within the EEA would no longer be covered, leaving over 20% of the currently covered aviation emissions without any compliance obligation, which is a regression compared to the current situation.

Option C3CLEAN: This option would avoid an overlap between the implementation of the EU ETS and CORSIA as their scopes of application would be distinct. Compared to option C1BASE, all flights would be covered by one of the two mechanisms. Airlines, whether European or non-European, would be required to apply the same mechanism when operating the same flights, which would avoid any distortion of competition on routes.

Option C4MIX: This option would avoid overlap between the implementation of the EU ETS and CORSIA, as their scopes of application would be distinct. Airlines, whether European or non-European, would be required to apply the same mechanism when operating the same flights, which would avoid distortion of competition.

All flights departing from the EU are covered by the EU's updated nationally determined contribution (NDC) under the Paris Agreement (on the basis of fuels sold in the EU). The European aviation industry also supports action to achieve net zero CO_2 emissions by 2050 in relation to all flights within and departing from the EU[112]. Furthermore, the NDC states that "*emissions from aviation are currently addressed by EU legislation and will be partially addressed by international measures under ICAO*". Therefore, option C2CONLY that abolishes the EU ETS coverage of aviation emissions and render CORSIA exclusive would contradict the updated NDC, as well as option C0WIDE, by excluding CORSIA implementation. Options that reduce the EU ETS current scope would run against the objectives laid down in the NDC.

6.5.3. Fuels

ICAO developed a framework to reduce offsetting requirements under CORSIA through the use of eligible aviation fuels that are subject to compliance with sustainability criteria. Based on the sustainability criteria, CORSIA Eligible Fuels (CEF) include Sustainable Aviation Fuels (SAF, a renewable or waste-derived aviation fuel) and in principle but not yet, Lower Carbon Aviation Fuels (LCAF, a fossil-based aviation fuel). As of January 2021, no LCAF have been identified as eligible fuels, only SAFs.

As all options maintain the zero emission factor approach for sustainable fuels in the EU ETS, there is no difference between the options in this regard. The question of how sustainable fuels are treated will be assessed in the frame of the general ETS review. The EU ETS provides for an incentive for the use of SAF of over 100 EUR per tonne fuel.

Options that increase the auction part of the allocation can potentially contribute to a higher degree to the better uptake of SAF by using the auction revenue for reducing the price gap from conventional fuels or by contributing to relevant innovation projects.

[112] https://www.destination2050.eu/commitments/

The revision of the Energy Taxation Directive would aim at incentives through the taxation of fuels. The taxation of traditional fossil fuels used in aviation would complement the review of the ETS for aviation. Taken together, these initiatives would reinforce the carbon price signal and the economic attractiveness of mitigation measures such as the implementation of energy efficiency measures or the switch to SAF. Both measures can be modelled in a similar way, as a carbon price or a fuel tax. It is worth noting, however, that the carbon price signal resulting from the options considered for application of ETS and CORSIA to aviation emissions are expected to be lower than the impact of the proposed taxes in aviation. The ReFuelEU Aviation initiative would aim at boosting the production and the demand of SAF. More specifically, the ReFuelEU Aviation initiative would likely oblige fuel suppliers to supply a minimum share of SAF and it would likely to impose on airlines a minimum share of SAF use. The revision of the Renewable Energy Directive also has the objective to further support the use of SAFs. All initiatives would have an interplay with this revision of the EU ETS as regards the uptake of SAF.

7. HOW DO THE OPTIONS COMPARE?

7.1. Effectiveness

7.1.1. Environmental effectiveness

The options have different coverage of emissions by CORSIA, the EU ETS or a combination of the two. Both CORSIA and the EU ETS are market-based measures to address CO2 emissions. However, there are important differences between them[113], which have been studied extensively in advance of preparing this Impact Assessment and were already looked at in the previous Impact Assessment (2016).

The environmental difference is twofold: ambition (reduction *versus* stabilisation) and units used (aviation, power or industrial EU sector vs international credits).

The EU ETS is a cap and trade system setting a limit on the total GHG emissions of the participating sectors so as to reduce them in absolute terms within the EU. CORSIA is a carbon-offsetting scheme, which allows emissions from the aviation sector to grow above the baseline (2019 emissions), and foresees offsetting with credits from reductions in other sectors worldwide (international offsetting).

Through the EU ETS, aviation has contributed to an average reduction of 25 Mt per year over the past 8 years mainly due to reductions in the EU power sector. While the in-sector aviation emissions for intra-EEA flights kept growing, from 53.5 million tonnes

[113] On the differences see heading 1.3.

CO_2 in 2013 to 69 million in 2019, the flexibility of the EU ETS, whereby aircraft operators may use any allowances to cover their emissions, meant that the CO_2 impacts is reduced at a rate of 2.2% per year.

However, the third difference from a global environmental perspective is its scale: while the EU ETS allows EU goals to be met, as CORSIA is going to be implemented by 88 countries, the impact at global level has the potential to move towards stabilizing the aviation emissions from international participants to a much larger degree than a regional approach.

CORSIA relies on international offsets. The quality of international offsets is harder to control and raises concerns over additionality, permanence, net harm and the applicable accounting rules to avoid double counting.

Quantitative analysis

First, there is very little difference in direct CO_2 emissions, i.e. emissions from aircraft without considering any reductions either by ETS allowances or by CORSIA offsetting, across the different options in 2030. The carbon costs for the different options are insufficient to drive significant reductions within the aviation sector:

- Full EU ETS scope (C0WIDE) leads to lower direct CO_2 emissions than all other options for global, extra and intra-EEA flights.
- Applying CORSIA to international flights (C2CONLY) leads to the highest direct CO_2 emissions in all cases.

This is due to the collective effect of CORSIA explained in Chapter 6 introduction.

Looking at net emissions (emissions after reductions in other ETS sectors or from use of CORSIA offsets), the picture is more complex. The reductions below will not include reductions from SAF as they are considered therefore come from use of ETS allowances and use of CORSIA offsets.

For global net emissions in 2030:

- Return to full-scope (C0WIDE) leads to the lowest net global emissions. These are projected to even be 74 Mt or 7.5% below the baseline C1BASE, which does not cover extra-EEA flights.
- Option C2CONLY, CORSIA only, leads to the highest net global emissions, at 55Mt or 5.5% above the baseline.
- After C1BASE, the next best options in terms of net global emissions are Option C3CLEAN, clean cut, with emissions 1.1% above baseline and Option C4MIX with emissions 3% above the baseline.

Global net emissions are lowest under C0WIDE, followed by C1BASE (see Table 6.1). Note that in both cases CORSIA offset use is at its highest at 61 Mt in 2030. C0WIDE, like C1BASE, leads to a higher use of CORSIA offsets in 2030 for routes not related to the EU, because the absence of extra-EEA and intra-EEA emissions from CORSIA (unlike in other options) leads to a lower CORSIA baseline and greater offsetting requirements for other routes within CORSIA. C1BASE has no coverage of extra-EEA emissions, but these are covered under C0WIDE, as reflected in the higher use of EU ETS allowances by the aviation sector to cover emissions, further amplifying the reduction in net global emissions.

For extra-EEA net emissions:

- C1BASE is the baseline that holds
- the highest net extra-EEA emissions at 170 Mt in 2030
- C3CLEAN is 9.4% below baseline levels
- C2CONLY and C4MIX are 5.3% below the baseline
- C0WIDE leads to the lowest net extra-EEA emissions as it includes full ETS (reduction not stabilisation) and it applies to all routes independently of whether the country of the airline has implemented CORSIA or not. In this case, emissions would be 45% lower than the baseline C1BASE.

For intra-EEA net emissions:

- Option C4MIX is projected to lead to the lowest net intra-EEA emissions, at 23.9 Mt in 2030, 1.1% below the baseline, C1BASE with emissions of 27Mt.
- C3CLEAN (clean cut) also leads to net intra-EEA emissions of 27Mt equal to the baseline C1BASE.
- Option C2CONLY leads to the highest net intra-EEA emissions, 82% above the baseline.

Some of the outcomes, especially for net intra-EEA emissions, may seem counter-intuitive, in that they are not in line with the impact expected of the relative carbon costs under the EU ETS and CORSIA. This is due to the different approach to covering emissions under ETS and CORSIA, in particular:

1) The EU ETS requires EU allowances to be surrendered to cover all emissions from flights covered, whereas under CORSIA, growth in emissions above the baseline (now 2019 for a limited period) should be offset.

2) The EU ETS regulates the actual emissions of CO_2 from flights covered, so that each extra tonne of emissions leads to use of one extra EU allowances whereas the number of offset credits to be used under CORSIA is not equal to the emissions from EU-related CORSIA routes. It is based on a share of the total

emissions above 2019 levels from all flights covered by CORSIA across the World. The EU's contribution changes as participation in CORSIA changes (as explained in more detail in text box 7.1 below). The EU share of offsets surrendered under CORSIA grows not just as more routes and emissions are covered, but also at a rate which changes depending on whether EU routes grow slower or faster than other routes under CORSIA.

Under collective offsetting, airlines in slow-growing regions, such as Europe, have higher CORSIA offset requirements than would be expected based on their own growth, and airlines in fast-growing regions have lower requirements. This distribution of effort provides an incentive for faster growing regions to implement CORSIA. But, along with use of a baseline, it also leads to some counter-intuitive outcomes. For example:

- Option C1BASE, where there is no implementation of CORSIA, leads to lower extra-EEA emissions than Option C3CLEAN where CORSIA is applied to flights to and from the EU. Including slow-growing flights to and from the EU, as in options C3CLEAN and C4MIX makes the CORSIA baseline higher, as the number of flights and emissions covered is increased, but growth above the baseline relatively smaller. The net result is that more CO_2 is offset in CORSIA under C1BASE, where extra-EEA flights are excluded from CORSIA and not the EU ETS, than under C3CLEAN when they are covered by CORSIA.

- Option C4MIX leads to a larger drop in intra-EEA net emissions than option C3CLEAN, even though under C3CLEAN all emissions are under the higher carbon price ETS and C4MIX has part of these emissions covered by CORSIA, with lower carbon costs. Intra-EEA flights are growing slowly compared to flights on other routes outside the EEA. Under CORSIA, airlines operating flights on these slower growing intra-EEA routes, should surrender offsets to cover not only the growth in their emissions, but also a share of the emissions growth on other faster growing flights covered by CORSIA. However, looking at the impact on extra-EEA emissions and global emissions, option C4MIX leads to significantly higher emissions than C3CLEAN, as airlines on faster-growing routes offset less than if they were had to cover each tonne of their emissions above 2019 levels themselves[114].

Given the complex effects of the sector-wide provisions of CORSIA, described above, it is important to look at the whole picture of net emissions – looking both within the Europe and at global level.

[114] . Comparing COWIDE and C2CONLY provides an indication of the difference in impact of CORSIA and EU ETS for net extra-EEA emissions. Emissions from flights to and from the EEA, covered by the EU ETS under C0WIDE, are 94 Mt in 2030 (see Table 61), whereas they are 161 Mt under C2CONLY where these are covered under CORSIA. That means use of the EU ETS to cover extra-EEA emissions results in a saving of 67 Mt for the climate in the year 2030.

The higher emissions under CORSIA options when compared to options with greater EU ETS coverage can be explained also by the fact that CORSIA is designed to stabilise emissions at 2019 levels, whereas the EU ETS is designed to reduce emissions in line with the EU's 2030 target.

Text Box 7.1 How the CORSIA sector-wide requirements work:

Until 2030, stabilisation of emissions at 2019 levels applies to emissions of the sector as a whole, or the total emissions from the sector that are covered by CORSIA, not stabilisation of emissions for an individual route, airline or state.

Until 2030, the baseline and the offsetting required for each operator under CORSIA is based on the emissions in 2019 (the baseline year) and growth in emissions above these 2019 levels for all routes included in CORSIA.

This is a dynamic system. Addition or removal of routes from the scope of CORSIA changes both:

The baseline: the sector-wide baseline is re-calculated when there is a change of routes included in CORSIA – if a State decides to participate or to withdraw. The baseline is also different for the options considered in the Impact Assessment where these have differences in the routes covered by CORSIA.

The level of emissions above the baseline to be offset by all operators covered by CORSIA.

In addition as the relative growth rate of routes included in CORSIA changes, so does the share of the total growth that each operator need to offset to stabilise emissions at 2019 levels. The amount of offsetting required for each airline or state depends not just on the growth in emissions on its own CORSIA-covered routes, but also on the growth in emissions of all the routes covered under CORSIA and whether its emissions grow faster or slower than others.

The formula for estimating each airline's offsetting requirements for routes under CORSIA:

Offset requirements for airline	=	own emissions for the year y	x	growth factor for all CORSIA emissions (Sector emissions in year y- Sector emissions in 2019) / Sector emissions in year y)

Under this formula, operators and countries with relatively low growth in emissions will cover a larger share of the total growth in emissions above the baseline than those with high growth in emissions.

This can be illustrated with an example taken from an ICAO training presentation on CORSIA, part of which is reproduced in the table below. It shows a very simplified case where two airlines – one with fast growth and one with slow growth in emissions- make up all CORSIA emissions. Here we show the case for 2021-2029, when CORSIA is 100% sectoral. (Note that for 2030-2032 he requirement shifts to 20% individual and 80% sectoral, and from 2033-2035 to 70% individual and 30% sectoral).

The offsetting requirements in year y in the table below are calculated using the formula above, so for the fast growing airline, offsetting in year y is given by:

125 x (230-200) / 230= 16

Table: simplified case illustrating calculation of offsetting requirements for operators and different routes

	CO_2 emissions Mt		Growth Factor for year y	Offsetting requirements in year y
	Baseline 2019	Year y		
Operator A – Fast Growth	100	125	20%	16
Operator B- Slow Growth	100	105	4.8%	14
Total emissions under CORSIA/ sector wide	200	230	13%	30

This simple example shows the impact of including routes, which grow more slowly than others, as is the case for both intra-EEA routes and extra-EEA routes when compared to routes elsewhere covered by CORSIA. A decision of other large, emerging economies with a faster growing sector in CORSIA (such as China or India) would under this system lead to EEA related routes under CORSIA offsetting a larger share of emissions.

Note that these results assume an initial implementation and participation in CORSIA by the 88 states (including the US) listed on the ICAO website in December 2020, but not China, Russia, India, Brazil. The results in Tables 6.2 and 6.3 in chapter 6 show the high sensitivity of the results to assumptions about participation. As domestic implementation by third countries is necessary and participation in CORSIA can be discontinued, this issue needs to be kept under review on an ongoing basis.

The figures presented assume full implementation and enforcement by the countries participating in CORSIA. Option C0WIDE assumes that third countries implement CORSIA, even when the EU does not; C0WIDE risks lower participation in CORSIA than presented, with global emissions somewhat higher than projected.

In terms of the 2030 target, C3CLEAN and C1BASE are the options that lead to greatest reduction in intra-EEA emissions through reductions in the EU and without use of international offsets. They are the policy options that lead to the greatest domestic contribution to meeting the net domestic reduction of at least 55% in greenhouse gas emissions by 2030.

From the quantitative analysis of the options, C0WIDE and C1BASE both lead to the lowest projected net global emissions. These are the options where ETS coverage is widest. Option C3CLEAN promotes broader implementation and continued participation in CORSIA and is the next best option in terms of net global greenhouse gas emissions. In terms of giving CORSIA support and incentives to actually deliver while still

contributing to the global goals of the Paris Agreement, C3CLEAN is the preferred option.

Price signal

It is also important to look beyond the quantitative analysis to qualitative attributes that have an impact on different policy options' environmental effectiveness. In doing so, it is important to look both at transition by the aviation sector and the impact of the options on other sectors and the economy wide transition to be achieved by Europe and all other countries affected by the options assessed.

The analysis shows that none of the policy options will significantly alter direct aviation emissions by 2030. However, scenarios diverge when reductions acquired through offsets or allowances are taken into account. The projected carbon costs remain relatively low compared to the cost of measures to reduce emissions within the aviation sector. The CORSIA offsets' cheaper price levels mean lower carbon price for the aviation industry, whereas under EU ETS, the aviation sector is subject to the same carbon price as other ETS sectors and contributes to EU's climate targets alongside other sectors. The EU ETS price signal is 6 to 31 times higher, depending on the scenario, than any price signal that airlines would pay under CORSIA. The policy options where EU ETS coverage is wider provide a stronger price signal for airlines.

To complement the EU ETS price signal, EU ETS auctioning revenues can be used to support transition towards climate neutrality. Under the EU ETS, Member States report that from 2012 until 2020, over €45 billion of ETS auction revenue has been used to tackle climate change[115], and additional support is available under the existing ETS Innovation Fund that is expected to deploy upwards of €12 billion in the period 2021-2030. Only options where ETS is retained yield auctioning revenues, with highest revenues coming from options where ETS coverage is widest and auctioning share is highest.

CORSIA's support for the climate transition would come from the impacts in the host countries from which airlines purchase carbon credits.

Participation and implementation of CORSIA

Wide participation in CORSIA is a key element of its global effectiveness. The aviation sector's net emissions are reduced most when State implementation and continued participation in CORSIA is highest.

[115] See the Reports on the functioning of the European carbon market, issued each year by the Commission.

The quantitative results presented in this impact assessment are based on the 'initial assumed implementation' of CORSIA, which includes the 88 states listed on the ICAO website in December 2020. These include the US, but exclude major economies such as Brazil, China, India, and Russia.

Table 6.3 in Chapter 6 shows how offset demand under CORSIA changes under high and low participation, giving an indication of the importance of engaging other major economies for making CORSIA a success.

However, if we were to look at CORSIA Phase 2, that is the time when CORSIA foresees full implementation, including China and other major economies (high implementation)[116], we would see increasing offset demand over the period by 72% to 109 % depending on the option, compared to the results presented in this Impact Assessment. For C3CLEAN, the amount of emissions offset rises to 902 Mt CO2, or about 100Mt per year over the 9 years of CORSIA Phase 2. For C4MIX the amount of CO2 offset rises to 781 Mt CO2 over the 9 years under high participation or 87Mt CO2 per year. In other words, the total level of offsetting under the highest level of CORSIA implementation is equivalent, in annual terms, to the current GHG emissions of Greece or around 7% of the emissions of Brazil. It is important to note though, that these offsets would result in the same level of emissions reductions only if there is no double counting and the offsets are additional.

Unit quality

The emission projections, especially for global and extra-EEA flights, are very sensitive to assumptions about CORSIA offset quality. The modelling looked at only one aspect of offset quality: additionality. An emission reduction project or programme is deemed additional if it would not have taken place in the absence of a market for offset credits. The results of the assessment in Table 6.4 show that net global emissions are 32 to 61 Mt CO_2 higher across the options in 2030 if CORSIA offsets are not additional at all. Additionality also affects the ranking of options if looking at intra-EEA emissions. Under the assumption of 0% additionality, options C2CONLY and C4MIX see an increase in net emissions, so that option C3CLEAN, clean cut, performs better than C4MIX, mix, in terms of emissions reductions.

Looking only at the impact of 'no additionality' may underestimate the full impacts of other determinants of offset quality.

[116] Defined as participation throughout the period 2021-2035 of the 81 States listed by ICAO on its website in July 2019, plus participation from 2027 of the currently five additional States - China, Russia, India, Brazil and Vietnam.

As described in Annex 10, ICAO established the CORSIA Emissions Unit Eligibility Criteria (EUC), as well as a Technical Advisory Body (TAB) to provide the ICAO Council with recommendations on units that should be 'eligible', based on assessment of programmes applying for eligibility under CORSIA. The TAB's assessment is at programme level rather than on individual project or unit level. In its assessments so far, the TAB has found that while most programmes meet most of the criteria, only one of the programmes meets all the criteria. Programmes also approach some of the critical issues such as safeguards, additionality, baselines, sustainability, MRV, permanence, leakage and no net harm differently. There are no powers under ICAO's founding instrument for offset standards to be enforced[117]. It should be noted that CORSIA eligible credits include removals, i.e. credits that are based on carbon sequestration rather than reducing emissions. These credits are subject to specific quality risks such as permanence and leakage.

Accounting

Environmental integrity under the Paris Agreement requires going beyond the traditional concept of additionality to ensure that there are measures in place to avoid double counting and to ensure that the market-based mechanisms generating the credits are in line with host parties' NDCs and long-term strategies.

CORSIA does not have provisions to ensure that offsets used come from Parties that are implementing the Paris Agreement and have taken into account the impact of issuing these offsets on their ability to meet their NDC.

None of the CORSIA eligible programmes have comprehensive provisions which guarantee avoidance of double counting with pre-2020 commitments[118]. The risk of double-counting extends to post-2020 commitments as well. As regards accounting for Parties' nationally determined contributions under the Paris Agreement, CORSIA requires offset credit programmes to ensure that double counting is avoided. While one of the eligible programmes fulfils this condition, Parties to the Paris Agreement have not concluded on accounting rules for the use of CORSIA offsets. This means that absence of UNFCCC decision on robust accounting and adjustment may lead to emission reductions being used and counted twice, or more than twice, leading to higher than

[117] See https://ec.europa.eu/clima/sites/clima/files/transport/aviation/docs/gmbm_legal_study_en.pdf. The lack of enforceability has also been noted by countries such as China. [see https://www.icao.int/Meetings/a40/Documents/Resolutions/china_EN.pdf]

[118] Whilst the eligible projects are typically not located in countries that have adopted binding climate commitments under the Kyoto Protocol and its subsequent Doha Amendment, number of eligible projects are located in countries which made pre-2020 emission reduction pledges under the Cancun Agreements. As there are no provisions to avoid double-counting with Cancun Pledges there is a risk that emission reduction outcomes are used both by the host country towards its Cancun Pledge and an aeroplane operator towards it compliance obligation under CORSIA.

perceived global greenhouse gas emissions. The CORSIA Central Registry (CCR) alone cannot address the risk of double counting at country level, given the wide potential sources and uses for eligible offsets.

A large share of offset projects ar25e delivering emission reductions within their host country's NDC scope[119]. Use of offsets in a way that may undermine the host country's NDC or path to climate neutrality will make it more difficult for host countries to meet current and future more ambitious targets.

Due to uncertainties associated with CORSIA participation, additionality of offset credits, and with accounting, the policy options with wider ETS coverage provide more certainty of environmental effectiveness.

7.1.2. Increasing the auctioning share of aviation allowances

Aviation sector emissions are projected to be higher than the aviation cap under all scenarios. At the outset, the environmental impacts between different options for auctioning share increase do not vary as allocation method does not affect the emission cap.

Different options for increase of auctioning share may have different impacts on carbon leakage or perceived risk thereof. In general, the results of the ICF Study suggest there is a low risk of positive carbon leakage when switching to a higher auctioning percentage, and that changes in cost associated with auctioning changes are still well within the range of cost variability due to fluctuations in fuel price. While airline profits may be impacted, effects on passengers are likely to be limited. Significant impacts are also unlikely for access to mobility for outermost regions.

7.1.3. Enforceability

CORSIA is based on a resolution adopted by ICAO which is not a binding international agreement. Detailed implementing rules are adopted in the form of ICAO Standards and Recommended Practices, and these only receive binding force through their implementation in national law but the stringency with which they are implemented varies from one state to another. As the implementation of CORSIA depends on legislative action by third countries, and hence entails some uncertainty, this needs to be kept under scrutiny. Continued participation in CORSIA is also not guaranteed, as countries can withdraw from it. In comparison, the EU ETS Directive applies in a consistent manner across all EU Member States (the question of participation opt-out is irrelevant), irrespective of the nationality of the aeroplane operator and it is further enforced through effective financial penalties that also require the environment shortfall

[119] Fearnehough, Warnecke, Schneider, Broekhoff, La Hoz Theuer, Offset credit supply potential for CORSIA, October 2019.

to be made up. By contrast, ICAO has no instruments at its disposal to enforce compliance, and thus no penalties can be enforced by ICAO in case of non-compliance with CORSIA.

While most of the options avoid an overlap between CORSIA and the EU ETS (see section 6.5.2 above), thus also ensuring that enforceability remains separated between the two instruments, some of those options ensure that all flights are covered by an instrument (cf. options C3CLEAN and C4MIX). C0WIDE would present a harder enforceability to implement provided its extra-EEA ETS scope, while C2CONLY would be defined by a weaker enforceability degree, provided the low binding character of CORSIA legal instruments. C4MIX presents additional enforceability challenges related to the additional legal complexity that may arise for the implementation for aircraft operators.

Based on enforceability assessment in the ICF Study, enforceability is stronger in options where ETS scope is wider.

7.2. Efficiency

7.2.1. Impacts on operating costs, prices and demand

7.2.1.1. CORSIA implementation options

There is very little difference between the options in terms of costs. Carbon costs remain very small or negligible relative to operating costs and fuel costs for all options, for intra- and extra-EEA flights, with the highest cost impact for C0WIDE (full scope ETS), which is projected to have carbon costs of 1% and 1.8% of operating costs for intra and extra-EEA flights, respectively.

As a result, the impact of the different options on fares paid by customers is small and varies by less than €1 for intra-EEA flights between C0WIDE the highest cost and other options in 2030 and less than €2 for extra-EEA flights. Even at the upper-most end of the uncertainty range, Option C0WIDE is at most €7 higher for one way for extra-EEA fares in 2030, around 2.6% of the total average fare.

With such small increases in price for customers, the assessment also predicts small changes in demand across all options for both passenger travel and freight, measured in Revenue Passenger Kilometres and Revenue Tonne Kilometres (RTK).

For Revenue Passenger Kilometre, all options have the same level of demand apart from C0WIDE which leads to the lowest demand, but with RPK just 1% below other options for extra-EEA flights.

For freight demand, the situation is very similar, with the same level of demand apart from C0WIDE, with RTK just 2% lower than other options.

The ICF Study also looked at sensitivity to carbon prices where these follow the higher prices from the uncertainty range analysis. The impact of using the higher price has little impact on demand. For example, the difference between option C0WIDE and option C2CONLY, the options with the highest and lowest impact on demand, is only 2.5% for intra-EEA freight demand (in RTK) and 3.7% for extra-EEA RTK in 2030.

7.2.1.2. Auctioning share increase options

By far the largest carbon cost for airlines is incurred in policy option C0WIDE, which includes flights to and from EEA within the EU ETS scope. In the case of extra-EEA flights with immediate full auctioning combined with option C0WIDE, carbon costs in 2024 add around 3.6% to total operating cost per RPK compared to a situation where no carbon price is applied to these routes, and about 3.5% by 2035. This is still well below the impact of recent fluctuations in oil price, which can change total operating cost by 10 or more percent.

7.2.2. Level playing field

7.2.2.1. CORSIA implementation options

Competitive distortions would arise when policies do not apply equally across routes, or where they are not enforced equally. EU ETS options avoid any distortion of competition on routes, as has been demonstrated over the past 8 years. The CORSIA options require widespread implementation and continued enforcement by participating States if they are to apply uniformly to all airlines and not create direct distortions. The EU obviously cannot enforce CORSIA on routes operated by non-EEA carriers not involving airports in the EEA, and so States should be incentivised to apply CORSIA in a meaningful manner. The carbon costs of the options covered are unlikely to lead to significant competition distortion between airports as passenger hubs or freight hubs.

As Europe and other countries and regions transition to climate neutrality, C0WIDE, followed by C1BASE and C3CLEAN, with the highest coverage of flights by the EU ETS, have the greatest potential to support the deployment of new, low carbon solutions. This will reduce the costs of transition and boost the competitiveness of European airlines as carbon budgets or amount of greenhouse gas that can be emitted whilst meeting the goals of the Paris Agreement gradually decline to zero.

For CORSIA implementation options, opinions differed between and within stakeholder groups. For business associations, the most preferable options were CORSIA ONLY and MIX option with 33% of responses for each option. The least preferable options were

ETS full legal scope and MIX BIS with 33% of responses for each option. For public authorities, 30% found CORSIA ONLY the most preferable option, and 40% found CORSIA ONLY the least preferable option. For NGOs, EU ETS full legal scope was the most preferable option with 89% of responses, and CORSIA only the least preferable option with 44% of responses.

Some stakeholders from business associations including the aviation industry make arguments for the importance of a harmonised coexistence of EU ETS and CORSIA, focusing especially on the level playing field between EEA and non-EEA airlines and the need to avoid more exemptions for the aviation sector. These stakeholders, with similar views presented in position papers, believe the aviation rules review should prevent and remove market distortion between EEA and third country carriers; prevent double regulation of emissions; ensure long-term regulatory stability by preventing international opposition; minimize deviation from CORSIA or the EU ETS principles; limit the increase in administrative burden; and limit the increase in cost (especially regarding the impact of COVID-19).

7.2.2.2. Auctioning share increase options

The option that maintains a share of free allocation for airlines, option A4RED, would partially maintain the current methodology of free allocation. The current methodology of free allocation is based on historical emissions and has the potential to create competitive distortion between incumbent and newcomer airlines. Option A1FULL removes the competitive distortion as all airlines are treated the same. The other options would lead to same result as A1FULL, but over a longer period of time.

Stakeholders' views were divided on the question of auctioning share increase. Immediate full auctioning was the most preferred option in 28 responses, and *status quo* was the most preferred option in 18 responses out of 79. At the same time, immediate full auctioning was the least preferred option in 33 responses and *status quo* was the least preferred option in 25 responses out of 87.

Most of the respondents supporting immediate full auctioning are EU citizens and NGOs. Respondents choosing *status quo* were dominantly aviation industry respondents i.e. beneficiaries of free allocation.

Several stakeholders make the argument that the inclusion of free allocation was originally included in the original EU ETS on aviation to protect against the risk of carbon leakage, but that there is no risk of carbon leakage with the today's level playing field and high compliance with the EU ETS rules, especially for intra-EU flights.

The business sector argued that following the current decline in the aviation sector, a reduction of free allowances would severely limit the sector's ability to recover. The business sector also argued to retain free allocation for the part of the emissions subject to market distortion, especially referring to the feeder flights into intra-EEA hubs. One

public authority remarked that a combination of 'status quo' and 'phase out' could be combined, where status quo is maintained for a few years to provide stability and time for recovery before the phase out process is launched.

7.2.3. Auction revenues

Option A1FULL combined with option C0WIDE yields the largest revenues from auctioning aviation allowances and the auctioning of general allowances additionally demanded by the aviation sector. For other policy option combinations, auctioning revenues are dependent on the timeline of increased auctioning share and on the extent of the ETS coverage. Option C2CONLY removes all aviation auctioning revenues from Member States' budgets or from EU own resources.

7.2.4. Social impacts

The modelling suggests that, among the policy options explored, and when taking into account the effect of revenue recycling, the option of extending the EU ETS to cover all flights (Option C0WIDE) would have the greatest positive impact on EU27 employment and GVA. The full-scope CORSIA scheme (Option C2CONLY) is associated with the weakest, albeit still positive, macroeconomic outcomes, while the other options with a mix of CORSIA and ETS scopes are expected to have broadly similar intermediate outcomes. However, the variation in expected macroeconomic effects between policy options is small. For example, aggregate EU27 employment is projected to be just over 50,000 workers higher by 2035 in Option C0WIDE than in option C2CONLY (a difference of around 0.02%).

At the EU aggregate level, employment in air transport is projected to be lowest in option C0WIDE while staying at a similar and slightly higher level for all other options. The impact on air transport GVA, however, is more in line with the whole economy impact, with option C0WIDE expected to generate the most positive outcome and option C2CONLY the least positive. The difference in impact on GVA and employment implies that where taxation and regulation result in lower demand for air transport, workers are likely to take a hit while airline operators have more options to maintain profits such as cutting back on intermediate purchases and investment.

The modelling shows that household impacts are mainly due to recycling of auctioning revenues. Policy options with higher auctioning shares, most prominently A1FULL, the option with immediate full auctioning, are more likely to yield positive impacts to low-income households in the form of lower income taxes or income transfers.

7.2.5. Administrative effort

7.2.5.1. CORSIA implementation options

Option C1BASE represents the least administrative costs (the current level). Options C0WIDE and C2CONLY are the next lowest costs as airlines are subject only to one regulation (i.e. only one MRV regime applies), followed by option C3CLEAN where either CORSIA or EU ETS applies on a specific route. Options C4MIX is likely to have the highest administrative costs due to the increased complexity of applying CORSIA and EU ETS on the same routes. Eurocontrol can effectively support the reporting and compliance process for all options, therefore this does not influence the relative ranking.

7.2.5.2. Auctioning share increase options

The bulk of the administrative burden is linked to the mere existence of free allocation, not to the level of free allocation. Therefore, the only difference in administrative effort between the options on increasing the auctioning share is whether there is free allocation or not. Accordingly, option A1FULL means the least administrative effort, while the other options maintain the current level at least for a certain transition time (A2SWIFT, A3SLOW), or perpetuate it (A0BASE, A4RED).

7.2.6. Outermost regions

The overall macroeconomic impacts of the different options, when evaluated through impacts on the aviation sector, fuel supply sectors, and through linked supply chains and associated multiplier effects, are relatively small: less than 0.05% in terms of both value added and employment in all cases at the EU27 level. The impacts are similarly small in the outermost regions, once a regionalisation method is applied to convert MS impacts: differences are always smaller than 0.1% between any of the options.

However, it is important to note that this presents only a partial analysis of the expected effects; there are changes in flight frequency and capacity as a result of different policy options, and these will affect the connectivity between regions and countries. Although modelling such effects is beyond the scope of this analysis, it is reasonable to expect that such impacts may be more substantial, in macroeconomic terms, than the changes felt through the aviation sector and associated supply changes.

7.3. Coherence

This section looks at the coherence of policy options with both EU and international policies.

EU policies

The European Green Deal calls for all sectors to contribute to the target of climate neutrality by 2050. To achieve economy-wide climate neutrality, at least a 90% reduction in EU transport emissions is needed by 2050 and aviation needs to contribute to these significant reductions. In the European Green Deal, the Commission recalled that "*the price of transport must reflect the impact it has on the environment and on health*". This must be taken into account when considering options for the implementation of CORSIA and reducing the share of free allocation of EU allowances to airlines. The Impact Assessments on Aviation Taxation and the revision of the Energy Taxation Directive are also important contributions to ensuring the price of aviation promotes this economy-wide effort.

In September 2020, the European Commission adopted the 2030 Climate Target Plan, to raise the EU's ambition from reducing greenhouse gas emissions from 40% to at least 55% below 1990 levels by 2030. In December 2020, the European Council confirmed the EU's target for 2030, endorsing a net domestic reduction of at least 55% in economy-wide emissions below 1990 levels:

'*To meet the objective of a climate-neutral EU by 2050 in line with the objectives of the Paris Agreement, the EU needs to increase its ambition for the coming decade and update its climate and energy policy framework. To that end, the European Council endorses a binding EU target of a net domestic reduction of at least 55% in greenhouse gas emissions by 2030 compared to 1990. It calls on the co-legislators to reflect this new target in the European Climate Law proposal and to adopt the latter swiftly*.'

Subsequently, the Union and its Member States submitted this revised economy-wide target for 2030 as its nationally determined contribution (NDC) to the Paris Agreement. The EU ETS facilitates the EU meeting its NDC commitment by ensuring all ETS sectors contribute in an efficient and cost-effective way. The EU ETS for other sectors is also now being reviewed to be consistent with the domestic 55% reduction for 2030 and economy-wide climate neutrality by 2050. The communication on the 2030 climate ambition requires that "in accordance with its international commitment to economy-wide action under the Paris Agreement, the EU should continue to regulate at least intra-EU aviation emissions in the EU ETS"[120]. It is also important to ensure consistency with the Climate Law, which is enshrining economy-wide climate neutrality in Union law for no later than 2050. The scope of the Climate Law covers all emissions regulated in Union law, including emissions from aviation that are the subject of this Impact Assessment.

As was already the case for the existing 40% target for 2030, a domestic reduction of at least 55% means that offset credits resulting from emissions reductions outside the EU

[120] COM(2020) 562 final.

should not be used towards this target. This argues against C4MIX, where CORSIA is used to cover intra-EEA emissions.

Given the limited impact of the various options on direct emissions from the aviation sector, it is necessary to look at the impacts of the various policy options on the complementary measures that support further emission reductions in the sector, including the transition to sustainable alternative fuels.

With respect to the decarbonisation of aviation through the uptake of SAF, the revision of the EU ETS for aviation is coherent with the ReFuelEU Aviation initiative. ReFuelEU Aviation would aim at encouraging the uptake of SAF by airlines, through actions on both the supply and demand sides. All policy options proposed for the revision of the EU ETS for aviation provide incentives for the use of SAF. In particular, all policy options will contribute to bridging the price gap between conventional and alternative fuels. The ReFuelEU assessment projects a SAF share of 4-8% in 2030. The effective fuel price to airlines will therefore be higher, but with limited impact: while the ICF study a high oil price reduces intra-EEA RPK by about 4%, the corresponding impact of ReFuelEU is likely to be only around 1%. ReFuelEU policies should also lead to a greater number of EU ETS biofuel recognitions, but emissions would nevertheless remain well above the cap. Overall this may lead to a small increase in net CO_2 emissions on EU ETS routes,[121] and decreases on any routes where the SAFs mandate applies but the EU ETS does not.

With respect to the taxation of aviation, the ongoing revision of the Energy Taxation Directive would also contribute to achieving the EU's climate policy objectives. Different policy options are being considered in relation to the air transport sector, including the introduction of intra-EU harmonized fuel tax and/or a harmonized ticket tax. These measures are likely to increase the price incentives to switch to SAF by ensuring that ticket and fuel prices reflect costs of climate impacts and other costs to the environment. All policy options are coherent with the ongoing revision of the Energy Taxation Directive.

Considering the developments in the years following the adoption of the Energy Efficiency Directive (i.e. 2013-2018), transport energy consumption rose by 33 Mtoe explaining 87% of the gap (38 Mtoe) to the EU final energy consumption target in 2020. Aviation, accounting for a growing proportion of overall EU energy consumption (over 5%), alone would explain over 27% of this gap. On aviation, world demand for air transport has more than doubled since 2000. It is worth noting that the growth in aviation energy consumption would be much higher without energy efficiency improvements. While policy and industry's efforts have shown concrete improvements over the past years (for example fuel burn per passenger has dropped by 24% from 2005 to 2017),

[121] Because SAF is fully exempt from the EU ETS, but SAF fuel lifecycle CO_2 is not zero, there is the possibility of a small increase in net CO2, though this may be balanced out by SAF use on non-ETS routes.

these benefits have been outpaced by the sustained growth in traffic.[122] As the EU increases the ambition towards 2030 and 2050 and the economy recovers from COVID-19, energy efficiency efforts will have to be increased also in the aviation sector.

International climate action

The EU is committed to promoting global climate action through multilateral cooperation. Working with third countries to support implementation of the Paris Agreement is a fundamental part of EU Climate Diplomacy under the European Green Deal. The EU's nationally determined contribution to the Paris Agreement reflects the EU's climate ambition and is the cornerstone of EU participation in international climate action. High ambition is also the driver in EU's participation in CORSIA.

Under all scenarios considered in the analysis underlying this impact assessment, emissions from international aviation rise to levels in the order of 1 billion t CO_2 by 2035 (the current end date of CORSIA). Emissions from domestic flights, which are over 40% of the global total, are not covered by CORSIA, which aims at carbon-neutral growth of international aviation only from 2019.

CORSIA's current aim, carbon-neutral growth of international aviation emissions above 2020 levels, is not ambitious enough to deliver a significant contribution from the international aviation sector towards the Paris Agreement's global goal. However, if fully implemented, CORSIA would stabilize aviation emission levels at global scale. At the same time, the risk of double counting (in particular as countries include aviation in domestic reduction targets while selling offsetting credits), and hence, undermining of NDC or Paris Agreement achievements, needs to be addressed at international level. The likely partial participation in CORSIA and inefficient enforcement further increase uncertainties related to the aviation sector's contribution to global emission reductions.

Through its participation in international market mechanisms, the EU was a large source of demand for carbon credits. In the light of the EU's experience with international credits and in line with the EU contribution to the Paris Agreement, no international credits can be used after 2020 in the EU ETS. The decisions that the EU takes about which offsets or credits could or could not be used to meet EU targets, send a strong message to other parties on the level of ambition and safeguards needed for the future development of offsets and credits for implementation of the Paris Agreement. Decisions on the use of CORSIA eligible credits for intra-EU emissions, such as in option C4MIX, need to carefully balance the benefits to multilateral action on international aviation against the risks of undermining the EU's leadership on environmental integrity for the

[122] COM/2020/326 final.

international carbon market and weakening the ambition of climate policies in countries combining domestic action with sale of credits.

The EU needs to remain consistent with its high climate ambition and support for multilateral climate action. This can be done by maintaining the necessary EU policy space to ensure credible NDC achievement while participating and implementing CORSIA and encouraging wide participation by others.

EU Member States have notified differences in their implementation of CORSIA due to the need not to invalidate existing Union law, in particular Directive 2003/87/EC[123], as well as to safeguard the roles of the EU co-legislator. Options that would equal to non-implementation of CORSIA (C0WIDE and C1BASE) would therefore not raise legal concerns, but would be politically undesirable if other countries including the US and China are implementing.

The implementation of CORSIA depends on legislative action by third countries, and hence entails some uncertainty; this needs to be kept under scrutiny. Continued participation in CORSIA is also not guaranteed, as countries can withdraw and, as noted, can make it challenging to ensure equal treatment on certain routes. It is important to note that the EU ETS has ensured equal treatment on routes and a high level of compliance based on oversight by Member States and the Court of Justice of the European Union.

Quality of offsets and their robust accounting are central to the overall environmental integrity of CORSIA. Therefore, even under option C3CLEAN it is proposed to build further on the ICAO list of eligible credits, for airlines subject to EU jurisdiction. To this end, in order to ensure that the EU's implementation of CORSIA supports the Paris Agreement goals and gives incentives for broad participation in CORSIA, the EU should only accept offsets as compliance credits under CORSIA that meet the following three conditions:

- credits are from projects in countries that are party to the Paris Agreement;
- credits are from projects in countries that participate in CORSIA; and
- double-counting of credits is avoided.

Other states should be encouraged to implement CORSIA also in this way. If this would not be the case, European airlines would potentially be put at a disadvantage. The way to avoid this would be to provide EU airlines an exemption from CORSIA compliance obligations on routes where there would not be equal conditions of competition, if there was a risk of meaningful divergence of costs.

[123] European countries notified differences, notably in order to safeguard the ability of the European Parliament and Council to decide on implementation of CORSIA as appropriate. Public documents refer to the differences notified by China, but the ICAO Secretariat has not yet published any of the differences notified to it.

In the open public consultation, stakeholders were asked to provide their opinion on whether market-based measures like the EU ETS and CORSIA should be combined with other policies. A majority of respondents (82%) agreed with the statement, most supportive groups being business associations, companies or business organisations, and EU citizens. Among other measures, stakeholders argued for governmental support in aircraft technology, operational and infrastructure development and SAF deployment. Taxation measures were however criticized for being environmentally inefficient and for tax revenues not being directed towards decarbonisation of the sector.

7.4. Conclusions

The above comparison shows that while ETS price incentives are orders of magnitude more meaningful than the price of CORSIA quality offsets, the overall environmental impact at global level across policy options is limited as the EU ETS has a limited geographical scope. This is shown in Table 7.1.

Table 7.1 Estimated net global aviation CO_2 emissions in 2030. The results are the nominal or central values. They assume 'initial assumed implementation' of CORSIA- that means implementation of CORSIA by the 88 states listed on the ICAO website in December 2020. These include the US, but exclude countries that have opposed CORSIA: Brazil, China, India, Russia, Vietnam. (Extract from Table 6.1)

Policy Options	Emissions 2030 in Mt
C0WIDE Return to full legal scope: The EU ETS applies to flights within Member States, between Member States and extra-EEA flights to and from Member States No implementation of CORSIA by the EU, but CORSIA is implemented by others under initial assumed implementation.	918
C1BASE Existing EU policy implementation: the EU ETS applies to flights within Member States and between Member States. No implementation of CORSIA by the EU, but CORSIA is implemented by others under initial assumed implementation.	992
C2CONLY EU ETS applies to flights within Member States only CORSIA covers all flights between Member States and extra-EEA flights to/from Member States, excluding those to/from countries not participating in CORSIA CORSIA is implemented by others under initial assumed implementation	1047
C3CLEAN EU ETS applies to flights inside Member States and between Member States. CORSIA applies to flights to/from Member States CORSIA is implemented by others under initial assumed implementation	1003

Policy Options	Emissions 2030 in Mt
C4MIX EU ETS applies to flights inside Member States and between Member States for emissions up to the level of the CORSIA baseline (sector-wide baseline - 2019 emissions for all CORSIA covered routes) CORSIA applies to flights to/from Member States CORSIA is implemented by others under initial assumed implementation	1022

However, there are significant differences between the options as regards the contribution to the EU's emission reduction target. There are also considerable differences in terms of revenues stemming from the different policy option combinations, as CORSIA, by design, does not generate any public revenue from airlines.

The effectiveness of the CORSIA implementation choice is not entirely in the hands of the EU regulators, option C3CLEAN is the one showing the best impacts with an active foothold in the CORSIA setup.

The comparison of the analysed options shows a strong case for moving to full auctioning from the date of entry into force of the revised legislation. While free allowances have been allocated notably to address potential adverse competitiveness impacts and carbon leakage, they constitute a derogation from the 'polluter pays' principle. The ICF Study suggests a low risk of carbon leakage when increasing the auctioning share. Switching to full auctioning implies stabilising the cap for aviation at current levels as auctioning is currently a fixed percentage of free allocations. This would maintain current levels of environmental integrity, and be subject to the linear reduction factor, as already required by the co-legislators and as is the case for all other operators in the EU ETS. The fastest possible abolition of free allocation in the EU ETS would reinforce its environmental integrity (by fully implementing the 'polluter pays' principle) and thus support maintaining its coverage for intra-EEA flights, instead of introducing CORSIA there.

The interlinkage and supportive incentives for emission reductions coming from other policy instruments that should ensure the contribution to the Climate Target Plan, like RefuelEU and the revision of the taxation of aviation fuels, should be ensured throughout the legislative process.

8. PREFERRED OPTION

When proposing its updated 2030 greenhouse gas emissions reduction target of at least 55%[124], the European Commission also described the actions across all sectors of the economy that would complement national efforts to achieve the increased ambition. A number of impact assessments have been prepared to support the envisaged revisions of key legislative instruments.

Against this background, this impact assessment has analysed the various options through which a revision of EU ETS in respect of aviation could effectively and efficiently contribute to the delivery of the updated target as part of a wider "Fit for 55" policy package.

Methodological approach

Drawing conclusions about preferred options from this analysis requires tackling two methodological issues.

First, as often the case in impact assessment analysis, ranking options may not be straightforward as it may not be possible to compare options through a single metric and no option may clearly dominate the others across relevant criteria. Ranking then requires an implicit weighting of the different criteria that can only be justifiably established at the political level. In such cases, an impact assessment should wean out as many inferior options as possible while transparently provide the information required for political decision- making.

Secondly, the package involves a high number of interlinked initiatives underpinned by individual impact assessments. Therefore, there is a need to ensure coherence between the preferred options of various impact assessments.

Policy interactions

Given the complex interdependence across policy tools and the interplay with the previous methodological issue outlined above, no simultaneous determination of a preferred policy package is thus possible. A sequential approach was therefore necessary.

First, the common economic assessment[125,126] underpinning the "Communication on Stepping up Europe's 2030 climate ambition" looked at the feasibility of achieving a higher climate target and provided insights into the efforts that individual sectors would have to make. It could not, however, discuss precise sectoral ambitions or detailed policy tools. Rather, it looked at a range of possible pathways/scenarios to explore the delivery

[124] Communication on Stepping up Europe's 2030 climate ambition - Com(2020)562.
[125] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52020SC0176
[126] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52020SC0331

of the increased climate ambition. It noted particular benefits in deploying a broad mix of policy instruments, including strengthened carbon pricing and increased regulatory policy ambition.

An update of the pathway/scenario focusing on a combination of extended use of carbon pricing and medium intensification of regulatory measures in the economy, while also reflecting the COVID-19 pandemic and the National Energy and Climate Plans, confirmed these findings.

Taking this pathway and the Communication on Stepping up Europe's 2030 climate ambition as central reference, individual impact assessments for all "Fit for 55" initiatives were then developed with a view to provide the required evidence base for the final step of detailing an effective, efficient and coherent "Fit for 55" package.

At the aggregate level, these impact assessments provide considerable reassurances about the policy indications adopted by the Commission in the Communication on Stepping up Europe's 2030 climate ambition. This concerns notably a stronger and more comprehensive role of carbon pricing, energy efficiency and renewable energy policies, land sector, and the instruments supporting sustainable mobility and transport. These would be complemented by a carbon border adjustment mechanism and phasing out of free allowances. This would allow to continue to address the risk of carbon leakage in an efficient manner. It would also preserve the full scope of the Effort Sharing Regulation for achieving the increased climate target.

Various elements of the analyses also suggest that parts of the revenues of a strengthened and extended ETS should be used to counter any undesirable distributional impacts such a package would entail (between and within Member States). While the best way to do this is still to be determined, this would seem a superior alternative to foregoing the relevant measures all together or simply disregarding the uneven nature of their distributional impacts. Under both these alternatives, the eventual success of any package proposed would be at risk.

Preferred policy options

Preliminarily assuming this fact and the analysis above as the framework for the aggregate "Fit for 55" package, the specific analysis carried out in this impact assessment comes to the main following conclusions and would suggest the following preferred policy options for the revision of the EU ETS in respect of aviation:

Since 2012, the EU ETS has been an effective and demonstrated policy instrument incentivising emission reductions in the aviation sector in Europe while also maintaining equal competition of airlines on the routes covered. Mitigation measures are solid and demonstrated under the EU ETS. Maintaining non-regression means preferring policy options that do not result in a reduced or abolished environmental ambition within the EU ETS (i.e. other than C2CONLY, C4MIX, C5MIX2).

It needs also to bear in mind that the EU wants to provide a constructive international signal and wants the CORSIA global emission scheme to succeed and deliver meaningful emission reductions. Therefore, policy options that do not apply CORSIA at all (C0WIDE, C1BASE) should not be the preferred option.

Considering these two important elements the preferred option is option C3CLEAN. This option maintains the EU ETS for the current intra-European scope and introduces CORSIA for extra-European flights to and from third countries which participate in the scheme. CORSIA Units should come from countries covered by the Paris Agreement, which implement CORSIA, and double-counting should be excluded to preserve the environmental integrity. C3CLEAN option will maintain both domestic ambition with a successful carbon scheme while providing a constructive international signal.

For increasing the auction share, the investigated aspects favour full auctioning of allowances for aviation to align the coverage of intra-European flights in the EU ETS with the "Fit for 55" ambition because of the limited risk of carbon leakage (low probability of changing/diverting route driven by climate policies) as well as the opportunity cost pass through that takes place. The rate of phase out of free allocation is subject to political decision to be taken.

9. HOW WILL ACTUAL IMPACTS BE MONITORED AND EVALUATED?

The Commission will continue to monitor and evaluate the implementation and results of the proposed initiative (C3CLEAN and A1FULL). In particular, the effectiveness of the proposed initiative in achieving the policy objectives identified in Chapter 4 will be assessed with the help of a set of indicators, as proposed in the table below.

Policy objectives	**Specific objectives**	**Operational objectives**	**Potential measuring indicators**
Objective 1: Environmental	Address aviation emissions to meet economy-wide 2030 and 2050 targets	Sufficiently reduce aviation emissions and contribute to EU (and global) efforts with reductions in other sectors.	Aviation emissions. Reductions achieved in other sectors.
Objective 2: Economic	Lead international efforts, build alliances with the like-minded, maintain competitiveness and ensure a level playing field and fairness	Achieve real cost-effective emission reductions. Encourage third countries to take meaningful action and avoid 'hub leakage' (i.e. preserve the competitiveness of EU hubs compared to non-EU hubs where carbon pricing is not applied). Preserve the competitiveness of EU tourist destinations.	Meaningful carbon price that incentivises emission reductions and efficiency improvements. Concrete international developments Equal treatment maintained on routes in practice as well as theory. Units prices multiplied by offset emissions compared to aviation operational costs. Ability to pass through carbon costs. Any change in airline behaviour (e.g. network changes and shift of hubs to countries taking less climate action).

			Evolution of the demand for certain tourist destinations. Evolution of employment in the aviation, tourism and fuel supply sectors.

The EU ETS implementation provides transparent information that allow, by large, monitoring the abovementioned objectives; for CORSIA, the ICAO Secretariat is expected to provide information on global aviation emissions.

The general policy objective of ensuring aviation's contribution to reducing the impacts of climate change and meeting corresponding climate targets (**Objective 1**) will be monitored on a yearly basis through the information provided by compliance data under the EU ETS and CORSIA.

More specifically, under the EU ETS, every year, aircraft operators report their emissions and surrender the corresponding amount of allowances. Compliance actions take place electronically through the Union Registry, which allows collecting individual and aggregated information, and Member States have an established track record of enforcement on a level-playing field basis. The Union Registry also includes data on the allocation issued under the EU ETS. The data easily allow the monitoring and evaluation of the extent to which the aviation sector is contributing to meet the EU climate targets either by reducing emissions or through the purchase of units from other sectors under the EU ETS cap for stationary installations, as well as the economic impacts it represents. The Commission will assess those aspects in its reports, including its annual Carbon Market Report.

The monitoring and reporting mechanism for CORSIA is already in place in the EU, and EU-based airlines' emission reports have already been made public. The CORSIA registry has been established, which should provide information on its functioning at global level.

Market analysts regularly closely follow various aspects of the carbon market and its functioning; the Commission will continue to monitor this work. In addition, through regular contacts with stakeholders the Commission is alert to their views and concerns about the functioning of the EU ETS.

The impact of this initiative in relation to **Objective 2** (i.e. leading international action, building alliances with the like-minded, maintaining competitiveness and ensuring a level-playing field in the sectors affected by the initiative, such as air transport services

and tourism) will be monitored through the indicators described in the table above. With respect to the policy objective of encouraging third countries to take meaningful actions will require a qualitative assessment rather than a quantitative one. The Commission will closely follow the international developments in the coming years, including the implementation by third-countries of CORSIA and the establishment of national emissions trading systems. As regards the policy objective of ensuring a level-playing field, the Commission will regularly carry out studies in order to assess the risk of competition distortions caused by this policy initiative. In relation to the policy objective of maintaining competitiveness of the relevant sectors, market analysts regularly closely follow various aspects of the EU carbon market and their impact on the competitiveness of these relevant sectors. The Commission will continue to monitor their work. The Commission also entertains regular contacts with stakeholders and is alert to their views and concerns about the functioning of the EU ETS.

The initiative will be periodically evaluated in light of its operational objectives. In particular, it is recommended that the Commission reports regularly on international developments to the European Parliament and the Council, and makes proposals, as appropriate, to adapt the EU system to these developments (e.g. with a view to preserving competitiveness of EU airlines).

Annex 1: Procedural information

Lead DG, D*E*cide Planning/CWP references

The Directorate-General (DG) for Climate Action has led the preparation of this initiative and the work on the Impact Assessment in the European Commission. The planning entry was approved in Decide Planning under the reference PLAN/2019/5485. It is included in the 2021 Commission Work Programme[127] under the headline ambition 'European Green Deal' and the policy objective 'Fit for 55 package'.

Organisation and timing

The planned adoption date (Q2 2021) was included in the Commission Work Programme and has remained unchanged.

The Inter-service Steering Group ('ISSG') was set up by the Secretariat-General to assist in the preparation of the initiative. The representatives of the following Directorates General participated in the ISSG work: SG, LS, AGRI, BUDG, COMM, COMP, CNECT, DEFIS, DGT, DIGIT, EAC, ECFIN, ECHO, EMPL, ENER, ENV, ESTAT, FISMA, FPI, GROW, HOME, HR, IAS, INTPA, JRC, JUST, MARE, MOVE, NEAR, OLAF, REFORM, REGIO, RTD, SANTE, TAXUD, TRADE.

A total of 4 ISSG meetings took place. The ISSG discussed the draft contractor study on 22 September 2020, the questionnaires for the open public consultation on 13 October 2020, the concept of the impact assessment on 14 December 2020, and the draft impact assessment report on 9 March 2021.

Consultation of the Regulatory Scrutiny Board

The Regulatory Scrutiny Board (RSB) received the draft version of this impact assessment report on 18 March 2021. The RSB meeting took place on 14 April 2021. On 19 April 2021, the RSB gave a positive opinion on the report, with reservations. The RSB made three main observations:

- The report is overly complex and does not clearly identify the political choices for the decision makers. It does not describe well the constraints imposed by the EU's international commitments. It does not present a clear intervention logic.

- The report does not assess the proposed initiative in the context of parallel initiatives pursuing similar objectives. It does not sufficiently reflect the impact of the multiple initiatives on the aviation sector.

[127] COM(2020) 690 final.

- The impact analysis does not compare well the merits of the retained policy options and does not sufficiently take into account the views of the different stakeholder groups. The report does not identify who will be affected and how. It does not present the main costs and benefits of the preferred options.

The RSB also made a number of recommendations, which were addressed in this impact assessment report as follows:

RSB recommendations	Modification of the IA report
The report should simplify its presentation and clearly identify the key policy choices. It should better describe how existing international EU commitments in the climate policy area (such as the Paris Agreement) and in support of international aviation emission reduction efforts (via CORSIA) limit the choice of the policy options. The impact analysis should more clearly focus on the most relevant policy options, weigh the advantages against the disadvantages and consider critical implementation aspects.	The report has been amended to present more clearly the key policy choices, notably taking into account the existing international commitments as regards climate policy.
The report should clarify the coherence between this initiative, the broader ETS revision and other parallel initiatives tackling aviation emissions (in particular the ReFuelEU Aviation initiative). The report should better describe how the various initiatives act together and what their respective objectives and expected emissions contributions are.	The revised report clarifies the coherence between this initiative and the parallel initiative tackling aviation emissions, in particular the ReFuelEU Aviation initiative, in Section 6. Section 6.2.3 has been introduced in order to present the cumulative impacts of the other Fit for 55 initiatives.
The report should clarify and simplify the intervention logic by establishing a clear link between the problems, the policy objectives and the policy options. For example, the specific objective on alternative fuels does not fit into the intervention logic as it is not analysed in the problems section and rather corresponds to the parallel RefuelEU Aviation initiative.	A new Section 5.4 has been introduced in order to clarify the intervention logic. In light of the RSB's comments, the uptake of SAF has been removed from Section 4.2 as specific objective.
The report should discuss the cumulative impacts (in the medium and longer term) on costs and the competitiveness of EU airport hubs and EU network carriers, particularly resulting from a loss of transfer passengers and more limited flight	The revised report presents the cumulative impacts on costs and the competitiveness of EU airport hubs and EU network carriers in Section 6.2.3.

options.	
The impact analysis and the option comparison should better describe the pros and cons of the policy options. First, the impacts should be assessed in comparison with the baseline. Second, the report should systematically take into account the comments made by stakeholders and confront them with the findings of the analysis throughout the report. Third, the analysis should better explain the sometimes counterintuitive impacts of the options on emissions.	In order to better describe the pros and cons of the policy options, the following changes have been made. First, a comparison of the policy options against the baseline has been included, in particular in Section 6. Second, the stakeholders' views are now presented throughout the document, where relevant. Third, the counterintuitive impacts are further explained in section 7.
The methodological section (in the annex), including methods, key assumptions, and baseline, should be harmonised as much as possible across all 'Fit for 55' initiatives. Key methodological elements and assumptions should be included concisely in the main report under the baseline section and the introduction to the options. The report should refer explicitly to uncertainties linked to the modelling. Where relevant, the methodological presentation should be adapted to the specific initiative.	Annex 4 has been amended in order to explain that the key assumptions have been harmonised across all 'Fit for 55' initiatives. The key methodological elements are included in Section 5. Section 5 also include an explanation for the uncertainties linked to the modeling.
Annex 3 should follow the standard format and present a summary of costs and benefits with all key information, including quantified estimates.	Annex 3 now includes a summary of the costs and benefits of the preferred policy options, compared to the baseline. Quantified estimates are presented in overview tables.

Evidence, sources and quality

This initiative builds upon evidence gathered in the Impact Assessment for the previous ETS revision concluded in 2018, the Impact Assessment accompanying the 2030 Communication, analysis conducted in support of the Commission's Long-Term Strategy and any relevant evidence compiled in other concurrent Green Deal initiatives. It builds on emissions data and experiences from the implementation of the EU monitoring, reporting and verification systems, and in particular data from the Union Registry. In addition, the Commission contracted an external, independent consortium of consultants (led by ICF) to support this impact assessment report, notably with respect to the underlying econometric modelling and analysis of this impact assessment report. The analytical methods are further described in Annex 4. The results of the open public consultation are described in Annex 2.

Annex 2: Stakeholder consultations

The Inception Impact Assessment for updated rules for aviation was published 3 July 2020 with a feedback period lasting until 28 August 2020. The open public consultation was conducted through an online survey between 1 October 2020 and 14 January 2021. Other stakeholder meetings were not organised for ETS aviation rules update.

Inception Impact Assessment

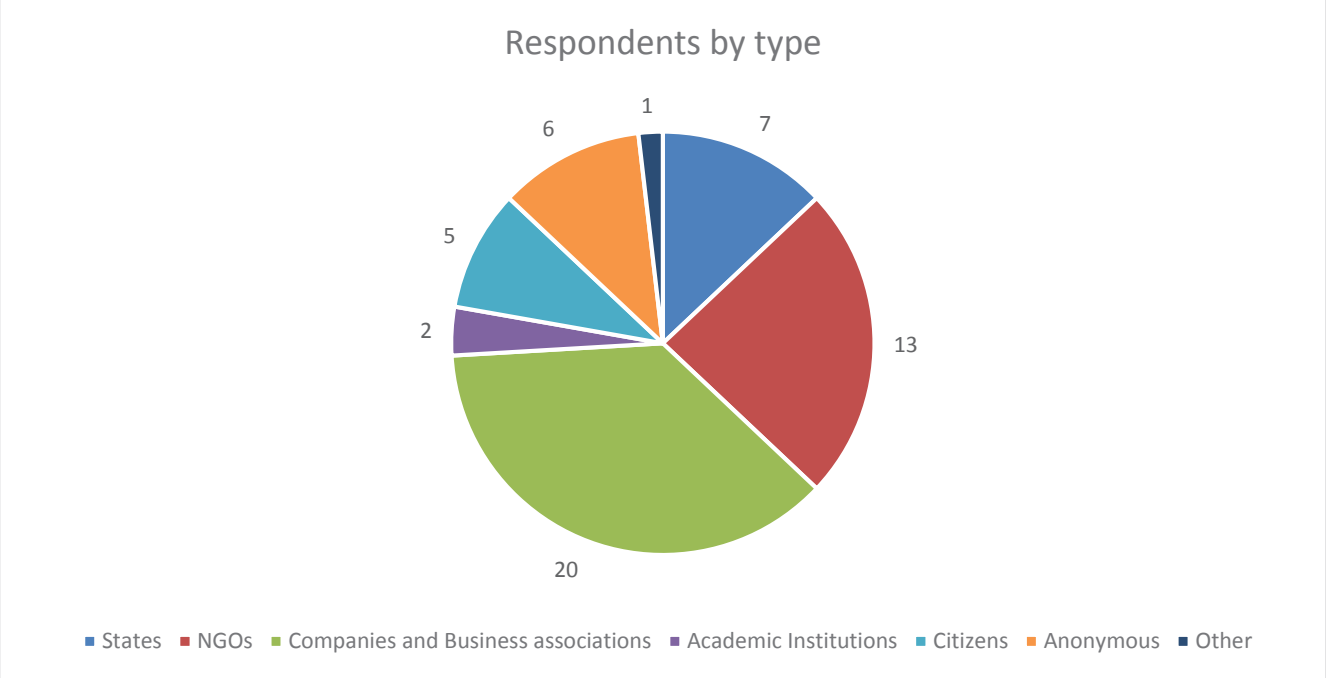
Feedback was invited to six policy options on CORSIA implementation:

1) EU ETS full legal scope;
2) Intra-EU/EFTA ETS only;
3) CORSIA only;
4) ETS-CORSIA "clean cut";
5) ETS-CORSIA "mix"; and
6) ETS-CORSIA "mix" according to licence of aircraft operators.

Feedback was invited to five policy options on auctioning share increase:

0) Status quo;
1) Immediate phase-out;
3) Slow phase-out; and
4) Slow reduction.

54 entities submitted their feedback to the Inception Impact Assessment.



Five Member States, Canada and the USA provided feedback. EU MS support a coexistence of the EU ETS and CORSIA. Non-EU countries are concerned with overlap between EU ETS and CORSIA, partial implementation of CORSIA, treatment of non-EU carriers and the exclusivity of CORSIA.

The vast majority of NGOs favour option 1 (EU ETS full scope) and/or options maintaining at minimum the current scope or hybrid options in between. They also support an immediate phase out of free allowances (option 1).

Most business associations and companies give preference to option 3 (CORSIA only) with openness to option 5 (ETS-CORSIA mix). On auctioning, most business associations and companies favour the status quo (option 0) or the slowest reduction (option 4) and the use of the revenues for the aviation industry.

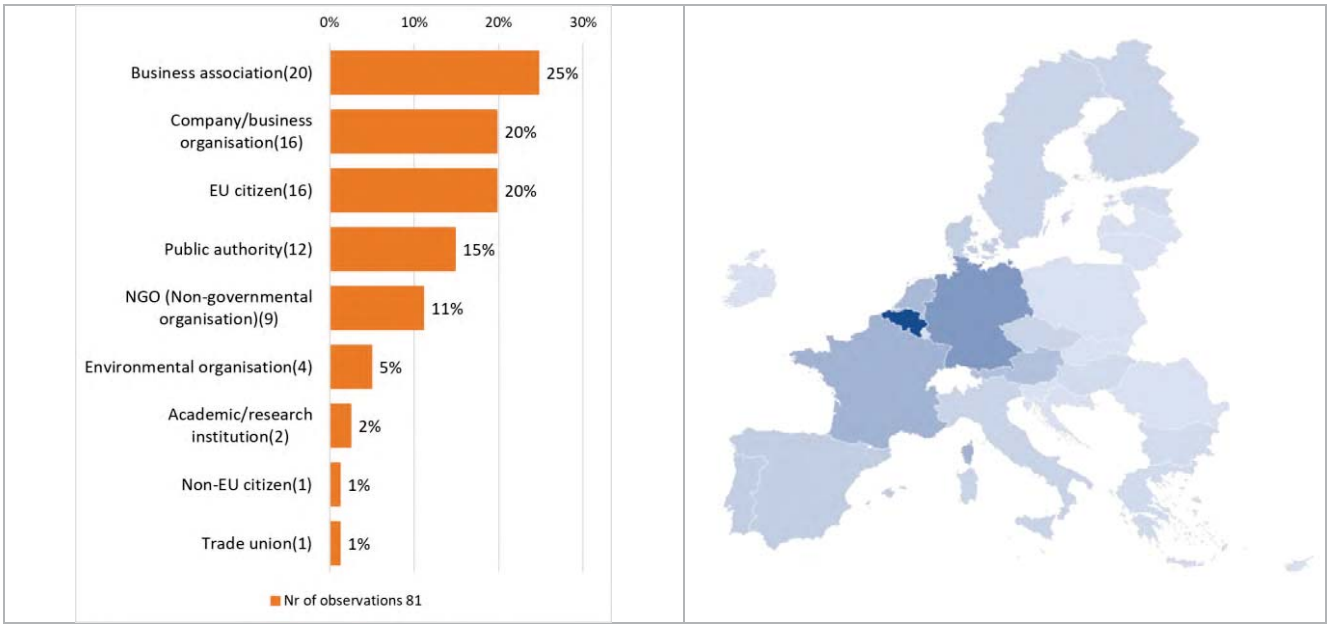
Among the citizens that participated in the consultations, the majority is in favour of more ambition either through the EU ETS full scope, full auctioning or taxation measure. One citizen considers that EU should lead by example and implement international agreements.

Results of the open public consultation

1. **Overview of respondents**

The OPC on the EU ETS on updated rules for aviation received a total of 81 replies from different stakeholder types. The largest group was private sector stakeholders (45%), followed by EU citizens (20%), public authorities (15%), non-governmental organisations (NGOs) (11%), environmental organisations (5%), academic/research institutions (2%), non-EU citizens (1%) and trade unions (1%).

*Figure 2-1- Distribution of respondents by type and country**



*Source: Technopolis. [*map based on data related to EU-based respondents]*

Most of the respondents (90%) came from 17 EU countries. The largest number of replies came from Belgium (27%)[128], followed by Germany (14%) and France (9%). Respondents from outside the EU were from the United Kingdom, Canada, Japan, Singapore, Taiwan, and the United States. In addition, 27 papers were submitted as attachments by 12 stakeholders.

The analysis of the stakeholder type by economic sector shows a heterogenous combination of stakeholders, with the most represented NACE sectors being *Other sector activities* (29%), *Transportation and storage* (26%) and *Professional, scientific and technical activities* (20%). Nine per cent indicated they are active in *Administrative and support service activities* sector followed by *Public administration and defence, and* C*ompulsory social security* (6%).

2. Methodology for data processing

The percentages presented below refer to the total respondents that answered the concerned questions. Some questions allowed respondents to 'rate' options (very negative-very positive). On these ratings, the report generally provides figures for the highest rating as well as for the lowest one, as these are indicative of most relevant positions.

The responses from the online survey were processed statistically and thematically, with a correlation analysis being conducted for each question. Position papers were processed via cataloguing. The papers were selected for analysis based on a series of criteria to capture the respondents' sentiment regarding the role of the current EU ETS as regards

[128] This result is influenced by the fact that a large number of business associations and NGOs that responded are based in Belgium.

aviation in light of the increased climate ambition, the interaction between EU ETS and CORSIA, the opportunity to review free allocation and auctioning, and recommendations about policy options.

3. Questionnaire

The questionnaire was composed of two parts. The first part dealt with the implementation of CORSIA through the EU ETS Directive, including the interaction between CORSIA and the EU ETS for aviation. The second one addressed possible policy changes on free allocation and auctioning of allowances in the EU ETS for aviation.

3.1 PART I: Market-based measures: EU ETS and CORSIA (from Q1 to Q7)

The vast majority of the respondents from all categories (91%, 71) agreed that the aviation sector should contribute more to climate actions than it currently does and that market-based measures can be effective to tackle aviation emissions in line with the EU Green Deal objectives (88%; 69). Respondents also stressed the need for market-based measures to better contribute to promote fair competition amongst EU air operators, EU and third-party operators, and between competing modes of transport.

The stakeholders were asked to give their opinion on their most preferable option(s) regarding the way to implement CORSIA by the EU. The total number of responses was 94, while the total number of respondents were 77. The question allowed for multiple-choice options. As such, respondents could choose more than one of the most preferred options, resulting in a combination of responses.

Over one-third of responses (30), mostly individuals and NGOs, but also including the only trade union who participated in the survey, preferred *Option 1 - EU ETS full legal scope*. The second most preferred option was *Option 3 - CORSIA only* (27%; 25), mainly supported by the private sector and public authorities. The third most favoured option was *Option 5 – ETS-CORSIA "mix"* which received one-fifth of preferences (21%; 20), again due to the private sector and public authorities. Next came *Option 4 – ETS-CORSIA "clean cut"* with 16% (15 responses), mainly from private sector stakeholders and public authorities.[129]

The results also indicate that the least favoured options if *Option 3 – CORSIA only* (27%, 42), due to the responses from individuals, NGOs, almost half of Public authorities that participated, and one fourth of private sector respondents. *Option 6 – ETS-CORSIA "mix" according to licence of aircraft operators* (21%, 33) and *Option 1 – EU ETS full legal scope* (20%, 31) follow closely as the second and third least favoured options,

[129] This was a multiple choice questions and respondents could select several options.

respectively due to 60% of total private sector responses for the former and, for the latter, to the responses from half of the public authorities and 64% of private sector.[130]

Overall, most of the respondents assessed the CORSIA aspects of the EU ETS Directive as rather positive. More that half of them (55%; 37), mainly from the private sector, appreciated the reference made in the EU ETS to the CORSIA's general ambition of the targets under the Paris Agreement. A similar pattern of responses emerged regarding the level of participation and implementation of CORSIA in the EU ETS (53%, 36). Likewise, most of respondents from private sector and public authorities considered registries as a positive aspect (42%, 28). On the assurance of equal treatment of airlines operating on the same routes, the responses showed a comparatively overwhelming positive response (62%, 41), represented mainly by the private sector, individuals, and public authorities.

Respondents from the private sector, NGOs, and individuals (59%) agreed upon the continuation of flights within an outermost region in the current scope of the EU ETS. More than half of the respondents (58%) from all categories were in favour of including international flights to or from outermost regions under CORSIA.

A large majority of respondents (82%; 62) agreed to combine market-based measures such as the EU ETS and CORSIA with other policies such as support for innovative aviation technologies, operational (ATM) improvements, taxation, and the production and use of sustainable aviation fuels.

Responses from across all stakeholder types overall acknowledged the need for the aviation sector to contribute to fight climate change (60%), with most of the private sector demanding such contributions to focus on technological improvements.

3.2 PART II: Free allocation and auctioning (from Q8 to Q11)

Regarding the effects of a reduction or removal of the free allocation of allowances to airlines, most of the respondents, mainly from the private sector, individuals, public authorities and NGOs (79%, 55) found that this measure would increase the cost of flying for both operators and consumers, although more than 60% (40) agreed it would increase the impact of climate change mitigation by the EU ETS.

As regards the assessment of the five options for amending the current modulation of the share of free allocation in the EU ETS, respondents most of all preferred *Option 2 – Immediate phase-out*, with 35% support (28 responses) mainly from individuals and NGOs. With 38% of responses (33), primarily from individuals and NGOs, the *status quo (Option 1*) resulted to be the least preferable choice. The importance of the risk of carbon leakage, which might arise for flights to destinations outside the scope of the

[130] This was a multiple choice questions and respondents could select several options.

ETS, was also underlined as a relevant factor to consider when assessing whether full phase-out is to be preferred over reduction[131].

In relation to how the revenues from the auctioning of aviation allowances can be best used to meet the EU Green Deal climate objectives suggestions were made by 69% of respondents (56). Most of them from all stakeholder types agreed that revenues collected through such measures should be utilised to support research & innovation to accelerate the decarbonisation of aviation.

More than one-third of respondents (38%; 31) provided additional comments beyond what already shared within each survey question. Private sector stakeholders requested more time before changing the allocation of allowances during the current pandemic situation, due to its hard impact on the EU aviation sector. Environmental organizations and private sector respondents emphasised the possibility of regulatory improvement of a "methodology to account for the use of sustainable aviation fuels and other aviation decarbonisation technologies such as hydrogen or electric-propulsion engines in the EU ETS". The NGOs remarked the necessity for the European Commission to release an assessment on CORSIA's environmental integrity before proposing new EU legislation. The trade union that participated in the survey expressed concern that the newly installed revision of EU ETS will be properly assessed and allow for revisions, and pricing.

4. Position papers

Key messages of the position papers
› The papers mainly focused on the following themes: co-existence and articulation between EU ETS and CORSIA, coverage of EU ETS, increase of the share of allowances to be auctioned › The implementation aspects of CORSIA in the EU mainly centered on the coverage of the flights. Aspects such as enforcement, MRV and other implementation aspects were only briefly mentioned. There was limited response on the coverage of outermost regions in the EU ETS, connectivity and regional impacts. › All papers assumed that market based mechanisms, in particular CORSIA and/or EU ETS, will be used in reducing emissions in the aviation sector. A majority of respondents support additional measures (e.g. sustainable aviation fuels, clean technologies and improving airline operations and infrastructure). › Especially public authorities, non-governmental organisations and citizens were of the opinion that EU ETS should be the main instrument for reducing emissions and that CORSIA should play a supplementary role because it has a less positive effect on the environmental integrity. › The main challenges listed on implementing CORSIA and EU ETS include double regulation, carbon leakage in hubs, unfair competition between EEA and non EEA

[131] In particular, respondents suggested to analyse whether long-haul flights with connections in non-European hubs (not subject to the EU ETS) will have a competitive advantage compared to flights with connections in European hubs (subject to ETS). If so, this might lead to increased emissions due to longer routes, in addition to distorting competition.

airlines. Several respondents made suggestions to fine-tune the options listed in the questionnaire or to provide additional options. Several measures were raised by some respondents to mitigate the challenges of implementing CORSIA and EU ETS, notably the introduction of a carbon border adjustment mechanism.

- Opinions in the papers differed on whether and how the free allocation of allowances should be decreased. COVID-19 played an important role in the selection of options.
- Nearly all positions papers emphasised the impact of COVID-19 on the aviation sector and called the Commission to analyse these impacts in the impact assessment and tailor policy options if that is necessary in view of COVID-19 recovery plans and environmental investments.

4.1 Sector coverage

The OPC on the EU ETS on updated rules for aviation received a total of 47 position papers (27 came from the IIA on EU ETS, 12 from the OPC). Eight papers found online were added to the analysis.

The largest group was business association (34%), followed by Company/Business organizations (25%), NGO (16%), Public authorities (14%), Academic/research institutions (5%) and EU Citizen (5%).

Most of the respondents (84%) came from 8 EU countries, notably Belgium (36%) and Germany (18%). Respondents from outside the EU were from the United Kingdom, the United States, Switzerland and Japan.

4.2 Adequacy of market based mechanisms

59% of papers expressed an opinion on the adequacy of market-based measures (MBMs) to address emissions in the aviation sector.

Almost a third (32%) commented that MBMs is a key solution, while some argued it should be part of a bundle of measures. 54% noted that additional measures are needed to make the Green Deal a success and to decarbonise the aviation sector, either as a bundle of instruments or with CORSIA or EU ETS as the key instrument. Among the 17 papers identifying those measures, most popular ones include the use of sustainable aviation fuels (75%), the introduction of clean technologies (53%) and operational improvements (41%) and infrastructural improvement (24%) including promoting the use of other transport modes on short-haul distances.

4.3 Implementation of CORSIA in the EU

Two thirds of the respondents expressed views on the supported policy options. Opinions differed on how CORSIA should be implemented in the EU. Option 3 (CORSIA only), Option 4 or another way of coexistence between EU ETS and CORSIA, Option 5, Option 1 (EU ETS full scope, mostly NGOs and EU citizens) were the most favoured options. Option 6 was discarded by respondents.

Some respondents expressed concerns if EU ETS and CORSIA remain parallel system, e.g. creation of market distortion, double regulation, increased administrative budget, non-compliance with the Chicago Convention and other international commitments. Several papers asked for alignment between CORSIA and EU ETS: i.e. implementing CORSIA MRV requirements fully in the EU ETS.

4.4 Outermost regions: coverage, connectivity and regional impacts

Only a few papers (4, 9%) addressed coverage of flights regarding the outermost regions directly, and the comments are varied. Two proposed including in the EU ETS, one wanted them addressed via CORSIA and another stated the existing exemption should be maintained.

Little feedback (7%) was also provided on the impact of implementing CORSIA and EU ETS on small regions and connectivity of those regions. Respondents did however recognise the importance of assessing overall impacts of the policy options to these regions, as air traffic plays a vital role.

4.5 Hub leakage, destination shift and modal shift

If the current scope of the EU ETS will be maintained and only flights to and from EEA countries are included, a feeder flight from an EEA country with a transfer at an European hub will be included in the EU ETS. According to most of the respondents (25%) that mentioned the risk of hub leakage, this could mean unfair competition between long-haul flights with connections in non-European hubs and flights connnected to European hubs. Traffic might be diverted to non-EEA hubs[132] and there could be a risk of carbon leakage (increased emissions due to longer routes). A proposal to implement a Carbon Border Adjustment Mechanism (CBAM) to address this competitive distortion was made by a respondent.

A limited number of position papers addressed the issue of investing into other modes of green transport such as sustainable rail transport on short-haul distances and building railway connections between hubs to better integrate transport modes and facilitate a modal shift towards sustainable transport modes.

4.6 Revisions in the free allocation of allowances and share to be auctioned

59% of papers expressed a view on the revision of the allowances system. A majority did not specifically indicate whether the share of emission allowances to be auctioned should be increased. Respondents supported in general a decrease or a phase out in the free allocation of allowances, although they expressed variations in the speed or reduction / phasing out. Some argued that an evolution of the share between free and auctioned allowances will not mitigate CO_2 emissions, as the environmental impact is determined

[132] The risk of carbon leakage and destination shifts are most prominent in the hubs located near the EEA, the Middle East, Turkey and - because of Brexit - the UK. The impact of Brexit on destination shift and hub leakage was explicitly mentioned by respondents.

by the overall "cap". Some responses were influenced by the impact of COVID-19 on air traffic and mentioned that increasing the auctioning share swiftly could distort the market and endanger COVID-19 recovery plans and environmental investments.

The top priorities for investing the revenues of auctioning include technologies that would promote decarbonisation of the sector, such as uptake of sustainable aviation fuels, research and development in the aviation sector, better infrastructure and operational issues and green aviation technologies.

5. Conclusions

The vast majority of the respondents (91%) from all categories, including from the aviation sector, agree that **the aviation sector should contribute more to climate actions**. Those in disagreement argue that the sector is already implementing the necessary measures to reduce its carbon footprint and that no further measures are required.

A very large majority of respondents (88%) believe that **market-based measures can be effective to tackle aviation emissions in line with the climate objectives**. This view is supported mainly by the business sector and EU Citizens, and they represent almost 60% of all the respondents. A majority of position papers advocate for additional measures (e.g. use of sustainable aviation fuels, introduction of new technologies, operational and infrastructural improvements).

The **main challenges listed on implementing CORSIA and EU ETS** include double regulation, carbon leakage in hubs, unfair competition between EEA and non-EEA airlines. Several measures were raised by some respondents to mitigate the challenges of implementing CORSIA and EU ETS, notably the introduction of a carbon border adjustment mechanism.

With regards to the **different policy options to assess whether and how the EU can implement CORSIA**, the most preferable option out of the six presented is *Option 1 - EU ETS full legal scope*, supported by 32% of responses, mainly EU Citizens and NGOs. The second most preferred option with 27% support from most of business sector stakeholders and Public authorities is *Option 3 - CORSIA only*, which together with *Option 5 ETS-Corsia mix* is also the preferred choice for aviation industry stakeholders. *Option 4 ETS CORSIA "clean cut" is the fourth most preferred with 16% of responses, whereas Option 6 ETS - CORSIA "mix" according to licence aircraft operators only* and *Option 2 – Intra-EU/EFTA ETS* had the least number of responses, with 3% and 1% respectively.

The majority of respondents (59%), including most of EU citizens, some private sector stakeholders and NGOs agree on keeping **flights within an outermost region** within the scope of the EU ETS. Almost half of respondents agree on the inclusion under the EU ETS of **domestic flights to or from outermost regions** (currently excluded until the end

of 2023), with half of positive responses coming from EU Citizens and NGOs, although also other stakeholder types support this. About half of respondents, primarily EU citizens and NGOs, support the inclusion in the EU ETS of **non-domestic flights to or from outermost regions**. A large majority of respondents from all categories, as well as 75% of the respondents from the aviation sector supports the **inclusion under CORSIA of international flights to or from outermost regions**. NGOs confirmed their scepticism about CORSIA as a long-term solution and disagreement against the inclusion of international flights under CORSIA.

A large majority of respondents (69%) gathering mostly NGOs and EU citizens agreed that **a reduction or removal of the free allocation of allowances to airlines would increase the climate change mitigation impact by the EU**, although most of the respondents from the aviation sector oppose this view. In position papers, expressed opinions were mixed, with a slight preference for removal of all free allocations, followed closely by a preference to either decrease or not decrease the allocations.

With regards to the effect of the reduction or removal of the free allocation of allowances to airlines, a majority of respondents gathering mainly EU Citizens, NGOs, and Public authorities agree that it would increase **fairness between those airlines eligible to receive the allocation and those that are not**. The private sector disagrees with the statement or does not know.

As regards the **modulation of the share of free allocation, relative to the current situation** the two most preferred options, "*status quo*" and "immediate phase-out", are at the same time the least preferred options showing a clear split in the distribution of the respondents preferences. As regards aviation sector respondents, status quo is their most preferred option and immediate phase out the least favoured.

On the topic of **improving the level playing field among transport modes**, over 50% of responses coming from a mixed group of stakeholders agree that a reduction or removal of the free allocation of allowances to airlines would be beneficial.

Most stakeholders across all user types agree that **revenues from the auctioning of aviation allowances should be focused on decarbonisation along the whole value chain of the aviation sector**. This opinion is particularly supported by aviation industry respondents, and is shared in position papers.

Several respondents emphasise both in the survey and the position papers the **impact of COVID-19 on the aviation sector** and call the Commission to analyse these impacts in the impact assessment and tailor policy options accordingly in future recovery plans and environmental investments.

Annex 3: Who is affected and how?

The EU ETS for aviation has been in force since 2012, covering approximately 500 airlines. The covered entities have become very familiar with the EU ETS's annual compliance cycle based on obligations related monitoring, reporting and verification of emissions. Compliance with these rules is almost 100%. This also holds for the national authorities responsible for various implementing tasks, such as the issuing of emission permits, the assessment of monitoring plans and emission data, as well as the allocation of free allowances.

The initiative does not affect these regular activities. However, the coverage of extra-EEA flights by CORSIA and immediate full auctioning are likely to have practical implications for certain stakeholders.

1. **Practical implications of the initiative**

Member States

On the one hand, the initiative will lead to an increased administrative burden for Member States, as they will have to commit resources to continued governance of CORSIA over its duration.

The increased administrative burden is likely to include the preparation and implementation of national regulations and ongoing engagement with CORSIA decision-making (including reviews) at ICAO.

On the other hand, immediate full auctioning (option A1FULL) means that the administrative burden linked to free allocation is completely removed. Under the preferred policy options (C3CLEAN and A1FULL), the estimate of possible cumulative auction revenues is €2.41 billion for the 3 years from 2023-2025 and €4.67 billion for the following five years from 2026-2030, based on the same approach to estimating auction revenues as used in the broader ETS impact assessment.

National competent authorities

National competent authorities are significantly involved in the implementation and enforcement of the initiative, including CORSIA. This involvement will result in an administrative burden, which will relate to the training of staff, calculating the offsetting obligations for aircraft operators, monitoring and enforcing compliance. However, full auctioning would reduce the administrative burden and costs related to the allocation of free allowances immediately and considerably..

Outermost regions

The macro-economic impacts of this initiative on outermost regions are likely to affect residents' access to employment, education and other opportunities. This initiative may have an impact on the connectivity between regions and limit their economic development.

Aircraft operators

This initiative will result in an increased level of administrative costs as the aircraft operators are subject to two sets of rules. However, the EU ETS part is the continuation of the existing administrative procedures, and the separation of the two regimes is simple as the two rule sets would apply to different routes. To comply with CORSIA, aircraft operators will likely need to engage in procuring and surrendering carbon offset credits.

However, these costs are expected to be relatively small compared to the overall operating costs. Finally, major part of the costs incurred by aircraft operators are likely to be passed through to the end-consumers.

Society at large

Society will benefit from the emission reductions achieved through the initiative and from a slight increase in employment. The initiative is expected to have no negative impact on low-income groups due to the insignificant increase in prices resulting from the measure.

2. Summary of costs and benefits

The estimates of the costs and benefits for the preferred option are relative to the baseline.

The administrative costs related to CORSIA implementation are based on estimates made by ICAO.[133] The administrative costs presented in the table below are ceiling costs and are likely to overestimate them. It is worth noting that the increased administrative costs incurred by airlines in relation to the implementation of CORSIA for extra-EEA flights represents a small share of the airlines' operating costs. This increase in administrative costs for extra-EEA flights is likely to be passed through to end-consumers.

[133] ICAO, 2019. Analysis on the estimation of CO2 emissions reductions and costs expected to result from CORSIA.

I. Overview of Benefits (total for all provisions) – Preferred Option (C3CLEAN+A1FULL)(relative to the baseline)		
Description	***Amount***	***Comments***
	Direct benefits	
Reduction of net extra-EU/EFTA air transport CO2 emissions in 2030 compared to the baseline	-9.4% compared to the baseline (Table 6.1)	Direct benefits to the society at large.
No change in net intra-EU/EFTA air transport CO2 emissions in 2030 compared to the baseline	Same amount of net intra-EU/EFTA air transport CO2 emissions as in the baseline: 27 Million tonnes.	Direct benefits to the society at large
Recyling of carbon revenues	The preferred policy options generate cumulative EU ETS auctioning revenues of EUR 2,413 billion compared to EUR 0,363 billion under the baseline	EU ETS auctioning revenues are expected to benefit to the society at large, as Member States increase their government expenditure or reduce taxes
	Indirect benefits	
Abolishment of the administrative costs related to free allocation	Compared to the baseline which maintains free allowances for aviation until 2030, the preferred option A1FULL removes free allowances from the entry into force of the revision	Direct benefits to national competent authorities and the Commission, as the administrative burden is abolished.
Distributional effects	Compared to the baseline, the preferred option A1FULL will yield positive impact on lower-income households as auctioning revenues are recycled by Member States. The increased carbon price under the preferred option compared to the baseline is likely to have a positive impact on lower-income households.	The increase carbon price is likely to be socially progressive as it affects predominantly higher-income households, which are more likely to fly than lower-income households.

II. Overview of costs – Preferred option							
		Citizens/Consumers		Businesses		Administrations	
		One-off	Recurrent	One-off	Recurrent	One-off	Recurrent
Compliance with CORSIA for extra-EEA flights	Direct costs				Negligible increase in the 2030 operating costs for extra-EEA flights under the preferred option compared to the baseline (carbon costs as 0.01% of the total operating costs)		
	Indirect costs		Negligible increase in the 2030 ticket price for extra-EEA flights compared to the baseline (+0.03 €)				
Administrative and enforcement costs of CORSIA for extra-EEA flights	Direct costs			Initial setting up of the monitoring and reporting systems under CORSIA for extra-EEA flights (approx. EUR 4 000-400 000 per large airline, EUR 0-800 per small airline, or under EUR 0.05/passenger in setup year)	Additional costs for the offsetting of emissions under CORSIA for extra-EEA flights (approx. yearly per-airline ceiling of EUR 4 000-17 000 for airlines that are eligible to use simplified reporting procedures, EUR 8 000-80 000 for those that are not)	Initial setting up of the monitoring and reporting systems under CORSIA for extra-EEA flights for Member States and EU authorities (approx. EUR 4 000-400 000 million)	Administrative costs for Member States and EU authorities as regards the participation in the governance, the implementation and the enforcement of CORSIA (approx. EUR 140 000-260 000 per year in total)
	Indirect costs						

Annex 4: Analytical methods

This Annex contains two sections. Section 1.1 describes the common analytical framework for the fit for 55 proposals. For this Impact Assessment, the most important element is the REF scenario, which was used for input variables for the aviation modelling for this impact assessment.

Section 1.2 describes the specific analytical approach used for this impact assessment.

Common analytical framework for the Impact Assessments of the revision of ESR, ETS, LULUCF, RED and EED Annex Methodology

1. Common analytical framework for the Impact Assessments of the revision of ESR, ETS, LULUCF, RED and EED

1.1.1 Introduction

Aiming at covering the entire GHG emissions from the EU economy, and combining horizontal and sectoral instruments, the various pieces of legislation under the "Fit for 55" package strongly interlink, either because they cover common economic sectors (e.g. buildings sector is currently addressed by energy efficiency and renewables polices but would be also falling in the scope of extended ETS) or by the direct and indirect interactions between these sectors (e.g. electricity supply sector and final demand sectors using electricity).

As a consequence, it is crucial to ensure consistency of the analysis across all initiatives. For this purpose, the impact assessments underpinning the "Fit for 55" policy package are using a collection of integrated modelling tools covering the entire GHG emissions of the EU economy.

These tools are used to produce a common Baseline and a set of core scenarios reflecting internally coherent policy packages aligned with the revised 2030 climate target, key policy findings of the CTP (see annex 1) and building on the Reference Scenario 2020, a projection of the evolution of EU and national energy systems and GHG emissions under the current policy framework[134]. These core scenarios serve as a common analytical basis for use across different "Fit for 55" policy initiatives, and are complemented by specific variants as well as additional tools and analyses relevant for the different initiatives.

This Annex describes the tools used to produce the common baseline (the Reference Scenario 2020) and the core policy scenarios, the key assumptions underpinning the analysis, and the policy packages reflected in the core policy scenarios.

[134] The "current policy framework" includes EU initiatives adopted as of end of 2019 and the national objectives and policies and measures as set out in the final National Energy and Climate Plans – see the EU Reference Scenario 2020 publication.

1.1.2 Modelling tools for assessments of policies

1.1.2.1 Main modelling suite

The main model suite used to produce the scenarios presented in this impact assessment has a successful record of use in the Commission's energy, transport and climate policy assessments. In particular, it has been used for the Commission's proposals for the Climate Target Plan[135] to analyse the increased 2030 mitigation target, the Sustainable and Smart Mobility Strategy[136], the Long Term Strategy[137] as well as for the 2020 and 2030 EU's climate and energy policy framework.

The PRIMES and PRIMES-TREMOVE models are the core elements of the modelling framework for energy, transport and CO_2 emission projections. The GAINS model is used for non-CO_2 greenhouse gas emission projections, the GLOBIOM-G4M models for projections of LULUCF emissions and removals and the CAPRI model is used for agricultural activity projections.

The model suite thus covers:

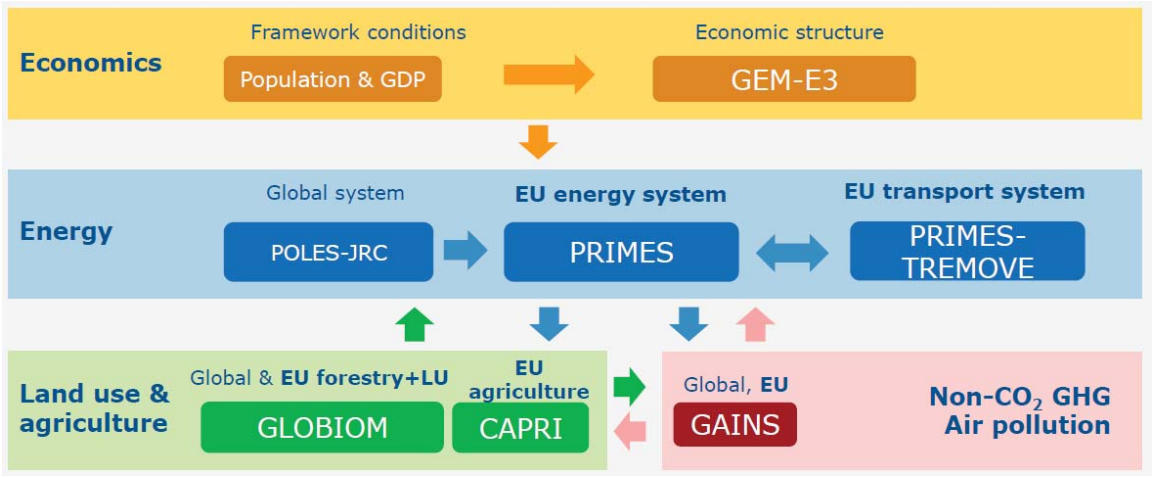
- **The entire energy system** (energy demand, supply, prices and investments to the future) and **all GHG emissions and removals** from the EU economy.
- **Time horizon:** 1990 to 2070 (5-year time steps).
- **Geography:** individually all EU Member States, EU candidate countries and, where relevant the United Kingdom, Norway, Switzerland and Bosnia and Herzegovina.
- **Impacts:** energy system (PRIMES and its satellite model on biomass), transport (PRIMES-TREMOVE), agriculture, waste and other non-CO_2 emissions (GAINS), forestry and land use (GLOBIOM-G4M), atmospheric dispersion, health and ecosystems (acidification, eutrophication) (GAINS).

The modelling suite has been continuously updated over the past decade. Updates include the addition of a new buildings module in PRIMES, improved representation of the electricity sector, more granular representation of hydrogen (including cross-border trade[138]) and other innovative fuels, improved representation of the maritime transport sector, as well updated interlinkages of the models to improve land use and non-CO_2 modelling. Most recently a major update was done of the policy assumptions, technology costs and macro-economic assumptions in the context of the Reference scenario 2020 update.

[135] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52020SC0176
[136] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52020SC0331
[137] https://ec.europa.eu/clima/sites/clima/files/docs/pages/com_2018_733_analysis_in_support_en_0.pdf
[138] While cross-border trade is possible, the assumption is that there are no imports from outside EU as the opposite would require global modelling of hydrogen trade.

The models are linked with each other in such a way to ensure consistency in the building of scenarios (Figure 1). These inter-linkages are necessary to provide the core of the analysis, which are interdependent energy, transport and GHG emissions trends.

Figure 1: Interlinkages between models



1.1.2.2 Energy: the PRIMES model

The PRIMES model (Price-Induced Market Equilibrium System)[139] is a large scale applied energy system model that provides detailed projections of energy demand, supply, prices and investment to the future, covering the entire energy system including emissions. The distinctive feature of PRIMES is the combination of behavioural modelling (following a micro-economic foundation) with engineering aspects, covering all energy sectors and markets.

The model has a detailed representation of policy instruments related to energy markets and climate, including market drivers, standards, and targets by sector or overall. It simulates the EU Emissions Trading System. It handles multiple policy objectives, such as GHG emissions reductions, energy efficiency, and renewable energy targets, and provides pan-European simulation of internal markets for electricity and gas.

The model covers the horizon up to 2070 in 5-year interval periods and includes all Member States of the EU individually, as well as neighbouring and candidate countries.

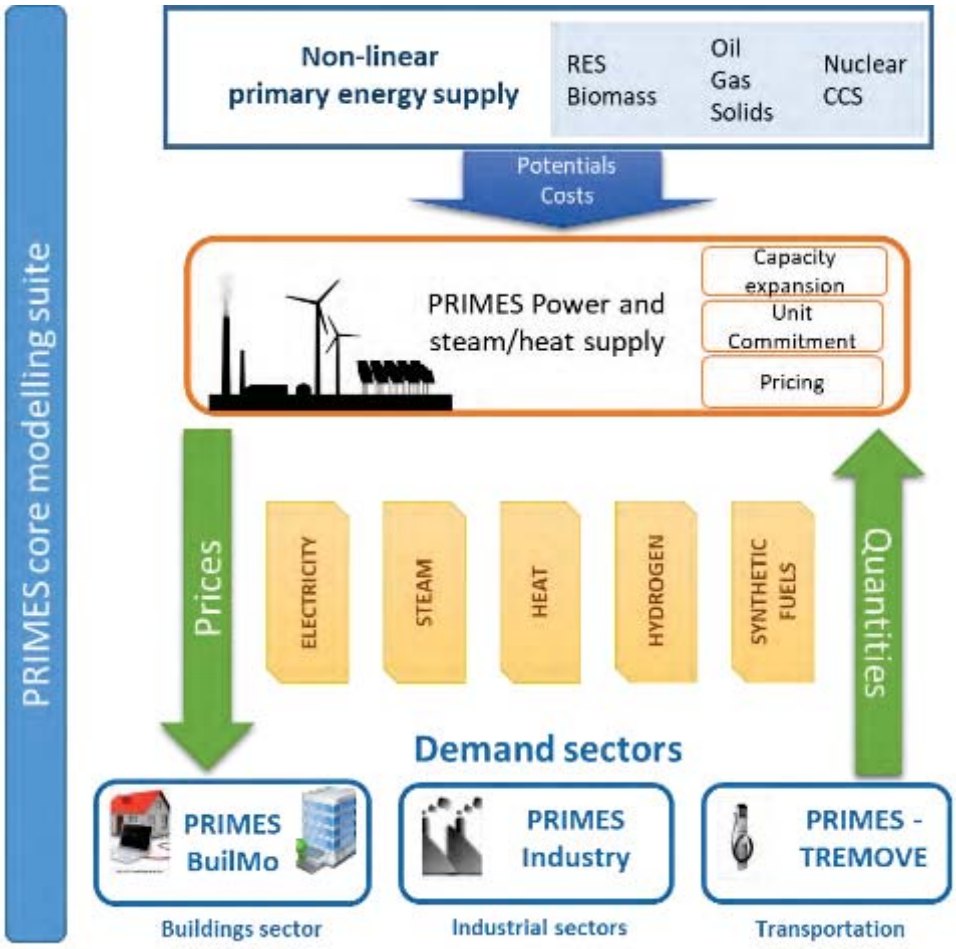
PRIMES offer the possibility of handling market distortions, barriers to rational decisions, behaviours and market coordination issues and it has full accounting of costs (CAPEX and OPEX) and investment on infrastructure needs.

[139] More information and model documentation: https://e3modelling.com/modelling-tools/primes/

PRIMES is designed to analyse complex interactions within the energy system in a multiple agent – multiple markets framework. Decisions by agents are formulated based on microeconomic foundation (utility maximization, cost minimization and market equilibrium) embedding engineering constraints and explicit representation of technologies and vintages, thus allowing for foresight for the modelling of investment in all sectors.

PRIMES allows simulating long-term transformations/transitions and includes non-linear formulation of potentials by type (resources, sites, acceptability etc.) and technology learning. Figure 2 shows a schematic representation of the PRIMES model.

Figure 2: Schematic representation of the PRIMES model



It includes a detailed numerical model on biomass supply, namely PRIMES-Biomass, which simulates the economics of current and future supply of biomass and waste for energy purposes. The model calculates the inputs in terms of primary feedstock of biomass and waste to satisfy a given demand for bio-energy and provides quantification of the required capacity to transform feedstock into bioenergy commodities. The resulting production costs and prices are quantified. The PRIMES-Biomass model is a

key link of communication between the energy system projections obtained by the core PRIMES energy system model and the projections on agriculture, forestry and non-CO_2 emissions provided by other modelling tools participating in the scenario modelling suite (CAPRI, GLOBIOM/G4M, GAINS).

It also includes a simple module which projects industrial process GHG emissions.

PRIMES is a private model maintained by E3Modelling[140], originally developed in the context of a series of research programmes co-financed by the European Commission. The model has been successfully peer-reviewed, last in 2011[141]; team members regularly participate in international conferences and publish in scientific peer-reviewed journals.

Sources for data inputs

A summary of database sources, in the current version of PRIMES, is provided below:

- Eurostat and EEA: Energy Balance sheets, Energy prices (complemented by other sources, such IEA), macroeconomic and sectoral activity data (PRIMES sectors correspond to NACE 3-digit classification), population data and projections, physical activity data (complemented by other sources), CHP surveys, CO_2 emission factors (sectoral and reference approaches) and EU ETS registry for allocating emissions between ETS and non ETS
- Technology databases: ODYSSEE-MURE[142], ICARUS, Eco-design, VGB (power technology costs), TECHPOL – supply sector technologies, NEMS model database[143], IPPC BAT Technologies[144]
- Power Plant Inventory: ESAP SA and PLATTS
- RES capacities, potential and availability: JRC ENSPRESO[145], JRC EMHIRES[146], RES ninja[147], ECN, DLR and Observer, IRENA
- Network infrastructure: ENTSOE, GIE, other operators
- Other databases: EU GHG inventories, district heating surveys (e.g. from COGEN), buildings and houses statistics and surveys (various sources, including ENTRANZE project[148], INSPIRE archive, BPIE[149]), JRC-IDEES[150], update to the EU Building stock Observatory[151]

[140] E3Modelling (https://e3modelling.com/) is a private consulting, established as a spin-off inheriting staff, knowledge and software-modelling innovation of the laboratory E3MLab from the National Technical University of Athens (NTUA).
[141] SEC(2011)1569 : https://ec.europa.eu/energy/sites/ener/files/documents/sec_2011_1569_2.pdf
[142] https://www.odyssee-mure.eu/
[143] Source: https://www.eia.gov/outlooks/aeo/info_nems_archive.php
[144] Source: https://eippcb.jrc.ec.europa.eu/reference/
[145] Source: https://data.jrc.ec.europa.eu/collection/id-00138
[146] Source: https://data.jrc.ec.europa.eu/dataset/jrc-emhires-wind-generation-time-series
[147] Source: https://www.renewables.ninja/
[148] Source: https://www.entranze.eu/
[149]Source: http://bpie.eu/
[150] Source: https://ec.europa.eu/jrc/en/potencia/jrc-idees

1.1.2.3 Transport: the PRIMES-TREMOVE model

The PRIMES-TREMOVE transport model projects the evolution of demand for passengers and freight transport, by transport mode, and transport vehicle/technology, following a formulation based on microeconomic foundation of decisions of multiple actors. Operation, investment and emission costs, various policy measures, utility factors and congestion are among the drivers that influence the projections of the model. The projections of activity, equipment (fleet), usage of equipment, energy consumption and emissions (and other externalities) constitute the set of model outputs.

The PRIMES-TREMOVE transport model can therefore provide the quantitative analysis for the transport sector in the EU, candidate and neighbouring countries covering activity, equipment, energy and emissions. The model accounts for each country separately which means that the detailed long-term outlooks are available both for each country and in aggregate forms (e.g. EU level).

In the transport field, PRIMES-TREMOVE is suitable for modelling *soft measures* (e.g. eco-driving, labelling); *economic measures* (e.g. subsidies and taxes on fuels, vehicles, emissions; ETS for transport when linked with PRIMES; pricing of congestion and other externalities such as air pollution, accidents and noise; measures supporting R&D); *regulatory measures* (e.g. CO_2 emission performance standards for new light duty vehicles and heavy duty vehicles; EURO standards on road transport vehicles; technology standards for non-road transport technologies, deployment of Intelligent Transport Systems) and *infrastructure policies for alternative fuels* (e.g. deployment of refuelling/recharging infrastructure for electricity, hydrogen, LNG, CNG). Used as a module that contributes to the PRIMES model energy system model, PRIMES-TREMOVE can show how policies and trends in the field of transport contribute to economy-wide trends in energy use and emissions. Using data disaggregated per Member State, the model can show differentiated trends across Member States.

The PRIMES-TREMOVE has been developed and is maintained by E3Modelling, based on, but extending features of, the open source TREMOVE model developed by the TREMOVE[152] modelling community. Part of the model (e.g. the utility nested tree) was built following the TREMOVE model.[153] Other parts, like the component on fuel consumption and emissions, follow the COPERT model.

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[151] Source: https://ec.europa.eu/energy/en/eubuildings

[152] Source: https://www.tmleuven.be/en/navigation/TREMOVE

[153] Several model enhancements were made compared to the standard TREMOVE model, as for example: for the number of vintages (allowing representation of the choice of second-hand cars); for the technology categories which include vehicle types using electricity from the grid and fuel cells. The model also incorporates additional fuel types, such as biofuels (when they differ from standard fossil fuel technologies), LPG, LNG, hydrogen and e-fuels. In addition, representation of infrastructure for refuelling and recharging are among the model refinements, influencing fuel choices. A major model enhancement concerns the inclusion of heterogeneity in the distance of stylised trips; the model considers that the trip

Data inputs

The main data sources for inputs to the PRIMES-TREMOVE model, such as for activity and energy consumption, comes from EUROSTAT database and from the Statistical Pocketbook "EU transport in figures[154]. Excise taxes are derived from DG TAXUD excise duty tables. Other data comes from different sources such as research projects (e.g. TRACCS project) and reports.

In the context of this exercise, the PRIMES-TREMOVE transport model is calibrated to 2005, 2010 and 2015 historical data. Available data on 2020 market shares of different powertrain types have also been taken into account.

1.1.2.4 Maritime transport: PRIMES-maritime model

The maritime transport model is a specific sub-module of the PRIMES and PRIMES-TREMOVE models aiming to enhance the representation of the maritime sector within the energy-economy-environment modelling nexus. The model, which can run in stand-alone and/or linked mode with PRIMES and PRIMES-TREMOVE, produces long-term energy and emission projections, until 2070, separately for each EU Member-State.

The coverage of the model includes the European intra-EU maritime sector as well as the extra-EU maritime shipping. The model covers both freight and passenger international maritime. PRIMES-maritime focuses only on the EU Member State, therefore trade activity between non-EU countries is outside the scope of the model. The model considers the transactions (bilateral trade by product type) of the EU-Member States with non-EU countries and aggregates these countries in regions. Several types and sizes of vessels are considered.

PRIMES-maritime features a modular approach based on the demand and the supply modules. The demand module projects maritime activity for each EU Member State by type of cargo and by corresponding partner. Econometric functions correlate demand for maritime transport services with economic indicators considered as demand drivers, including GDP, trade of energy commodities (oil, coal, LNG), trade of non-energy commodities, international fuel prices, etc. The supply module simulates a representative operator controlling the EU fleet, who offers the requested maritime transport services. The operator of the fleet decides the allocation of the vessels activity to the various markets (representing the different EU MS) where different regulatory regimes may apply (e.g. environmental zones). The fleet of vessels disaggregated into several categories is specific to cargo types. PRIMES maritime utilises a stock-flow relationship to simulate the evolution of the fleet of vessels throughout the projection period and the purchasing of new vessels.

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distances follow a distribution function with different distances and frequencies. The inclusion of heterogeneity was found to be of significant influence in the choice of vehicle-fuels especially for vehicles-fuels with range limitations.

[154] Source: https://ec.europa.eu/transport/facts-fundings/statistics_en

PRIMES-maritime solves a virtual market equilibrium problem, where demand and supply interact dynamically in each consecutive time period, influenced by a variety of exogenous policy variables, notably fuel standards, pricing signals (e.g. ETS), environmental and efficiency/operational regulations and others. The PRIMES maritime model projects energy consumption by fuel type and purpose as well as CO_2, methane and N_2O and other pollutant emissions. The model includes projections of costs, such as capital, fuel, operation costs, projections of investment expenditures in new vessels and negative externalities from air pollution.

The model serves to quantify policy scenarios supporting the transition towards carbon neutrality. It considers the handling of a variety of fuels such as fossil fuels, biofuels (bioheavy[155], biodiesel, bio-LNG), synthetic fuels (synthetic diesel, fuel oil and gas, e-ammonia and e-methanol) produced from renewable electricity, hydrogen produced from renewable electricity (for direct use and for use in fuel cell vessels) and electricity for electric vessels. Well-to-Wake emissions are calculated thanks to the linkage with the PRIMES energy systems model which derives ways of producing such fuels. The model also allows to explore synergies with Onshore Power Supply systems. Environmental regulation, fuel blending mandates, GHG emission reduction targets, pricing signals and policies increasing the availability of fuel supply and supporting the alternative fuel infrastructure are identified as drivers, along fuel costs, for the penetration of new fuels. As the model is dynamic and handles vessel vintages, capital turnover is explicit in the model influencing the pace of fuel and vessel substitution.

Data inputs

The main data sources for inputs to the PRIMES-maritime model, such as for activity and energy consumption, comes from EUROSTAT database and from the Statistical Pocketbook "EU transport in figures[156]. Other data comes from different sources such as research projects (e.g. TRACCS project) and reports. PRIMES-maritime being part of the overall PRIMES model is it calibrated to the EUROSTAT energy balances and transport activity; hence the associated CO_2 emissions are assumed to derive from the combustion of these fuel quantities. The model has been adapted to reflect allocation of CO_2 emissions into intra-EU, extra-EU and berth, in line with data from the MRV database.[157] For air pollutants, the model draws on the EEA database.

In the context of this exercise, the PRIMES-maritime model is calibrated to 2005, 2010 and 2015 historical data.

1.1.2.5 Non-CO_2 GHG emissions and air pollution: GAINS

The GAINS (Greenhouse gas and Air Pollution Information and Simulation) model is an integrated assessment model of air pollutant and greenhouse gas emissions and their

[155] Bioheavy refers to bio heavy fuel oil.
[156] Source: https://ec.europa.eu/transport/facts-fundings/statistics_en
[157] https://mrv.emsa.europa.eu/#public/eumrv

interactions. GAINS brings together data on economic development, the structure, control potential and costs of emission sources and the formation and dispersion of pollutants in the atmosphere.

In addition to the projection and mitigation of non-CO_2 greenhouse gas emissions at detailed sub-sectorial level, GAINS assesses air pollution impacts on human health from fine particulate matter and ground-level ozone, vegetation damage caused by ground-level ozone, the acidification of terrestrial and aquatic ecosystems and excess nitrogen deposition of soils.

Model uses include the projection of non-CO_2 GHG emissions and air pollutant emissions for the EU Reference scenario and policy scenarios, calibrated to UNFCCC emission data as historical data source. This allows for an assessment, per Member State, of the (technical) options and emission potential for non-CO_2 emissions. Health and environmental co-benefits of climate and energy policies such as energy efficiency can also be assessed.

The GAINS model is accessible for expert users through a model interface[158] and has been developed and is maintained by the International Institute of Applied Systems Analysis[159]. The underlying algorithms are described in publicly available literature. GAINS and its predecessor RAINS have been peer reviewed multiple times, in 2004, 2009 and 2011.

Sources for data inputs

The GAINS model assesses emissions to air for given externally produced activity data scenarios. For Europe, GAINS uses macroeconomic and energy sector scenarios from the PRIMES model, for agricultural sector activity data GAINS adopts historical data from EUROSTAT and aligns these with future projections from the CAPRI model. Projections for waste generation, organic content of wastewater and consumption of F-gases are projected in GAINS in consistency with macroeconomic and population scenarios from PRIMES. For global scenarios, GAINS uses macroeconomic and energy sector projections from IEA World Energy Outlook scenarios and agricultural sector projections from FAO. All other input data to GAINS, i.e., sector- and technology- specific emission factors and cost parameters, are taken from literature and referenced in the documentation.

1.1.2.6 Forestry and land-use: GLOBIOM-G4M

The Global Biosphere Management Model (GLOBIOM) is a global recursive dynamic partial equilibrium model integrating the agricultural, bioenergy and forestry sectors with

[158] Source: http://gains.iiasa.ac.at/models/
[159] Source: http://www.iiasa.ac.at/

the aim to provide policy analysis on global issues concerning land use competition between the major land-based production sectors. Agricultural and forestry production as well as bioenergy production are modelled in a detailed way accounting for about 20 globally most important crops, a range of livestock production activities, forestry commodities as well as different energy transformation pathways.

GLOBIOM covers 50 world regions / countries, including the EU27 Member States.

Model uses include the projection of emissions from land use, land use change and forestry (LULUCF) for EU Reference scenario and policy scenarios. For the forestry sector, emissions and removals are projected by the Global Forestry Model (G4M), a geographically explicit agent-based model that assesses afforestation, deforestation and forest management decisions. GLOBIOM-G4M is also used in the LULUCF impact assessment to assess the options (afforestation, deforestation, forest management, and cropland and grassland management) and costs of enhancing the LULUCF sink for each Member State.

The GLOBIOM-G4M has been developed and is maintained by the International Institute of Applied Systems Analysis[160].

Sources for data inputs

The main market data sources for GLOBIOM-EU are EUROSTAT and FAOSTAT, which provide data at the national level and which are spatially allocated using data from the SPAM model[161]. Crop management systems are parameterised based on simulations from the biophysical process-based crop model EPIC. The livestock production system parameterization relies on the dataset by Herrero et al[162]. Further datasets are incorporated, coming from the scientific literature and other research projects.

GLOBIOM is calibrated to FAOSTAT data for the year 2000 (average 1998 - 2002) and runs recursively dynamic in 10-year time-steps. In the context of this exercise, baseline trends of agricultural commodities are aligned with FAOSTAT data for 2010/2020 and broadly with AGLINK-COSIMO trends for main agricultural commodities in the EU until 2030.

The main data sources for G4M are CORINE, Forest Europe (MCPFE, 2015)[163], countries' submissions to UNFCCC and KP, FAO Forest Resource Assessments, and

[160] Source : http://www.iiasa.ac.at/
[161] See You, L., Wood, S. (2006). An Entropy Approach to Spatial Disaggregation of Agricultural Production, Agricultural Systems 90, 329–47 and http://mapspam.info/ .
[162] Herrero, M., Havlík, P., et al. (2013). Biomass Use, Production, Feed Efficiencies, and Greenhouse Gas Emissions from Global Livestock Systems, Proceedings of the National Academy of Sciences 110, 20888–93.
[163] MCPFE (2015). Forest Europe, 2015: State of Europe's Forests 2015. Madrid, Ministerial Conference on the Protection of Forests in Europe: 314.

national forest inventory reports. Afforestation and deforestation trends in G4M are calibrated to historical data for the period 2000-2013.

1.1.2.7 Agriculture: CAPRI

CAPRI is a global multi-country agricultural sector model, supporting decision making related to the Common Agricultural Policy and environmental policy and therefore with far greater detail for Europe than for other world regions. It is maintained and developed in a network of public and private agencies including the European Commission (JRC), Universities (Bonn University, Swedish University of Agricultural Sciences, Universidad Politécnica de Madrid), research agencies (Thünen Institute), and private agencies (EuroCARE), in charge for use in this modelling cluster). The model takes inputs from GEM-E3, PRIMES and PRIMES Biomass model, provides outputs to GAINS, and exchanges information with GLOBIOM on livestock, crops, and forestry as well as LULUCF effects.

The CAPRI model provides the agricultural outlook for the Reference Scenario, in particular on livestock and fertilisers use, further it provides the impacts on the agricultural sector from changed biofuel demand. It takes into account recent data and builds on the 2020 EU Agricultural Outlook[164]. Depending on the need it may also be used to run climate mitigation scenarios, diet shift scenarios or CAP scenarios.

Cross checks are undertaken ex-ante and ex-post to ensure consistency with GLOBIOM on overlapping variables, in particular for the crop sector.

Sources for data inputs

The main data source for CAPRI is EUROSTAT. This concerns data on production, market balances, land use, animal herds, prices, and sectoral income. EUROSTAT data are complemented with sources for specific topics (like CAP payments or biofuel production). For Western Balkan regions a database matching with the EUROSTAT inputs for CAPRI has been compiled based on national data. For non-European regions the key data source is FAOSTAT, which also serves as a fall back option in case of missing EUROSTAT data. The database compilation is a modelling exercise on its own because usually several sources are available for the same or related items and their reconciliation involves the optimisation to reproduce the hard data as good as possible while maintaining all technical constraints like adding up conditions.

In the context of this exercise, the CAPRI model uses historical data series at least up to 2017, and the first simulation years (2010 and 2015) are calibrated on historical data.

[164] EU Agricultural Outlook for markets, income and environment 2020-2030, https://ec.europa.eu/info/sites/info/files/food-farming-fisheries/farming/documents/agricultural-outlook-2020-report_en.pdf

1.1.3 Assumptions on technology, economics and energy prices

In order to reflect the fundamental socio-economic, technological and policy developments, the Commission prepares periodically an EU Reference Scenario on energy, transport and GHG emissions. The scenarios assessment used for the "Fit for 55" policy package builds on the latest "EU Reference Scenario 2020" (REF2020)[165].

The main assumptions related to economic development, international energy prices and technologies are described below.

1.1.3.1 *Economic assumptions*

The modelling work is based on socio-economic assumptions describing the expected evolution of the European society. Long-term projections on population dynamics and economic activity form part of the input to the energy model and are used to estimate final energy demand.

Population projections from Eurostat[166] are used to estimate the evolution of the European population, which is expected to change little in total number in the coming decades. The GDP growth projections are from the Ageing Report 2021[167] by the Directorate General for Economic and Financial Affairs, which are based on the same population growth assumptions.

Table 1. Projected population and GDP growth per MS

	Population			GDP growth	
	2020	2025	2030	2020-'25	2026-'30
EU27	447.7	449.3	449.1	0.9%	1.1%
Austria	8.90	9.03	9.15	0.9%	1.2%
Belgium	11.51	11.66	11.76	0.8%	0.8%
Bulgaria	6.95	6.69	6.45	0.7%	1.3%
Croatia	4.06	3.94	3.83	0.2%	0.6%
Cyprus	0.89	0.93	0.96	0.7%	1.7%

[165] See related publication.
[166] EUROPOP2019 population projections
https://ec.europa.eu/eurostat/web/population-demography-migration-projections/population-projections-data
[167] The 2021 Ageing Report : Underlying assumptions and projection methodologies
https://ec.europa.eu/info/publications/2021-ageing-report-underlying-assumptions-and-projection-methodologies_en

Czechia	10.69	10.79	10.76	1.6%	2.0%
Denmark	5.81	5.88	5.96	2.0%	1.7%
Estonia	1.33	1.32	1.31	2.2%	2.6%
Finland	5.53	5.54	5.52	0.6%	1.2%
France	67.20	68.04	68.75	0.7%	1.0%
Germany	83.14	83.48	83.45	0.8%	0.7%
Greece	10.70	10.51	10.30	0.7%	0.6%
Hungary	9.77	9.70	9.62	1.8%	2.6%
Ireland	4.97	5.27	5.50	2.0%	1.7%
Italy	60.29	60.09	59.94	0.3%	0.3%
Latvia	1.91	1.82	1.71	1.4%	1.9%
Lithuania	2.79	2.71	2.58	1.7%	1.5%
Luxembourg	0.63	0.66	0.69	1.7%	2.0%
Malta	0.51	0.56	0.59	2.7%	4.1%
Netherlands	17.40	17.75	17.97	0.7%	0.7%
Poland	37.94	37.57	37.02	2.1%	2.4%
Portugal	10.29	10.22	10.09	0.8%	0.8%
Romania	19.28	18.51	17.81	2.7%	3.0%
Slovakia	5.46	5.47	5.44	1.1%	1.7%
Slovenia	2.10	2.11	2.11	2.1%	2.4%
Spain	47.32	48.31	48.75	0.9%	1.6%
Sweden	10.32	10.75	11.10	1.4%	2.2%

Beyond the update of the population and growth assumptions, an update of the projections on the sectoral composition of GDP was also carried out using the GEM-E3 computable general equilibrium model. These projections take into account the potential medium- to long-term impacts of the COVID-19 crisis on the structure of the economy,

even though there are inherent uncertainties related to its eventual impacts. Overall, conservative assumptions were made regarding the medium-term impacts of the pandemic on the re-localisation of global value chains, teleworking and teleconferencing and global tourism.

1.1.3.2 International energy prices assumptions

Alongside socio-economic projections, EU energy modelling requires projections of international fuel prices. The 2020 values are estimated from information available by mid-2020. The projections of the POLES-JRC model – elaborated by the Joint Research Centre and derived from the Global Energy and Climate Outlook (GECO[168]) – are used to obtain long-term estimates of the international fuel prices.

The COVID crisis has had a major impact on international fuel prices[169]. The lost demand cause an oversupply leading to decreasing prices. The effect on prices compared to pre-COVID estimates is expected to be still felt up to 2030. Actual development will depend on the recovery of global oil demand as well as supply side policies[170].

Table 2 shows the international fuel prices assumptions of the REF2020 and of the different scenarios and variants used in the "Fit for 55" policy package impact assessments.

Table 2: International fuel prices assumptions

in $'15 per boe	2000	'05	'10	'15	'20	'25	'30	'35	'40	'45	'50
Oil	38.4	65.4	86.7	52.3	39.8	59.9	80.1	90.4	97.4	105.6	117.9
Gas (NCV)	26.5	35.8	45.8	43.7	20.1	30.5	40.9	44.9	52.6	57.0	57.8
Coal	11.2	16.9	23.2	13.1	9.5	13.6	17.6	19.1	20.3	21.3	22.3
in €'15 per boe	2000	2005	'10	'15	'20	'25	'30	'35	'40	'45	'50
Oil	34.6	58.9	78.2	47.2	35.8	54.0	72.2	81.5	87.8	95.2	106.3
Gas (NCV)	23.4	31.7	40.6	38.7	17.8	27.0	36.2	39.7	46.6	50.5	51.2
Coal	9.9	15.0	20.6	11.6	8.4	12.0	15.6	16.9	18.0	18.9	19.7

Source: Derived from JRC, POLES-JRC model, Global Energy and Climate Outlook (GECO)

[168] https://ec.europa.eu/jrc/en/geco
[169] IEA, Global Energy Review 2020, June 2020
[170] IEA, Oil Market Report, June 2020 and US EIA, July 2020.

1.1.3.3 Technology assumptions

Modelling scenarios on the evolution of the energy system is highly dependent on the assumptions on the development of technologies - both in terms of performance and costs. For the purpose of the impact assessments related to the "Climate Target Plan" and the "Fit for 55" policy package, these assumptions have been updated based on a rigorous literature review carried out by external consultants in collaboration with the JRC[171].

Continuing the approach adopted in the long-term strategy in 2018, the Commission consulted on the technology assumption with stakeholders in 2019. In particular, the technology database of the main model suite (PRIMES, PRIMES-TREMOVE, GAINS, GLOBIOM, and CAPRI) benefited from a dedicated consultation workshop held on 11th November 2019. EU Member States representatives also had the opportunity to comment on the costs elements during a workshop held on 25th November 2019. The updated technology assumptions are published together with the EU Reference Scenario 2020.

1.1.4 The existing 2030 framework: the EU Reference Scenario 2020

1.1.4.1 The EU Reference Scenario 2020 as the common baseline

The EU Reference Scenario 2020 (REF2020) provides projections for energy demand and supply, as well as greenhouse gas emissions in all sectors of the European economy under the current EU and national policy framework. It embeds in particular the EU legislation in place to reach the 2030 climate target of at least 40% compared to 1990, as well as national contributions to reaching the EU 2030 energy targets on Energy efficiency and Renewables under the Governance of the Energy Union. It thus gives a detailed picture of where the EU economy and energy system in particular would stand in terms of GHG emission if the policy framework were not updated to enable reaching the revised 2030 climate target to at least -55% compared to 1990 proposed under the Climate Target Plan[172].

The Reference Scenario serves as the common baseline shared by all the initiatives of the "Fit for 55" policy package to assess options in their impact assessments:

- updating the Effort Sharing Regulation,
- updating the Emission Trading System,
- revision of the Renewables Energy Directive,
- revision of the Energy Efficiency Directive,
- revision of the Regulation setting CO_2 emission performance standards for cars and light commercial vehicles,

[171] JRC118275
[172] COM/2020/562 final

- review of the LULUCF EU rules.

1.1.4.2 Difference with the CTP "BSL" scenario

The REF2020 embeds some differences compared to the baseline used for the CTP impact assessment. While the technology assumptions (consulted in a workshop held on 11th November 2019) were not changed, the time between CTP publication and the publication of the "Fit for 55" package allowed updating some other important assumptions:

- GDP projections, population projections and fossil fuel prices were updated, in particular to take into account the impact of the COVID crisis through an alignment with the 2021 Ageing Report[173] and an update of international fossil fuel prices notably on the short run.
- While the CTP baseline aimed at reaching the current EU 2030 energy targets (on energy efficiency and renewable energy), the Reference Scenario 2020, used as the baseline for the "Fit for 55" package, further improved the representation of the National Energy Climate Plans (NECP). In particular it aims at reaching the national contributions to the EU energy targets, and not at respecting these EU targets themselves.

1.1.4.3 Reference scenario process

The REF2020 scenario has been prepared by the European Commission services and consultants from E3Modelling, IIASA and EuroCare, in coordination with Member States experts through the Reference Scenario Experts Group.

It benefitted from a stakeholders consultation (on technologies) and is aligned with other outlooks from Commission services, notably DG ECFIN's Ageing Report 2021 (see section 0), as well as, to the extent possible, the 2020 edition of the EU Agricultural Outlook 2020-2030 published by DG AGRI in December 2020[174].

1.1.4.4 Policies in the Reference scenario

The REF2020 also takes into account the still-unfolding effects of the COVID-19 pandemic, to the extent possible at the time of the analysis. According to the GDP assumptions of the Ageing Report 2021, the pandemic is followed by an economic recovery resulting in moderately lower economic output in 2030 than pre-COVID estimates.

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[173] The 2021 Ageing Report : Underlying assumptions and projection methodologies https://ec.europa.eu/info/publications/2021-ageing-report-underlying-assumptions-and-projection-methodologies_en

[174] https://ec.europa.eu/info/news/eu-agricultural-outlook-2020-30-agri-food-sector-shown-resilience-still-covid-19-recovery-have-long-term-impacts-2020-dec-16_en

The scenario is based on existing policies adopted at national and EU level at the beginning of 2020. In particular, at EU level, the REF2020 takes into account the legislation adopted in the Clean Energy for All European Package[175]. At national level, the scenario takes into account the policies and specific targets, in particular in relation with renewable energy and energy efficiency, described in the final National Energy and Climate Plans (NECPs) submitted by Member States at the end of 2019/beginning of 2020.

The REF2020 models the policies already adopted, but not the target of net-zero emissions by 2050. As a result, there are no additional policies introduced driving decarbonisation after 2030. However, climate and energy policies are not rolled back after 2030 and several of the measures in place today continue to deliver emissions reduction in the long term. This is the case, for example, for products standards and building codes and the ETS Directive (progressive reduction of ETS allowances is set to continue after 2030).

Details on policies and measures represented in the REF2020 can be found in the dedicated "EU Reference Scenario 2020" publication.

1.1.4.5 Reference Scenario 2020 key outputs

For 2030, the REF2020 scenario mirrors the main targets and projections submitted by Member States in their final NECPs. In particular, aggregated at the EU level, the REF2020 projects a 33.2% share of renewable energy in Gross Final Energy Consumption. Final energy consumption is 823 Mtoe, which is 29.6% below the 2007 PRIMES Baseline.

In the REF2020, GHG emissions from the EU in 2030 (including all domestic emissions & intra EU aviation and maritime) are 43.8% below the 1990 level. A carbon price of 30 EUR/tCO_2eq. in 2030 drives emissions reduction in the ETS sector. Table 3 shows a summary of the projections for 2030. A detailed description of the REF2020 can be found in a separate report published by the Commission[176].

Table 3: REF2020 summary energy and climate indicators.

EU 2030	REF2020
GHG reductions (incl. Domestic emissions & intra EU aviation and maritime) vs 1990	-43.8%
RES share	33.2%
PEC energy savings	-32.7%

[175] COM(2016) 860 final.
[176] Link to reference.

FEC energy savings	-29.6%
Environmental impacts	
GHG emissions reduction in current ETS sectors vs 2005	-48.2%
GHG emissions reduction in current non-ETS sectors vs 2005	-30.7%
Energy system impacts	
GIC (Mtoe)	1224.2
- Solid fossil fuels	9.3%
- Oil	31.9%
- Natural gas	22%
- Nuclear	11%
- Renewables	25.8%
Final Energy Demand (Mtoe)	822.6
RES share in heating & cooling	32.8%
RES share in electricity	58.5%
RES share in transport	21.2%
Economic and social impacts	
System costs (excl. auction payment) (average 2021-30) as % of GDP	10.9%
Investment expenditures (incl. transport) average annual (2021-30) vs (2011-20) (bn€)	285
EU ETS carbon price (€/ton, 2030)	30
Energy- expenditures (excl. transport) of households as % of total consumption	7.0%

Source: PRIMES model

The system costs (excluding ETS carbon-related payments) reaches close to 11% of the EU's GDP on average over 2021-2030. This cost[177] is calculated ex-post with a private

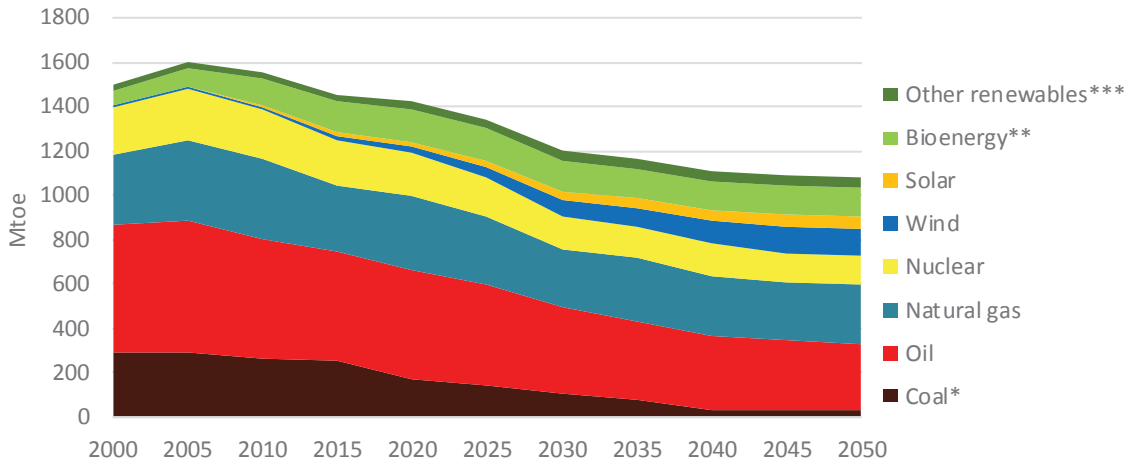
[177] Energy system costs for the entire energy system include capital costs (for energy installations such as power plants and energy infrastructure, energy using equipment, appliances and energy related costs of transport), energy purchase costs (fuels + electricity + steam) and direct efficiency investment costs, the latter being also expenditures of capital nature. For transport, only the additional capital costs for energy purposes (additional capital costs for improving energy efficiency or for using alternative fuels, including alternative fuels infrastructure) are covered, but not other costs including the significant transport related infrastructure costs e.g. related to railways and roads. Direct efficiency investment costs include additional costs for house insulation, double/triple glazing, control systems, energy management and for efficiency

sector perspective applying a flat 10% discount rate[178] over the simulation period up to 2050 to compute investment-related annualized expenditures.

By 2050, final energy consumption is projected at around 790 Mtoe and approximately 74% of the European electricity is generated by renewable energy sources. GHG emissions in the EU are projected to be about 60% lower than in 1990: the REF2020 thus falls short of the European goal of climate neutrality by 2050.

Focusing on the energy system, REF2020 shows that in 2030 fuel mix would still be dominated by fossil fuels. While the renewables grow and fossil fuels decline by 2050, the substitution is not sufficient for carbon neutrality. It also has to be noted that there is no deployment of e-fuels that are crucial for achievement of carbon neutrality as analysed in the Long Term Strategy[179] and in the CTP.

Figure 3: Fuel mix evolution of the Reference Scenario 2020



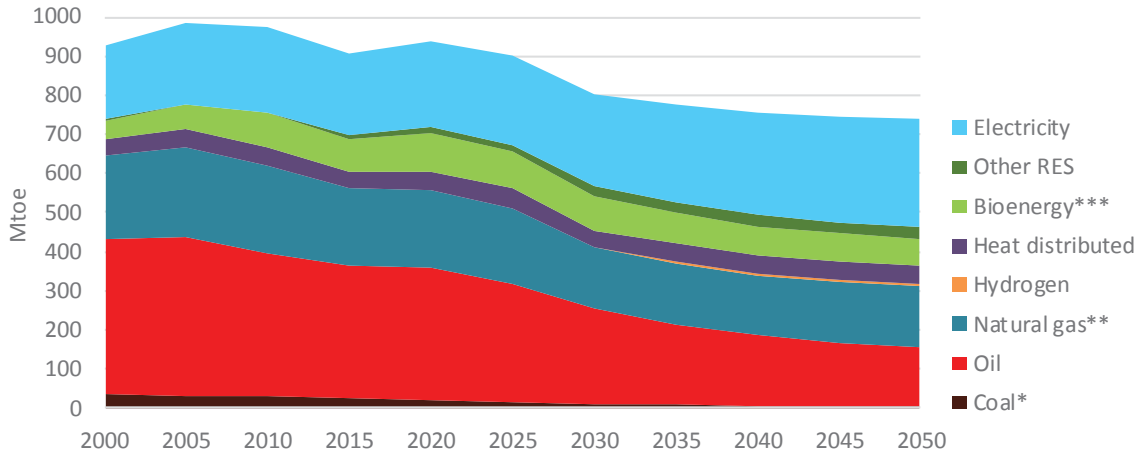
Source: Eurostat, PRIMES model

enhancing changes in production processes not accounted for under energy capital and fuel/electricity purchase costs. Energy system costs are calculated ex-post after the model is solved.

[178] See the EU Reference Scenario 2020 publication for a further discussion on the roles and levels of discount rates in the modelling, which also represent risk and opportunity costs associated with investments.

[179] COM(2018) 773

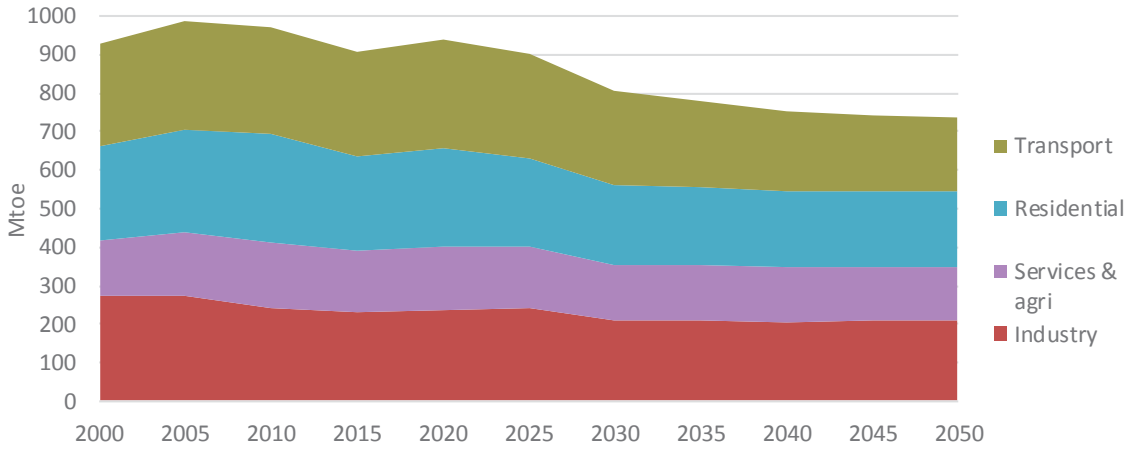
Figure 4: Share of energy carriers in final energy consumption in the Reference Scenario 2020



*Note: * includes peat and oil shale; ** includes manufactured gases, *** includes waste*
Source: Eurostat, PRIMES model

Coal use in power generation decrease by 62% by 2030 and almost completely disappear by 2050. Also demand for oil sees a significant decrease of 54% over the entire period – the most important in absolute terms. Electricity generation grows by 24% by 2050.

Figure 5: Final energy demand by sector in the Reference Scenario 2020



Source: Eurostat, PRIMES model

Despite continued economic growth, final energy demand decreases by 18% between 2015 and 2050 (already by 2030 it decreases by more than 8%).

1.1.5 Scenarios for the "Fit for 55" policy analysis

1.1.5.1 From the Climate Target Plan scenarios to "Fit for 55" core scenarios

In the Climate Target Plan (CTP) impact assessment, the increase of efforts needed for the GHG 55% target was illustrated by policy scenarios (developed with the same

modelling suite as the scenarios done for the "Fit for 55" package) showing increased ambition (or stringency) of climate, energy and transport policies and, consequently, leading to a significant investment challenge.

The first key lesson from the CTP exercise was that while the tools are numerous and have a number of interactions (or even sometimes trade-offs) a **complete toolbox of climate, energy and transport policies is needed** for the increased climate target as all sectors would need to contribute effectively towards the GHG 55% target.

The second key lesson was that even though policy tools chosen in the CTP scenarios were different - illustrating in particular the fundamental interplay between the strength of the carbon pricing and intensity of regulatory measures - **the results achieved were convergent**. All CTP policy scenarios that achieved a 55% GHG target[180] showed very similar levels of ambition for energy efficiency, renewables (overall and on sectoral level) and GHG reductions across the sectors indicating also the cost-effective pathways.

The third lesson was that carbon pricing working hand in hand with regulatory measures helps avoid "extreme" scenarios of either:

- a very high carbon price (in absence of regulatory measures) that will translate into increased energy prices for all consumers,
- very ambitious policies that might be difficult to be implemented (e.g. very high energy savings or renewables obligations) because they would be costly for economic operators or represent very significant investment challenge.

The Figure 6 below illustrates the interactions between different policy tools relevant to reach the EU's climate objectives.

[180] A 50% GHG target was also analysed

Figure 6: Interactions between different policy tools

With the 55% GHG target confirmed by EU leaders in the December 2020 EUCO Conclusions[181] and the 2021 Commission Work Programme[182] (CWP 2021) that puts forward the complete toolbox to achieve the increased climate target (so-called "Fit for 55" proposals), the fundamental set-up of the CTP analysis was confirmed. This set-up is still about the interplay between carbon pricing and regulatory measures as illustrated above, and the extension of the ETS is the central policy question.

As described above, the policy scenarios of the CTP assessment are cost-effective pathways that capture all policies needed to achieve the increased climate target of 55% GHG reductions. This fundamental design remains robust and the CTP scenarios were thus used as the basis to define the "Fit for 55" policy scenarios.

In the context of the agreed increased climate target of a net reduction of 55% GHG compared to 1990, the 50% GHG scenario (CTP MIX-50) explored in the CTP has been discarded since no longer relevant. The contribution of extra EU aviation and maritime emissions in the CTP ALLBNK scenario was assessed in the respective sector specific impact assessments and was not retained as a core scenario. This leaves the following CTP scenarios in need of further revisions and updates in the context of preparing input in a coherent manner for the set of IAs supporting the "Fit for 55" package, ensuring the achievement of the overall net 55% GHG reduction ambition with similar levels of renewable energy and energy efficiency deployment as in CTP:

[181] https://www.consilium.europa.eu/media/47328/1011-12-20-euco-conclusions-fr.pdf
[182] COM(2020) 690 final

- CTP REG (relying only on intensification of energy and transport policies in absence of carbon pricing beyond the current ETS sectors);
- CTP MIX (relying on both carbon price signal extension to road transport and buildings and intensification of energy and transport policies);
- CTP CPRICE (relying chiefly on carbon price signal extension, and more limited additional sectoral policies).

1.1.5.2 Scenarios for the "Fit for 55" package

Based on the Climate Target Plan analysis, some **updates were needed** though for the purpose of the "Fit for 55" assessment, in terms of:

- **Baseline**:
  - to reflect the most recent statistical data available, notably in terms of COVID impacts,
  - to capture the objectives and policies put forward by Member States in the NECPs, which were not all available at the time of the CTP analysis,

The baseline used in the Fit for 55 package is thus the "Reference Scenario 2020", as described in section 2.1.4.

- **Scenario design** in order to align better with policy options as put forward in the CWP 2021 and respective Inception Impact Assessments[183].

As a consequence, the three following core policy scenarios were defined to serve as common policy package analysis across the various initiatives of the "Fit for 55" policy assessments:

- **REG**: an update of the CTP REG case (relying only on very strong intensification of energy and transport policies in absence of carbon pricing beyond the current ETS sectors).
- **MIX**: reflecting an update of the CTP MIX case (relying on both carbon price signal extension to road transport and buildings and strong intensification of energy and transport policies). With its uniform carbon price (as of 2025), it reflects either an extended and fully integrated EU ETS or an existing EU ETS and new ETS established for road transport and buildings with emission caps set in line with cost-effective contributions of the respective sectors.

[183] Importantly, all "Fit for 55" core scenarios reflect the Commission Work Programme (CWP) 2021 in terms of elements foreseen. This is why assumptions are made about legislative proposals to be made later on - by Quarter 4 2021. On the energy side, the subsequent proposals are: the revision of the EPBD, the proposal for Decarbonised Gas Markets and the proposal for reducing methane emissions in the energy sector. For transport they refer to the revision of the TEN-T Regulation and the revision of the ITS Directive. In addition, other policies that are planned for 2022 are also represented in a stylised way in these scenarios, similar to the CTP scenarios. In this way, core scenarios represent all key policies needed to deliver the increased climate target.

- **MIX-CP**: representing a more carbon price driven policy mix, combining thus the general philosophy of the CTP CPRICE scenario with key drivers of the MIX scenario albeit at a lower intensity. It illustrates a revision of the EED and RED but limited to a lower intensification of current policies in addition to the carbon price signal applied to new sectors.
  Unlike MIX, this scenario allows to separate carbon price signals of "current" and "new" ETS. The relative split of ambition in GHG reductions between "current" ETS and "new ETS" remains, however, close in MIX-CP to the MIX scenario leading to differentiated carbon prices between "current" ETS and "new" ETS[184].

These three "Fit for 55" core policy scenarios have been produced starting from the Reference Scenario 2020 and thus use the same updated assumptions on post-COVID economics and international fuel prices.

Table 4 provides an overview of the policy assumptions retained in the three core policy scenarios. It refers in particular to different scopes of emissions trading system ("ETS"):

- "current+": refers to the current ETS extended to cover also national and international intra-EU maritime emissions[185]: this scope applies to all scenarios,
- "new": refers to the new ETS for buildings and road transport emissions: this scope applies in MIX and MIX-CP up to 2030,
- "large": refers to the use of emissions trading systems covering the "current" scope ETS, intra-EU maritime, buildings and road transport (equivalent to "current+" + "new"): this scope applies in MIX and MIX-CP after 2030.

The scenarios included focus on emissions within the EU, including intra-EU navigation and intra-EU aviation emissions. The inclusion or not of extra-EU navigation and extra-EU maritime emissions is assessed in the relevant sector specific Impact Assessments.

[184] This is a feature not implemented in the CTP CPRICE scenario.
[185] For modelling purposes "national maritime" is considered as equal to "domestic navigation", i.e. also including inland navigation.

Table 4: Scenario assumptions description (scenarios produced with the PRIMES-GAINS-GLOBIOM modelling suite)

<table>
<tr><th>Scenario</th><th>REG</th><th>MIX</th><th>MIX-CP</th></tr>
<tr><td rowspan="3">Brief description: ETS</td><td rowspan="3">Extension of “current” ETS to also cover intra-EU maritime navigation[186]
Strengthening of “current+” ETS in line with -55% ambition</td><td colspan="2">By 2030: 2 ETS systems:
- one “current+” ETS (current extended to intra-EU maritime)
- one “new” ETS applied to buildings and road transport

After 2030: both systems are integrated into one “large” ETS</td></tr>
<tr><td rowspan="2">*Relevant up to 2030*: the 2 ETSs are designed so that they have the same carbon price, in line with -55% ambition</td><td>*Relevant up to 2030:* “current+” ETS reduces emissions comparably to MIX</td></tr>
<tr><td>Lower regulatory intervention resulting in higher carbon price than in MIX, notably in the “new” ETS</td></tr>
<tr><td>Brief description: sectoral policies</td><td>High intensity increase of EE, RES, transport policies versus Reference</td><td>Medium intensity increase of EE, RES and transport policies versus Reference</td><td>Lower intensity increase of EE and RES policies versus Reference.
Transport policies as in MIX (except related to CO_2 standards)</td></tr>
<tr><td>Target scope</td><td colspan="3">EU27</td></tr>
<tr><td>Aviation</td><td colspan="3">Intra-EU aviation included, extra-EU excluded</td></tr>
<tr><td>Maritime</td><td colspan="3">Intra-EU maritime included, extra-EU excluded</td></tr>
</table>

[186] “Intra-EU navigation” in this table includes both international intra-EU and national maritime. Due to modelling limitations, energy consumption by “national maritime” is assumed to be the same as “domestic navigation”, although the latter also includes inland navigation.

Scenario	REG	MIX	MIX-CP
navigation			
Achieved GHG reduction of the target scope			
Including LULUCF	Around 55% reductions		
Excluding LULUCF	Around 53% reductions		
Assumed Policies			
Carbon pricing (stylised, for small industry, international aviation and maritime navigation may represent also other instruments than EU ETS such as taxation or CORSIA for aviation)			
Stationary ETS	Yes		
Aviation-Intra EU ETS	Yes		
Aviation - Extra EU ETS	Yes: mixture 50/50 carbon pricing (reflecting inclusion in the "current+" / "large" ETS, or taxation, or CORSIA) and carbon value (reflecting operational and technical measures); total equal to the carbon price of the "current+" (up to 2030) / "large" ETS		
Maritime-Intra EU ETS	Yes, carbon pricing equal to the price of the "current+" (up to 2030) / "large" EU ETS		
Maritime-Extra EU ETS	As in MIX (but applied to the "current+" ETS)	Up to 2030: no carbon pricing. After 2030: 50% of extra-EU MRV[187] sees the "large" ETS price, while the remaining 50% sees a carbon value equal to the "large" ETS carbon price.	
Buildings and road transport ETS	No	Yes (in the "new" ETS up to 2030, and in the "large" ETS after 2030)	
CO_2 standards for LDVs and	CO_2 standards for LDVs and HDVs + Charging and refuelling infrastructure development (review of the Directive on alternative fuels infrastructure and TEN-T Regulation & funding), including strengthened role of buildings		

[187] 50% of all incoming and all outgoing extra-EU voyages

Scenario	REG	MIX	MIX-CP
HDVs	High ambition increase	Medium ambition increase	Lower ambition increase
EE policies overall ambition	High ambition increase	Medium ambition increase	Lower ambition increase
EE policies in buildings	High intensity increase (more than doubling of renovation rates assumed)	Medium intensity increase (at least doubling of renovation rates assumed)	Lower intensity increase, no assumptions on renovation rates increases
EE policies in transport	High ambition increase	Medium intensity increase	As in MIX
RES policies overall ambition	High ambition increase	Medium intensity increase	Lower ambition increase except for transport (see below)
RES policies in buildings + industry	Incentives for uptake of RES in heating and cooling	Incentives for uptake of RES in heating and cooling	No increase of intensity of policy (compared to Reference)
RES policies in transport and policies impacting transport fuels	Increase of intensity of policies to decarbonise the fuel mix (reflecting ReFuelEU aviation and FuelEU maritime initiatives). Origin of electricity for "e-fuels" under the aviation and shipping mandates: up to 2035 (inclusive) "e-fuels" (e-liquids, e-gas, hydrogen) are produced from renewable electricity, applying additionality principle. from 2040 onwards "e-fuels" are produced from "low carbon" electricity (i.e. nuclear and renewable origin). No application of additionality principle. CO_2 from biogenic sources or air capture.		
Taxation policies	Central option on energy content taxation of the ETD revision		

Scenario	REG	MIX	MIX-CP
Additional non-CO_2 policies (represented by a carbon value)	Medium ambition increase		

1.1.5.3 Quantitative elements and key modelling drivers

Policies and measures are captured in the modelling analysis in different manners. Some are explicitely represented such as for instance improved product energy performance standards, fuel mandates or carbon pricing in an emission trading system. Others are represented by modelling drivers ("shadow values") used to achieve policy objectives.

The overall need for investment in new or retrofitted equipment depends on expected future demand and expected scrapping of installed equipment. The economic modelling of the competition among available investment options is based on:

- the investment cost, to which a "private" discount rate is applied to represent risk adverseness of the economic agents in the various sectors[188],
- fuel prices (including their carbon price component),
- maintenance costs as well as performance of installations over the potential lifetime of the installation,
- the relevant shadow values representing energy efficiency or renewable energy policies.

In particular, carbon pricing instruments impact economic decisions related to operation of existing equipment and to investment, in the different sectors where they apply. Table 5 shows the evolution of the ETS prices by 2030 in the Reference and core scenarios.

Table 5: ETS prices by 2030 in the difference scenarios (€2015/tCO₂)

Scenarios	Carbon price "current" ETS sectors		Carbon price "new" ETS sectors	
	2025	2030	2025	2030
REF2020	27	30	0	0
REG	31	42	0	0
MIX	35	48	35	48
MIX-CP	35	52	53	80

The investment decisions are also taken considering foresight of the future development of fuel prices, including future carbon values[189] post 2030. Investment decisions take into account expectations about climate and energy policy developments, and this carbon value achieves in 2050 levels between €360/tCO₂ (in REG, where energy policy drivers play comparatively a larger role) and €430/tCO₂ (MIX-CP)[190].

[188] For more information on the roles and levels of discount rates applied per sector, see the EU Reference Scenario 2020 publication.
[189] Post 2030, carbon values should not be seen as a projected carbon price in emissions trading, but as a shadow value representing a range of policies to achieve climate neutrality that are as yet to be defined.
[190] The foresight and the discounting both influence the investment decisions. While in the modelling the discounting is actually applied to the investment to compute annualised fixed costs for the investment

In complement to carbon pricing drivers, the modelling uses "shadow values" as drivers to reach energy policy objectives of policies and measures that represent yet to be defined policies in the respective fields: the so-called "energy efficiency value" and "renewable energy value", which impact investment decision-making in the model. These values are thus introduced to achieve a certain ambition on energy efficiency, for instance related to national energy efficiency targets and renewable energy targets in the NECPs as represented in the Reference Scenario 2020, or increased renovation rates in buildings and increased sector specific renewable energy ambition related to heating and cooling in the policy scenarios.

Table 6 shows average 2025-2035 values for the different scenarios. The values in REF2020 reflect the existing policy framework, to meet notably the national energy targets (both energy efficiency and renewable energy) as per the NECPs. They are typically higher in policy scenarios that are based on regulatory approaches than in scenarios that are more based on carbon pricing. The "energy efficiency value" and "renewable energy value" also interact with each other through incentivising investment in options which are both reducing energy demand and increasing the contribution of renewables, like heat pumps. This is for instance the case in the REG scenario, where the comparatively higher "energy efficiency value" complements the "renewable energy value" in contributing to the renewable energy performance of the scenario, notably through the highest heat pump penetration of all scenarios.

Table 6: Energy efficiency value and renewable energy value (averaged 2025-2035)

Scenarios	Average renewables shadow value	Average energy efficiency shadow value
	(€'15/ MWh)	(€'15/ toe)
REF2020	62	330
REG	121	1449
MIX	61	1052
MIX-CP	26	350

Specific measures for the transport system

Policies that aim at improving the efficiency of the transport system (corresponding to row "EE in Transport" in the Table 4), and thus reduce energy consumption and CO_2 emissions, are phased-in in scenarios that are differentiated in terms of level of ambition (low, medium, high ambition increase). All scenarios assume an intensification of such policies relative to the baseline. Among these policies, the CO_2 emission standards for vehicles are of particular importance. The existing standards[191], applicable from 2025 and

decision, its effect can be illustrated if applied to the future prices instead: for example, the average discounted carbon price in 2030 for the period 2030-2050 for renovation of houses and for heating equipment, applying a 12% discount rate, is €65 in the MIX scenario and €81 in the MIX CP scenario.

[191] The existing legislation sets for newly registered passengers cars, an EU fleet-wide average emission target of 95 gCO_2/km from 2021, phased in from 2020. For newly registered vans, the EU fleet-wide

from 2030, set binding targets for automotive manufacturers to reduce emissions and thus fuel consumption and are included in the Reference Scenario.

Medium ambition increase

In this case, the following policy measures are considered that drive improvements in transport system efficiency and support a shift towards more sustainable transport modes, and lead to energy savings and emissions reductions:

- Initiatives to increase and better manage the capacity of railways, inland waterways and short sea shipping, supported by the TEN-T infrastructure and CEF funding;
- Gradual internalisation of external costs ("smart" pricing);
- Incentives to improve the performance of air navigation service providers in terms of efficiency and to improve the utilisation of air traffic management capacity;
- Incentives to improve the functioning of the transport system: support to multimodal mobility and intermodal freight transport by rail, inland waterways and short sea shipping;
- Deployment of the necessary infrastructure, smart traffic management systems, transport digitalisation and fostering connected and automated mobility;
- Further actions on clean airports and ports to drive reductions in energy use and emissions;
- Measures to reduce emissions and air pollution in urban areas;
- Pricing measures such as in relation to energy taxation and infrastructure charging;
- Revision of roadworthiness checks;
- Other measures incentivising behavioural change;
- Medium intensification of the CO_2 emission standards for cars, vans, trucks and buses (as of 2030), supported by large scale roll-out of recharging and refuelling infrastructure. This corresponds to a reduction in 2030 compared to the 2021 target of around 50% for cars and around 40% for vans.

Low ambition increase

In this case, the same policy measures as in the *Medium ambition increase* are included. However, limited increase in ambition for CO_2 emission standards for vehicles (passenger cars, vans, trucks and buses) as of 2030 is assumed, supported by the roll-out of recharging and refuelling infrastructure. This corresponds to a reduction in 2030 compared to the 2021 target of around 40% for cars and around 35% for vans.

High ambition increase

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average emission target is 147 gCO_2 /km from 2020 onward. Stricter EU fleet-wide CO_2 emission targets, start to apply from 2025 and from 2030. In particular emissions will have to reduce by 15% from 2025 for both cars and vans, and by 37.5% and 31% for cars and vans respectively from 2030, as compared to 2021. From 2025 on, also trucks manufacturers will have to meet CO_2 emission targets. In particular, the EU fleet-wide average CO_2 emissions of newly registered trucks will have to reduce by 15% by 2025 and 30% by 2030, compared to the average emissions in the reference period (1 July 2019–30 June 2020). For cars, vans and trucks, specific incentive systems are also set to incentivise the uptake of zero and low-emission vehicles.

Beyond measures foreseen in the medium ambition increase case, the high ambition increase case includes:

- Further measures related to intelligent transport systems, digitalisation, connectivity and automation of transport - supported by the TEN-T infrastructure;
- Additional measures to improve the efficiency of road freight transport;
- Incentives for low and zero emissions vehicles in vehicle taxation;
- Increasing the accepted load/length for road in case of zero-emission High Capacity Vehicles;
- Additional measures in urban areas to address climate change and air pollution;
- Higher intensification of the CO_2 emission standards for cars, vans, trucks and buses (as of 2030) as compared to the medium ambition increase case, leading to lower CO_2 emissions and fuel consumption and further incentivising the deployment of zero- and low-emission vehicles, supported by the large scale roll-out of recharging and refuelling infrastructure. This corresponds to a reduction in 2030 compared to the 2021 target of around 60% for cars and around 50% for vans.

Drivers of reduction in non-CO_2 GHG emissions

Non-CO_2 GHG emission reductions are driven by both the changes taking place in the energy system due to the energy and carbon pricing instruments, and further by the application of a carbon value that triggers further cost efficient mitigation potential (based on the GAINS modelling tool) in specific sectors such as waste, agriculture or industry.

Table 7: Carbon value applied to non-CO_2 emissions in the GAINS model (€2015/tCO_2)

Scenarios	Non-CO_2 carbon values	
	2025	2030
REF2020	0	0
REG	4	4
MIX	4	4
MIX-CP	5	10

1.1.5.4 Key results and comparison with Climate Target Plan scenarios

Table 8: Key results of the "Fit for 55" core scenarios analysis for the EU

2030 unless otherwise stated		REF	REG	MIX	MIX-CP
Key results					
GHG emissions* reductions (incl. intra EU aviation and maritime, incl. LULUCF)	% reduction from 1990	45%	55%	55%	55%
GHG emissions* reductions (incl. intra EU aviation and maritime, excl. LULUCF)	% reduction from 1990	43.4%	53.0%	52.9%	52.9%
Overall RES share	%	33%	40%	38%	38%
RES-E share	%	59%	65%	65%	65%
RES-H&C share	%	33%	41%	38%	36%
RES-T share	%	21%	29%	28%	27%
PEC energy savings	% reduction from 2007 Baseline	33%	39%	39%	38%
FEC energy savings	% reduction from 2007 Baseline	30%	37%	36%	35%
Environmental impacts					
CO_2 emissions reductions (intra-EU scope, excl. LULUCF), of which	(% change from 2015)	-30%	-43%	-42%	-42%
Supply side (incl. power generation, energy branch, refineries and district heating)	(% change from 2015)	-49%	-62%	-63%	-64%
Power generation	(% change from 2015)	-51%	-64%	-65%	-67%
Industry (incl. process emissions)	(% change from 2015)	-10%	-23%	-23%	-23%
Residential	(% change from 2015)	-32%	-56%	-54%	-50%
Services	(% change from 2015)	-36%	-53%	-52%	-48%
Agriculture (energy)	(% change from 2015)	-23%	-36%	-36%	-35%
Transport (incl. domestic and intra EU aviation and navigation)	(% change from 2015)	-17%	-22%	-21%	-21%
Non-CO_2 GHG emissions reductions (excl. LULUCF)	(% change from 2015)	-22%	-32%	-32%	-33%
Reduced air pollution vs. REF	(% change)			-10%	
Reduced health damages and air pollution control cost vs. REF - Low estimate	(€ billion/year)			24.8	
Reduced health damages and air pollution control cost vs. REF - High estimate	(€ billion/year)			42.7	
Energy system impacts					
Primary Energy Intensity	toe/M€'13	83	75	76	76
Gross Available Energy (GAE)	Mtoe	1,289	1,194	1,198	1,205
- Solids share	%	9%	6%	5%	5%
- Oil share	%	34%	33%	33%	33%
- Natural gas share	%	21%	20%	20%	21%
- Nuclear share	%	10%	11%	11%	11%
- Renewables share	%	26%	31%	30%	30%
- Bioenergy share	%	13%	13%	12%	12%
- Other Renewables share	%	13%	18%	18%	18%
Gross Electricity Generation	TWh	2,996	3,152	3,154	3,151

- Gas share	%	14%	12%	13%	14%
- Nuclear share	%	17%	16%	16%	16%
- Renewables share	%	59%	65%	65%	65%
Economic impacts					
Investment expenditures (excl. transport) (2021-30)	bn €'15/year	297	417	402	379
Investment expenditures (excl. transport) (2021-30)	% GDP	2.1%	3.0%	2.9%	2.7%
Additional investments to REF	*bn €'15/year*		*120*	*105*	*83*
Investment expenditures (incl. transport) (2030-51)	bn €'15/year	944	1068	1051	1028
Investment expenditures (incl. transport) (2030-51)	% GDP	6.8%	7.7%	7.6%	7.4%
Additional investments to REF	*bn €'15/year*		*124*	*107*	*84*
Additional investments to 2011-20	*bn €'15/year*	*285*	*408*	*392*	*368*
Energy system costs excl. carbon pricing and disutility (2021-30)	bn €'15/year	1518	1555	1550	1541
Energy system costs excl. carbon pricing and disutility (2021-30)	% GDP	10.9%	11.2%	11.15%	11.1%
Energy system costs incl. carbon pricing and disutility (2021-30)	bn €'15/year	1535	1598	1630	1647
Energy system costs incl. carbon pricing and disutility (2021-30)	% GDP	11.0%	11.5%	11.7%	11.8%
ETS price in current sectors (and maritime)	€/tCO_2	30	42	48	52
ETS price in new sectors (buildings and road transport)	€/tCO_2	0	0	48	80
Average Price of Electricity	€/MWh	158	156	156	157
Import dependency	%	54%	52%	53%	53%
Fossil fuels imports bill savings compared to REF (2021-30)	bn €'15		136	115	99
Energy-related expenditures in buildings (excl. disutility)	% of private consumption	6.9%	7.5%	7.5%	7.4%
Energy-related expenditures in transport (excl. disutility)	% of private consumption	18.1%	18.1%	18.3%	18.5%

*Note: *All scenarios achieve 55% net reductions in 2030 compared to 1990 for domestic EU emissions, assuming net LULUCF contributions of 255 Mt CO_2-eq. in 1990 and 225 Mt CO_2-eq. in 2030 and including national, intra-EU maritime and intra-EU aviation emissions[192].*

Source: PRIMES model, GAINS model

Table 9: Comparison with the CTP analysis

Results for 2030	CTP 55% GHG reductions scenarios range (REG, MIX, CPRICE, ALLBNK)	"Fit for 55" core scenarios range (REG, MIX, MIX-CP)

[192] Emissions estimates for 1990 are based on EU UNFCCC inventory data 2020, converted to IPCC AR5 Global Warming Potentials for notably methane and nitrous oxide. However, international intra-EU aviation and international intra-EU navigation are not separated in the UNFCCC data from the overall international bunker fuels emissions. Therefore, 1990 estimates for the intra-EU emissions of these sectors are based on (a combination of) data analysis for PRIMES modelling and 2018-2019 MRV data for the maritime sector.

Overall net GHG reduction (w.r.t. 1990)*	55%	55%
Overall RES share	38-40%	38-40%
RES-E	64-67%	65%
RES-H&C	39-42%	36-41%
RES-T	22-26%	27-29%
FEC EE	36-37%	35-37%
PEC EE	39-41%	38-39%
CO_2 reduction on the supply side (w.r.t. 2015)	67-73%	62-64%
CO_2 reduction in residential sector (w.r.t. 2015)	61-65%	50-56%
CO_2 reduction in services sector (w.r.t. 2015)	54-61%	48-53%
CO_2 reduction in industry (w.r.t. 2015)	21-25%	23%
CO_2 reduction in intra-EU transport (w.r.t. 2015)	16-18%	21-22%
CO_2 reduction in road transport (w.r.t. 2015)	19-21%	24-26%
Non-CO_2 GHG reductions (w.r.t. 2015, excl. LULUCF)	31-35%	32-33%
Investments magnitude, excluding transport (in bn€/per year)	401-438 bn/year	379-417 bn/per year
Energy system costs (excl. auction payments and disutility) as share of GDP (%, 2021-2030)	10.9-11.1%	11.1-11.2%

*Note: *All scenarios achieve 55% net reductions in 2030 compared to 1990 for domestic EU emissions, assuming net LULUCF contributions of 255 Mt CO_2-eq. in 1990 and 225 Mt CO_2-eq. in 2030 and including national, intra-EU maritime and intra-EU aviation emissions[60] (except the CTP ALLBNK that achieves 55% net reductions including also emissions from extra-EU maritime and aviation).*

Source: PRIMES model, GAINS model

1.1.6 Results per Member State

This document is completed by detailed modelling results at EU and MS level for the different core policy scenarios:

- Energy, transport and overall GHG (PRIMES model)
- Details on non-CO_2 GHG emissions (GAINS model)
- LULUCF emissions (GLOBIOM model)
- Air pollution (GAINS model)

2. SPECIFIC ANALYTICAL ELEMENTS FOR THIS IMPACT ASSESSMENT

The quantitative analysis of the options for this Impact Assessment is based on modelling of the aviation sector using the Aviation Integrated Model (AIM) global aviation systems model and of the wider economy using the E3ME global macro-economic model, for impacts up to 2035. Here we present the results for 2030. The full results are presented in the study commissioned by the Commission[193].

Description of the Aviation Integrated Model (AIM)

The **Aviation Integrated Model** (AIM) is a global aviation systems model, which simulates interactions between passengers, airlines, airports and other system actors into the future, with the goal of providing insight into how policy levers and other projected system changes will affect aviation's externalities and economic impacts.

The model was originally developed in 2006-2009 with UK research council funding (e.g. Reynolds et al., 2007; Dray et al. 2014)[194], and was updated as part of the ACCLAIM project (2015-2018) between University College London, Imperial College and Southampton University (e.g. Dray et al., 2019)[195], with additional input from MIT regarding electric aircraft (e.g. Schäfer et al., 2018)[196].

AIM uses a modular, integrated approach to simulate the global aviation system and its response to policy. The basic model structure is shown in Figure A4.1 below. AIM consists of seven interconnected modules.

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[193] ICF Consulting et al. (2020), Assessment of ICAO's global market-based measure (CORSIA) pursuant to Article 28b and for studying cost pass-through pursuant to Article 3d of the EU ETS Directive (hereafter "ICF Study").

[194] Reynolds, T., Barrett, S., Dray, L., Evans, A., Köhler, M., Vera-Morales, M., Schäfer, A., Wadud, Z., Britter, R., Hallam, H., Hunsley, R., 2007. Modelling Environmental and Economic Impacts of Aviation: Introducing the Aviation Integrated Modelling Tool. In: Proceedings of the 7th AIAA Aviation Technology, Integration and Operations Conference, Belfast, 18–20 September 2007, AIAA-2007-7751; Dray, L., Evans, A., Reynolds, T., Schäfer, A., Vera-Morales, M. and Bosbach, W., 2014. Airline fleet replacement funded by a carbon tax: an integrated assessment. Transport Policy, 34, 75-84.

[195] Dray L., Krammer P., Doyme K., Wang B., Al Zayat K, O'Sullivan A., Schäfer A., 2019. "AIM2015: Validation and initial results from an open-source aviation systems model", *Transport Policy,* 79, 93-102.

[196] Schäfer A., Barrett, S., Doyme, K., Dray, L., Gnadt, A., Self, R., O'Sullivan, A., Synodinos, A., & Torija, A., 2018. Technological, economic and environmental prospects of all-electric aircraft. Nature Energy, 4, 160-166.

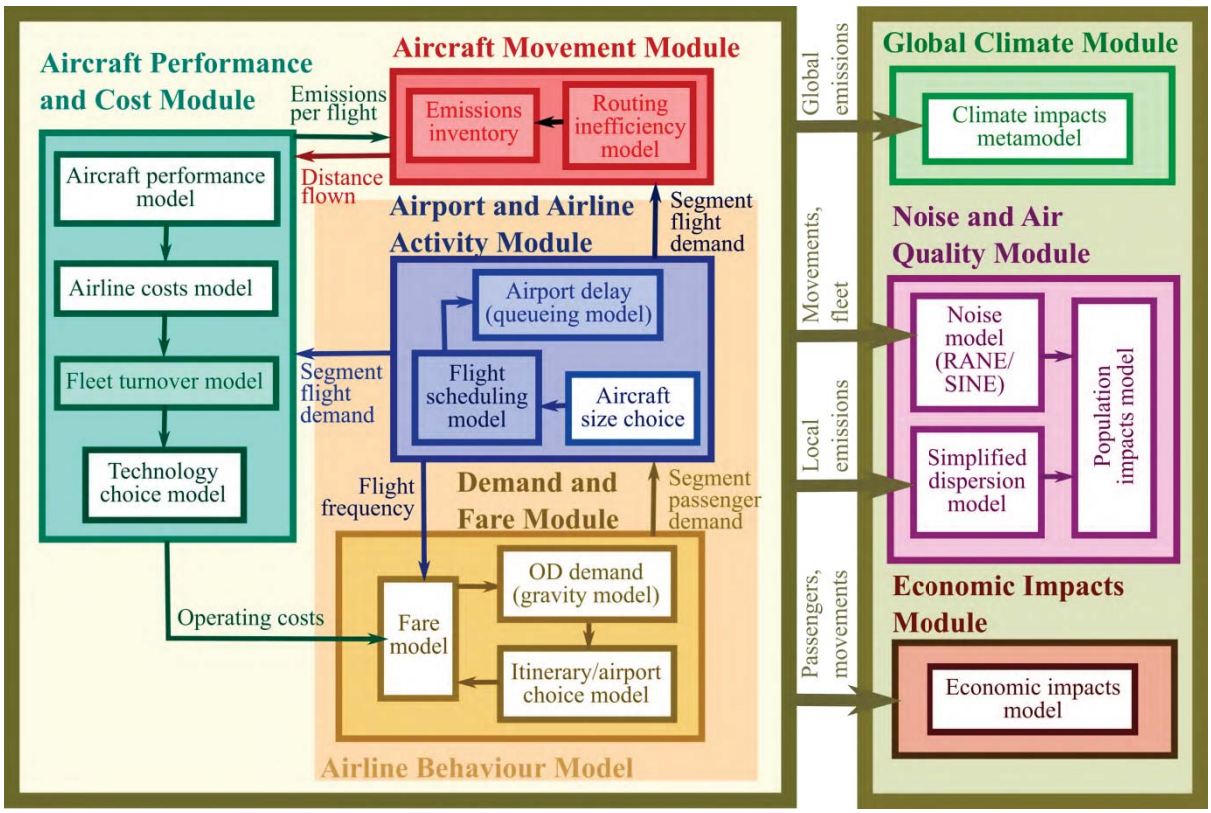


Figure A4.1 AIM model structure

The Demand and Fare Module projects true origin-ultimate destination demand between a set of cities representing approximately 95% of global scheduled RPK[197], using a gravity-type model based on origin and destination population and income, average journey generalized cost, and other factors, as detailed in Dray et al. (2014). Within each city-city passenger flow, airport choice and routing choice (including hub airport for multi-segment journeys) are handled using a multinomial logit model. Itinerary choice is modelled as a function of journey time, cost, number flight segments, available flight frequency and characteristics of the origin and destination airports. This model is described further in Dray & Doyme (2019)[198].

Fares per individual itinerary are simulated using a fare model (Wang et al., 2017)[199] based on airline costs by type per segment, demand, route-level competition, low-cost

[197] Note that non-scheduled flights and freight are also modelled for this report. Because less information is available on routing for these flights, they are dealt with using a segment-based scaling approach.
[198] Dray, L. and Doyme, K., 2019. "Carbon Leakage in Aviation Policy", *Climate Policy,* 19 (10), 1284-1296.
[199] Wang, B., O'Sullivan, A., Dray, L., Al Zayat, K. and Schäfer, A., 2017. Modelling the Pass-Through of Airline Operating Costs on Average Fares in the Global Aviation Market. 21st ATRS conference, Antwerp, 5-8 July 2017.

carrier presence and other factors. These models are estimated primarily on detailed disaggregate global passenger routing and fare data from Sabre (2017)[200].

The Airline and Airport Activity Module, given segment-level demand, assesses which aircraft will be used to fly these routes and at what frequency, using a multinomial logit model estimated from historical scheduling data (Sabre, 2017) and dividing the fleet into nine size categories. Given these aircraft movements per airport, a queuing model then estimates what the resulting airport-level delays would be (Evans, 2008)[201]. Given the lack of long-term airport capacity forecasts, in most cases this delay model is used to estimate the amount of (city-level) capacity that would be required to keep delays at current levels.

The aircraft movement module assesses the corresponding airborne routes and the consequent location of emissions. In particular, routing inefficiencies which increase ground track distance flown beyond great circle distance, and fuel use above optimal for the given flight distance, are modelled using distance-based regional inefficiency factors based on an analysis of radar track data, as discussed in Reynolds (2008)[202].

Given typical aircraft utilization, the aircraft technology and cost module assesses the size, composition, age and technology use of the aircraft fleet, and the resulting costs for airlines and emissions implications. First, aircraft movements by size class including routing inefficiency from the Aircraft Movement Module are input to a performance model (estimated from outputs of the PIANO-X[203] model with reference aircraft types and missions for CO_2 and NOx, the FOX methodology (Stettler et al. 2013)[204] for PM2.5, and Wood et al. (2008)[205] for NO_2). Second, the costs of operating this fleet for the given schedule are estimated based on historical cost data by category and aircraft type (Al Zayat et al, 2017[206]). Third, emissions and costs are adjusted to account for the current age distribution and technology utilization of the fleet, including typical retirement and freighter conversion behavior (e.g. Dray, 2013)[207]. Finally, any shortfall in aircraft required to perform the given schedule is assumed made up by new purchases, and the uptake of technology and emissions mitigation measures by both new aircraft and

[200] Sabre, 2017. Market Intelligence passenger demand, routing and aircraft schedule databases. https://www.sabreairlinesolutions.com
[201] Evans, A., 2008. "Rapid Modelling of Airport Delay". 12th Air Transport Research Society (ATRS) World Conference, Athens, Greece, July 6-10.
[202] Reynolds, T. G., 2009. Development of flight inefficiency metrics for environmental performance assessment of ATM. 8th USA/Europe Air Traffic Management Research and Development Seminar, Napa, CA, June 29 - July 2.
[203] Lissys, 2017. The PIANO X Aircraft Performance Model. www.piano.aero
[204] Stettler, M. E. J., Boies, A. M., Petzold, A. and Barrett, S. R. H., 2013. Global civil aviation black carbon emissions. Environmental Science and Technology, 47, 10397-10404.
[205] Wood, E.C., Herndon, S. C., Timko, M. T., Yelvington, P. E. and Miake-Lye, R.C., 2008. Speciation and chemical evolution of nitrogen oxides in aircraft exhaust near airports. Environmental Science and Technology, 2008, 42(6), 1884-1891.
[206] Al Zayat, K., Dray, L., Schäfer A., 2017. A Comparative Analysis of Operating Cost between Future Jet-Engine Aircraft and Battery Electric Aircraft. 21st ATRS Conference, Antwerp, 5-8 July 2017.
[207] Dray, L., 2013. An analysis of the impact of aircraft lifecycles on aviation emissions mitigation policies. Journal of Air Transport Management, 28, 62-69.

existing ones is assessed on a net present value basis, as described in Dray et al. (2018)[208], and the impact of this on costs and emissions is assessed.

These four modules are run iteratively until a stable solution is reached. The output is then used in the impacts modules, shown on the right of Figure 71. The global climate module is a rapid, reduced-form climate model which calculates the CO2 emissions. The air quality and noise module are similarly rapid, reduced-form models which provide metrics by airport for the noise and local/regional air quality impacts of the projected aviation system. In the case of air quality, dispersion modelling for primary pollutants uses a version of the RDC code (e.g. Yim et al., 2015)[209]. The type of noise modelling carried out depends on whether data on standard flight routes per airport is available, but for all airports noise modelling based on total noise energy is carried out (Torija et al. 2016, 2017)[210]. The regional economics module looks in more detail at the economic impacts, including benefits such as increased employment as well as costing of noise and air quality impacts.

Description of the E3ME model

Overview

E3ME is a computer-based model of the world's economic and energy systems and the environment. It was originally developed through the European Commission's research framework programmes and is now widely used in Europe and beyond for policy assessment, for forecasting and for research purposes. The global version of E3ME provides:

1. better geographical coverage
2. better feedbacks between individual European countries and other world economies
3. better treatment of international trade with bilateral trade between regions
4. new technology diffusion sub-modules

This model description provides a short summary of the E3ME model. For further details, please read the full model manual available online from www.e3me.com.

[208] Dray, L., Schäfer, A. & Al Zayat, K., 2018. The global potential for CO_2 emissions reduction from jet engine passenger aircraft. *Transportation research Record*, 2672(23), 40-51.
[209] Yim, S. H. L., Lee, G. L., Lee, I. H., Allroggen, F., Ashok, A., Caiazzo, F., Eastham, S. D., Malina, R. and Barrett, S. R. H., 2015. Global, regional and local health impacts of civil aviation emissions. Environmental Research Letters, 10(3), 034001.
[210] Torija, A. J., Self, R. H. and Flindell, I. H., 2016. On the CO_2 and noise emissions forecast in future aviation scenarios in the UK. Proceedings of inter.noise 2016, Hamburg; Torija, A. J. , Self, R. H. and Flindell, I. H., 2016. Evolution of noise metrics in future aviation scenarios in the UK. 23rd International Congress on Sound and Vibration, Athens, 10-14 July 2016; Torija, A.J., Self, R. H. and Flindell, I. H., 2017. A model for the rapid assessment of the impact of aviation noise near airports. Journal of the Acoustical Society of America 141(2), 981-995.

Applications of E3ME

Scenario-based analysis

Although E3ME can be used for forecasting, the model is more commonly used for evaluating the impacts of an input shock through a scenario-based analysis. The shock may be either a change in policy, a change in economic assumptions or another change to a model variable. The analysis can be either forward looking (ex-ante) or evaluating previous developments in an ex-post manner. Scenarios may be used either to assess policy, or to assess sensitivities to key inputs (e.g. international energy prices).

For ex-ante analysis a baseline forecast up to 2050 is required; E3ME is usually calibrated to match a set of projections that are published by the European Commission and the International Energy Agency but alternative projections may be used. The scenarios represent alternative versions of the future based on a different set of inputs. By comparing the outcomes to the baseline (usually in percentage terms), the effects of the change in inputs can be determined.

Price or tax scenarios

Model-based scenario analyses often focus on changes in price because this is easy to quantify and represent in the model structure. Examples include:

- changes in tax rates including direct, indirect, border, energy and environment taxes
- changes in international energy prices

Regulatory impacts

All of the price changes above can be represented in E3ME's framework reasonably well, given the level of disaggregation available. However, it is also possible to assess the effects of regulation, albeit with an assumption about effectiveness and cost. For example, an increase in vehicle fuel-efficiency standards could be assessed in the model with an assumption about how efficient vehicles become, and the cost of these measures. This would be entered into the model as a higher price for cars and a reduction in fuel consumption (all other things being equal). E3ME could then be used to determine:

- secondary effects, for example on fuel suppliers
- rebound effects[211]
- overall macroeconomic impacts

Comparison with CGE models and econometric specification

E3ME is often compared to Computable General Equilibrium (CGE) models. In many ways the modelling approaches are similar; they are used to answer similar questions and use similar inputs and outputs. However, underlying this there are important theoretical differences between the modelling approaches.

[211] In the example, the higher fuel efficiency effectively reduces the cost of motoring. In the long-run this is likely to lead to an increase in demand, meaning some of the initial savings are lost. Barker et al (2009) demonstrate that this can be as high as 50% of the original reduction.

In a typical CGE framework, optimal behaviour is assumed, output is determined by supply-side constraints and prices adjust fully so that all the available capacity is used. In E3ME the determination of output comes from a post-Keynesian framework and it is possible to have spare capacity. The model is more demand-driven and it is not assumed that prices always adjust to market clearing levels.

The differences have important practical implications, as they mean that in E3ME regulation and other policy may lead to increases in output if they are able to draw upon spare economic capacity. This is described in more detail in the model manual.

The econometric specification of E3ME gives the model a strong empirical grounding. E3ME uses a system of error correction, allowing short-term dynamic (or transition) outcomes, moving towards a long-term trend. The dynamic specification is important when considering short and medium-term analysis (e.g. up to 2020) and rebound effects[212], which are included as standard in the model's results.

Limitations of the approach

As with all modelling approaches, E3ME is a simplification of reality and is based on a series of assumptions. Compared to other macroeconomic modelling approaches, the assumptions are relatively non-restrictive as most relationships are determined by the historical data in the model database. This does, however, present its own limitations, for which the model user must be aware:

The quality of the data used in the modelling is very important. Substantial resources are put into maintaining the E3ME database and filling out gaps in the data. However, particularly in developing countries, there is some uncertainty in results due to the data used.

Econometric approaches are also sometimes criticised for using the past to explain future trends. In cases where there is large-scale policy change, the 'Lucas Critique' that suggests behaviour might change is also applicable. There is no solution to this argument using any modelling approach (as no one can predict the future) but we must always be aware of the uncertainty in the model results.

E3ME basic structure and data

The structure of E3ME is based on the system of national accounts, with further linkages to energy demand and environmental emissions. The labour market is also covered in detail, including both voluntary and involuntary unemployment. In total there are 33 sets of econometrically estimated equations, also including the components of GDP (consumption, investment, international trade), prices, energy demand and materials demand. Each equation set is disaggregated by country and by sector.

[212] Where an initial increase in efficiency reduces demand, but this is negated in the long run as greater efficiency lowers the relative cost and increases consumption. See Barker et al (2009).

E3ME's historical database covers the period 1970-2014 and the model projects forward annually to 2050. The main data sources for European countries are Eurostat and the IEA, supplemented by the OECD's STAN database and other sources where appropriate. For regions outside Europe, additional sources for data include the UN, OECD, World Bank, IMF, ILO and national statistics. Gaps in the data are estimated using customised software algorithms.

The main dimensions of the model

The main dimensions of E3ME are:

- 61 countries – all major world economies, the EU28 and candidate countries plus other countries' economies grouped
- 44 or 70 (Europe) industry sectors, based on standard international classifications
- 28 or 43 (Europe) categories of household expenditure
- 22 different users of 12 different fuel types
- 14 types of air-borne emission (where data are available) including the 6 HG's monitored under the Kyoto Protocol

Standard outputs from the model

As a general model of the economy, based on the full structure of the national accounts, E3ME is capable of producing a broad range of economic indicators. In addition there is range of energy and environment indicators. The following list provides a summary of the most common model outputs:

- GDP and the aggregate components of GDP (household expenditure, investment, government expenditure and international trade)
- sectoral output and GVA, prices, trade and competitiveness effects
- international trade by sector, origin and destination
- consumer prices and expenditures
- sectoral employment, unemployment, sectoral wage rates and labour supply
- energy demand, by sector and by fuel, energy prices
- CO_2 emissions by sector and by fuel
- other air-borne emissions
- material demands

This list is by no means exhaustive and the delivered outputs often depend on the requirements of the specific application. In addition to the sectoral dimension mentioned in the list, all indicators are produced at the national and regional level and annually over the period up to 2050.

E3ME as an E3 model

The E3 interactions

Each data set has been constructed by statistical offices to conform with accounting conventions. Exogenous factors coming from outside the modelling framework are

shown on the outside edge of the chart as inputs into each component. For each region's economy the exogenous factors are economic policies (including tax rates, growth in government expenditures, interest rates and exchange rates). For the energy system, the outside factors are the world oil prices and energy policy (including regulation of the energy industries). For the environment component, exogenous factors include policies such as reduction in SO2 emissions by means of end-of-pipe filters from large combustion plants. The linkages between the components of the model are shown explicitly by the arrows that indicate which values are transmitted between components.

The economy module provides measures of economic activity and general price levels to the energy module; the energy module provides measures of emissions of the main air pollutants to the environment module, which in turn can give measures of damage to health and buildings. The energy module provides detailed price levels for energy carriers distinguished in the economy module and the overall price of energy as well as energy use in the economy.

Treatment of international trade

An important part of the modelling concerns international trade. E3ME solves for detailed bilateral trade between regions (similar to a two-tier Armington model). Trade is modelled in three stages:

5. econometric estimation of regions' sectoral import demand
6. econometric estimation of regions' bilateral imports from each partner
7. forming exports from other regions' import demands

Trade volumes are determined by a combination of economic activity indicators, relative prices and technology.

The labour market

Treatment of the labour market is an area that distinguishes E3ME from other macroeconomic models. E3ME includes econometric equation sets for employment, average working hours, wage rates and participation rates. The first three of these are disaggregated by economic sector while participation rates are disaggregated by gender and five-year age band.

The labour force is determined by multiplying labour market participation rates by population. Unemployment (including both voluntary and involuntary unemployment) is determined by taking the difference between the labour force and employment. This is typically a key variable of interest for policy makers.

The role of technology

Technological progress plays an important role in the E3ME model, affecting all three E's: economy, energy and environment. The model's endogenous technical progress indicators (TPIs), a function of R&D and gross investment, appear in nine of E3ME's econometric equation sets including trade, the labour market and prices. Investment and R&D in new technologies also appears in the E3ME's energy and material demand

equations to capture energy/resource savings technologies as well as pollution abatement equipment. In addition, E3ME also captures low carbon technologies in the power sector through the FTT power sector model.[213]

Model Inputs and Assumptions

The inputs to the modelling were derived from the (Draft) PRIMES Reference Scenario, as used for other Impact Assessments following the Climate Target Plan. New model runs were undertaken in December 2020 and January 2021 using revised input from the PRIMES Reference Scenario, reflecting the impacts of the COVID-19 pandemic.

Aviation modelling was carried out both for a set of 'most likely' trajectories in uncertain input scenario variables (oil price, carbon price, demand growth, CORSIA participation and changes in technology) and across a grid of variant scenarios for these input variables. Outputs are then reported for nominal scenario conditions (i.e., using the 'most likely' trajectories for all uncertain scenario variables; the E3ME modelling is also carried out on this basis) along with a given range in each output metric across all other combinations of uncertain scenario variables.

The variables, and scenarios or trajectories modelled for these variables, are:

- The main options (C0WIDE, C1BASE, C2CONLY, C3CLEAN, C4MIX)
- Demand growth (at nominal values for other variables): high, central and low growth via different scenarios for demand drivers (e.g. GDP/capita, population) and development of elasticities.
- Oil price: high, central low oil price trajectories
- Carbon price: separate higher and lower price trajectories for EU ETS allowance price and CORSIA-eligible offsets.
- Technology: optimistic, central and pessimistic lenses for timeline and effectiveness of within-sector emissions mitigation measures.
- CORSIA Participation: Low, Initial Assumed and High.

The ICF report provides a detailed description of these. Some key elements are described below.

The following oil price assumptions are used, as provided by the Commission to the modelers.

Oil prices during the pandemic recovery period are lower in all cases than projected ahead of the crisis, and for the nominal scenario they remain lower than previously projected throughout the entire modelled period to 2035.

[213] See Mercure (2012).

Table A4.1: Assumptions about oil price used for the high, nominal, and low scenarios with COVID-19 adjustment. Values in the previous impact assessment are shown in brackets (where different).

Scenario	Oil price, year 2015 US dollars				
	2015	2020	2025	2030	2035
COVID-19-adjusted High	52	40 (67)	96	108	124
COVID-19-adjusted Nominal	52	40 (58)	60 (73)	80 (87)	90 (94)
COVID-19-adjusted Low	52	40 (58)	60 (61)	59	57

The following carbon price assumptions were used for EU allowances and CORSIA eligible offsets (adjusted for the impacts of COVID-19).

Table A4.2: Carbon price assumptions by scenario and allowance type, corrected for the impacts of COVID-19.

Scenario	*Carbon price €/tCO2, year 2020 euros*			
	2015	2020	2025	2030
EUA (EU ETS) Base COVID-19 (nominal)	7.8	26.5	27.5	32
EUA (EU ETS) IIb COVID-19 (high)	7.8	26.5	47.8	84.5
CORSIA Sc1 (nominal)	0.20	1.02	1.02	1.02
CORSIA Sc2 (high)	0.20	1.02	5.09	13.2

Technology Assumptions

In AIM, technology developments are modelled by specifying values for the individual characteristics of candidate technologies per aircraft size class, for nine size classes from Small Regional Jets to Very Large Aircraft. The resulting change in fuel use per RPK or RTK is then an output of the model. The characteristics of future technologies (e.g. new aircraft models, retrofits, operational measures or alternative fuels) can be highly uncertain. In many cases, estimates of the benefits of technologies depend on engineering breakthroughs that have still to be made. Therefore, the technology adoption model uses a lens approach to assess the impact of uncertainty in technology parameters (e.g. Allaire et al. 2014)[214]. A lens is a set of input parameters which reflect a particular scenario for future technology. For example, the 'pessimistic' technology lens used in this study describes a future in which it is particularly hard to reduce aviation emissions through technology; this assumes the reduction in fuel use from new technologies is at the low end of available estimates, costs are at the high end of available estimates, and the date from which the technology is available is at the late end of available estimates. For this impact assessments, three lenses have been defined using technology parameters, including changes in aircraft operating costs by cost type and changes in fuel burn, as derived from Schäfer et al. (2016)[215] and Dray et al. (2018). As well as the pessimistic lens discussed above, we use a central lens which assumes all technology parameters are at central/'most likely' values from available estimates, and an 'optimistic' scenario in which reductions in fuel use from new technologies are at the high end of available estimates, costs are at the low end of available estimates, and the date from which the technology is available is at the early end of available estimates. In all cases we assume consistency with ICAO's CO_2 standard.

Within AIM, measures are adopted based on their cost-effectiveness, using a Net Present Value (NPV) model as described in Dray et al. (2018). This means that high fuel and/or carbon prices can affect which technologies, retrofits and operational strategies are adopted. Because airlines typically use individual aircraft on multiple routes across their networks, technology uptake is assessed at a regional level (e.g. Europe, North America) based on average route-level costs within each region.

The results also depend on a number of other input assumptions, for the scale of supply of cellulosic biomass-derived drop-in aviation fuel.

As the analysis for this impact assessment looks to 2030 and 2035, not 2050, assumptions are fairly conservative[216]

Projections of how much biofuel might be in use in aviation up to 2050 vary widely and are dependent on the costs and supply of biomass assumed, as well as the characteristics

[214] Allaire D, Noel G, Willcox K and Cointin R. Uncertainty quantification of an Aviation Environmental Toolsuite. *Reliability Engineering and System Safety*, 2014; 126:14-24.
[215] Schäfer, A., Evans, A. D., Reynolds, T. and Dray, L. M. Costs of Mitigating CO_2 Emissions from Passenger Aircraft. *Nature Climate Change*, Vol. 6, 2016, pp. 412-417.
[216] ICF report p181-183.

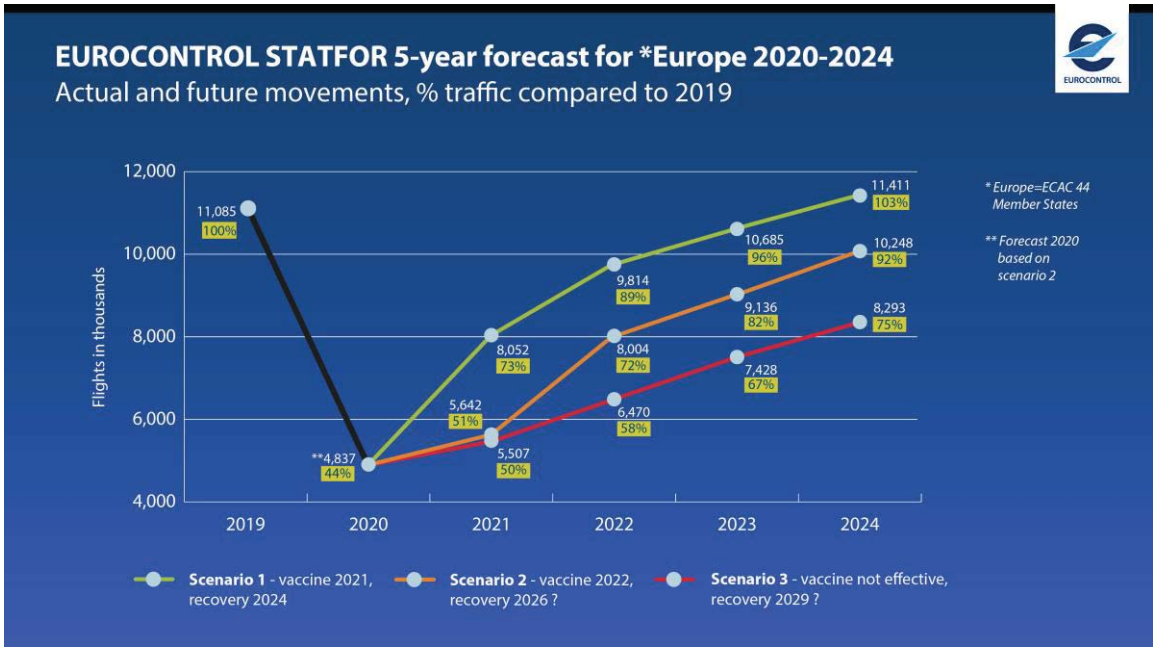
of and demand from other sectors and policies. Most recent multi-sectoral analyses project relatively low aviation biomass use to 2035.

Electrofuels (or power-to-liquid fuels) also have potential to contribute to climate neutrality. However, given the current costs at 3-6 times that of untaxed kerosene and uncertainties about uptake, electrofuels are not included in the modelling for this impact assessment.

No additional policy support for aviation biofuel beyond ETS or CORSIA carbon pricing and biofuel exemptions are assumed. Operators are assumed to use biofuels only if they can reduce total operating costs by doing so.

Annex 5: COVID-19 impacts on growth of greenhouse gas emissions in the aviation sector

In November 2020, Eurocontrol published its forecast for the recovery of the European aviation sector for the years 2020-2024[217] that was updated in May 2021[218]. This describes the severe impact of the COVID-19 pandemic on the air traffic. According to the forecast, even in the most optimistic scenario, the 2019 emission levels would not be reached before 2024, and the worst-case scenario shows a recovery by 2029.



[217] https://www.eurocontrol.int/publication/eurocontrol-five-year-forecast-2020-2024
[218] https://www.eurocontrol.int/press-release/new-eurocontrol-four-year-forecast-finds-air-traffic-not-expected-reach-2019-levels

Annex 6: 2019 ICAO Resolution on CORSIA

Resolution A40-19: Consolidated statement of continuing ICAO policies and practices related to environmental protection - Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA)

Whereas Assembly Resolution A38-18 decided to develop a global market-based measure (GMBM) scheme for international aviation, for decision by the 39th Session of the Assembly;

Recalling that Assembly Resolution A38-18 requested the Council, with the support of Member States, to identify the major issues and problems, including for Member States, and make a recommendation on a GMBM scheme that appropriately addresses them and key design elements, including a means to take into account special circumstances and respective capabilities, and the mechanisms for the implementation of the scheme from 2020 as part of a basket of measures which also include technologies, operational improvements and sustainable aviation fuels to achieve ICAO's global aspirational goals;

Whereas Assembly Resolution A39-3 decided to implement a GMBM scheme in the form of the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) as part of a basket of measures which also include aircraft technologies, operational improvements and sustainable aviation fuels to achieve ICAO's global aspirational goals;

Recognizing that ICAO is the appropriate forum to address emissions from international aviation, and the significant amount of work undertaken by the Council, its Advisory Group on CORSIA (AGC), its Technical Advisory Body (TAB) and its Committee on Aviation Environmental Protection (CAEP) to support the implementation of CORSIA;

Welcoming the adoption of the first edition of Annex 16 – Environmental Protection, Volume IV – CORSIA, the provisions of which include Monitoring, Reporting and Verification (MRV) procedures for CORSIA;

Also welcoming the publication of the first edition of Environmental Technical Manual (ETM, Doc 9501), Volume IV – Procedures for demonstrating compliance with the CORSIA;

Welcoming the progress made for the development of ICAO CORSIA Implementation Elements, which are reflected in 14 ICAO documents directly referenced in Annex 16, Volume IV, containing materials that are approved by the Council, and are essential for the implementation of CORSIA;

Also welcoming the establishment by the Council of the Technical Advisory Body (TAB), with the mandate to make recommendations to the Council on the CORSIA eligible emissions units;

Recognizing the importance of a coordinated approach for capacity building activities by ICAO and its Member States, in cooperation with the aviation industry, to support the implementation of CORSIA, in particular through the ICAO Assistance, Capacity-building and Training for CORSIA (ACTCORSIA) programme that includes the organization of seminars, development of outreach materials, and establishment of CORSIA partnerships among States;

Welcoming the increasing number of announcements by Member States of their intention to voluntarily participate in CORSIA in the pilot phase from 2021;

Recognizing that strong capacity-building activities can facilitate the decision of Member States to voluntarily participate in CORSIA;

Noting the support of the aviation industry for CORSIA as a single global carbon offsetting scheme, as opposed to a patchwork of State and regional MBMs, as a cost effective measure to complement a broader package of measures including technology, operations and infrastructure measures;

Recognizing that MBMs should not be duplicative and international aviation CO2 emissions should be accounted for only once;

Emphasizing that the decision by the 39th Session of the Assembly to implement the CORSIA reflects the strong support of Member States for a global solution for the international aviation industry, as opposed to a possible patchwork of State and regional MBMs;

Reaffirming the concern with the use of international civil aviation as a potential source for the mobilization of revenue for climate finance to the other sectors, and that MBMs should ensure the fair treatment of the international aviation sector in relation to other sectors;

Recalling the United Nations Framework Convention on Climate Change (UNFCCC) and the Paris Agreement and acknowledging its principle of common but differentiated responsibilities and respective capabilities, in light of different national circumstances;

Also acknowledging the principles of non-discrimination and equal and fair opportunities to develop international aviation set forth in the Chicago Convention;

Recognizing that the work related to CORSIA and its implementation will contribute to the achievement of the goals set out in the Paris Agreement adopted under the UNFCCC;

Whereas the UNFCCC and the Paris Agreement provide for mechanisms, such as the Clean Development Mechanism (CDM) and a new market mechanism under the Paris

Agreement, to contribute to the mitigation of GHG emissions to support sustainable development, which benefit developing States in particular;

Welcoming the cooperation between the UNFCCC and ICAO on the development of CDM methodologies for aviation;

Recognizing that this Resolution does not set a precedent for or prejudge the outcome of negotiations under the UNFCCC, the Paris Agreement, or other international agreements, nor represent the position of the Parties to the UNFCCC, the Paris Agreement, or other international agreements;

The Assembly:

1. *Resolves* that this Resolution, together with Resolution A40-17: Consolidated statement of continuing ICAO policies and practices related to environmental protection - General provisions, noise and local air quality and Resolution A40-18: Consolidated statement of continuing ICAO policies and practices related to environmental protection – Climate change, supersede Resolutions A39-1, A39-2 and A39-3 and constitute the consolidated statement of continuing ICAO policies and practices related to environmental protection;

2. *Acknowledges* the progress achieved on all elements of the basket of measures available to address CO2 emissions from international aviation, including aircraft technologies, operational improvements, sustainable aviation fuels and CORSIA, and affirms the preference for the use of aircraft technologies, operational improvements and sustainable aviation fuels that provide the environmental benefits within the aviation sector;

3. *Also acknowledges* that, despite this progress, the environmental benefits from aircraft technologies, operational improvements and sustainable aviation fuels may not deliver sufficient CO2 emissions reductions to address the growth of international air traffic, in time to achieve the global aspirational goal of keeping the global net CO2 emissions from international aviation from 2020 at the same level;

4. *Emphasizes* the role of CORSIA to complement a broader package of measures to achieve the global aspirational goal, without imposing inappropriate economic burden on international aviation;

5. *Recalls* its decision at the 39th Session to implement a GMBM scheme in the form of the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) to address any annual increase in total CO2 emissions from international civil aviation (i.e. civil aviation flights that depart in one country and arrive in a different country) above the 2020 levels, taking into account special circumstances and respective capabilities;

6. *Requests* the Council to continue to ensure all efforts to make further progress on aircraft technologies, operational improvements and sustainable aviation fuels be taken by Member States and reflected in their action plans to address CO2 emissions from

international aviation, and to monitor and report the progress on implementation of action plans, and that a methodology should be developed to ensure that an aeroplane operator's offsetting requirements under the scheme in a given year can be reduced through the use of CORSIA eligible fuels (i.e., CORSIA sustainable aviation fuels and CORSIA lower carbon aviation fuels), so that all elements of the basket of measures are reflected;

7. *Request* the Council to continuously monitor the implementation of all elements of the basket of measures, and consider the necessary policies and actions to ensure that progress is achieved in all of the elements in a balanced way with an increasing percentage of emissions reductions accruing from non-MBM measures over time;

8. *Acknowledges* special circumstances and respective capabilities of States, in particular developing States, in terms of vulnerability to the impacts of climate change, economic development levels, and contributions to international aviation emissions, among other things, while minimizing market distortion;

9. *Recalls* its decision at the 39th Session on the use of a phased implementation for the CORSIA to accommodate the special circumstances and respective capabilities of States, in particular developing States, while minimizing market distortion, as follows:

a) Pilot phase applies from 2021 through 2023 to States that have volunteered to participate in the scheme. States participating in this phase may determine the basis of their aeroplane operator's offsetting requirements from paragraph 11 e) i) below;

b) First phase applies from 2024 through 2026 to States that voluntarily participate in the pilot phase, as well as any other States that volunteer to participate in this phase, with the calculation of offsetting requirements in paragraph 11 a) below;

c) All States are strongly encouraged to voluntarily participate in the pilot phase and the first phase, noting that developed States, which have already volunteered, are taking the lead, and that several other States have also volunteered;

d) The Secretariat will make public on the ICAO website updated information on the States that volunteered to participate in the pilot phase and first phase;

e) Second phase applies from 2027 through 2035 to all States that have an individual share of international aviation activities in RTKs in year 2018 above 0.5 per cent of total RTKs or whose cumulative share in the list of States from the highest to the lowest amount of RTKs reaches 90 per cent of total RTKs, except Least Developed Countries (LDCs), Small Island Developing States (SIDS) and Landlocked Developing Countries (LLDCs) unless they volunteer to participate in this phase;

f) States that are exempted or have not yet participated are strongly encouraged to voluntarily participate in the scheme as early as possible, in particular those States that are members of a regional economic integration organization. States who decide to voluntarily participate in the scheme, or decide to discontinue the voluntary participation

from the scheme, may only do so from 1 January in any given year and they shall notify ICAO of their decision by no later than 30 June of the preceding year;

g) Starting in 2022, the Council will conduct a review of the implementation of the CORSIA every three years, including its impact on the growth of international aviation, which serves as an important basis for the Council to consider whether it is necessary to make adjustments to the next phase or compliance cycle and, as appropriate, to recommend such adjustments to the Assembly for its decision;

10. *Recalls* its decision at the 39th Session that the CORSIA shall apply to all aeroplane operators on the same routes between States with a view to minimizing market distortion, as follows:

a) all international flights on the routes between States, both of which are included in the CORSIA by paragraph 9 above, are covered by the offsetting requirements of the CORSIA;

b) all international flights on the routes between a State that is included in the CORSIA and another State that is not included in the CORSIA by paragraph 9 above are exempted from the offsetting requirements of the CORSIA, while retaining simplified reporting requirements; and

c) all international flights on the routes between States, both of which are not included in the CORSIA by paragraph 9 above, are exempted from the offsetting requirements of the CORSIA, while retaining simplified reporting requirements;

11. *Recalls* its decision at the 39th Session that the amount of CO2 emissions required to be offset by an aeroplane operator in a given year from 2021 is calculated every year as follows:

a) an aeroplane operator's offset requirement = [% Sectoral × (an aeroplane operator's emissions covered by CORSIA in a given year × the sector's growth factor in the given year)] + [% Individual × (an aeroplane operator's emissions covered by CORSIA in a given year × that aeroplane operator's growth factor in the given year);

b) where the sector's growth factor = (total emissions covered by CORSIA in the given year – average of total emissions covered by CORSIA between 2019 and 2020) / total emissions covered by CORSIA in the given year;

c) where the aeroplane operator's growth factor = (the aeroplane operator's emissions covered by CORSIA in the given year – average of the aeroplane operator's emissions covered by CORSIA between 2019 and 2020) / the aeroplane operator's emissions covered by CORSIA in the given year;

d) where the % Sectoral = (100% – % Individual) and;

e) where the % Sectoral and % Individual will be applied as follows:

i) from 2021 through 2023, 100% sectoral and 0% individual, though each participating State may choose during this pilot phase whether to apply this to:

a) an aeroplane operator's emissions covered by CORSIA in a given year, as stated above, or

b) an aeroplane operator's emissions covered by CORSIA in 2020;

ii) from 2024 through 2026, 100 % sectoral and 0% individual;

iii) from 2027 through 2029, 100 % sectoral and 0% individual;

iv) from 2030 through 2032, at least 20% individual, with the Council recommending to the Assembly in 2028 whether and to what extent to adjust the individual percentage;

v) from 2033 through 2035, at least 70% individual, with the Council recommending to the Assembly in 2028 whether and to what extent to adjust the individual percentage;

f) the aeroplane operator's emissions and the total emissions covered by CORSIA in the given year do not include emissions exempted from the scheme in that year;

g) the scope of emissions in paragraphs 11 b) and 11 c) above will be recalculated at the start of each year to take into account routes to and from all States that will be added due to their voluntary participation or the start of a new phase or compliance cycle;

12. *Recalls* its decision at the 39th Session that a new entrant[219] is exempted from the application of the CORSIA for three years or until the year in which its annual emissions exceed 0.1 per cent of total emissions in 2020, whichever occurs earlier. From the subsequent year, the new entrant is included in the scheme and treated in the same way as the other aeroplane operators;

13. *Recalls* its decision at the 39th Session that, notwithstanding with the provisions above, the CORSIA does not apply to low levels of international aviation activity with a view to avoiding administrative burden: aeroplane operators emitting less than 10,000 metric tonnes of CO2 emissions from international aviation per year; aeroplane with less than 5,700 kg of Maximum Take Off Mass (MTOM); or humanitarian, medical and firefighting operations;

14. *Recalls* its decision at the 39th Session that the emissions that are not covered by the scheme, as the results of phased implementation and exemptions, are not assigned as offsetting requirements of any aeroplane operators included in the scheme;

[219] A new entrant is defined as any aeroplane operator that commences an aviation activity falling within the scope of Annex 16, Volume IV on or after its entry into force and whose activity is not in whole or in part a continuation of an aviation activity previously performed by another aeroplane operator.

15. Recal*ls* its decision at the 39th Session on a three year compliance cycle, starting with the first cycle from 2021 to 2023, for aeroplane operators to reconcile their offsetting requirements under the scheme, while they report the required data to the authority designated by the aeroplane operator's State of registry every year;

16. *Recalls* its decision at the 39th Session on the need to provide for safeguards in the CORSIA to ensure the sustainable development of the international aviation sector and against inappropriate economic burden on international aviation, and requests the Council to decide the basis and criteria for triggering such action and identify possible means to address these issues;

17. *Recalls* its decision at the 39th Session that a periodic review of the CORSIA is undertaken by the Council, with the technical contribution of CAEP, for consideration by the Assembly, every three years from 2022 for the purpose referred to in paragraph 9 g) above and to contribute to the sustainable development of the international aviation sector and the effectiveness of the scheme. This will involve, inter alia:

a) assessment of: progress towards achieving the ICAO's global aspirational goal; the scheme's market and cost impact on States and aeroplane operators and on international aviation; and the functioning of the scheme's design elements;

b) consideration of the scheme's improvements that would support the purpose of the Paris Agreement, in particular its long-term temperature goals; and update the scheme's design elements to improve implementation, increase effectiveness, and minimize market distortion, taking into account the consequential impact of changing the scheme's design elements, e.g., to MRV requirements; and

c) a special review by the end of 2032 on termination of the scheme, its extension or any other improvements of the scheme beyond 2035, including consideration of the contribution made by aircraft technologies, operational improvements and sustainable aviation fuels towards achieving the ICAO's environmental objectives;

18. *Determines* that the CORSIA is the only global market-based measure applying to CO2 emissions from international aviation so as to avoid a possible patchwork of duplicative State or regional MBMs, thus ensuring that international aviation CO2 emissions should be accounted for only once;

19. *Requests* the following actions be taken for implementation of the CORSIA:

a) the Council, with the technical contribution of CAEP, to update the Annex 16, Volume IV and Environmental Technical Manual, Volume IV, as appropriate;

b) the Council, with the technical contribution of CAEP, to continue to develop and update the ICAO CORSIA documents referenced in Annex 16, Volume IV related to: ICAO CORSIA CO2 Estimation and Reporting Tool; CORSIA eligible fuels; CORSIA emissions units criteria (EUC); and CORSIA Central Registry, as appropriate;

c) the Council to develop and update the ICAO CORSIA document referenced in Annex 16, Volume IV related to the eligible emissions units for use by the CORSIA, considering the recommendations of the TAB;

d) the Council to establish, by early 2020, and maintain the CORSIA Central Registry under the auspices of ICAO to enable the reporting of relevant information from Member States to ICAO;

e) the Council to continue to oversee the implementation of the CORSIA, with support provided by the AGC and CAEP, as appropriate; and

f) Member States to take the necessary action to ensure that national policies and regulatory frameworks are established for the compliance and enforcement of the CORSIA, in accordance with the timeline set forth by Annex 16, Volume IV;

20. *Recalls* its decision at the 39th Session that emissions units generated from mechanisms established under the UNFCCC and the Paris Agreement are eligible for use in CORSIA, provided that they align with decisions by the Council, with the technical contribution of TAB and CAEP, including on avoiding double counting and on eligible vintage and timeframe;

21. *Decides* that ICAO and Member States take all necessary actions in providing the capacity building and assistance and building partnerships for implementation of the CORSIA, in accordance with the timeline set forth in Annex 16, Volume IV, including through the ICAO Assistance, Capacity-building and Training for CORSIA (ACT-CORSIA) programme that includes the organization of seminars, development of outreach materials, and establishment of CORSIA partnerships among States, while emphasizing the importance of a coordinated approach under the umbrella of ICAO for undertaking capacity building and assistance activities;

22. *Recalls* its decision at the 39th Session that the CORSIA will use emissions units that meet the Emissions Unit Criteria (EUC) in paragraph 19 above;

23. *Requests* the Council to promote the use of emissions units generated that benefit developing States, and encourages States to develop domestic aviation-related projects; and

24. *Requests* the Council to explore further development of aviation-related methodologies for use in offsetting programmes, including mechanisms or other programmes under the UNFCCC, and encourages States to use such methodologies in taking actions to reduce aviation CO2 emissions, which could further enable the use of credits generated from the implementation of such programmes by the CORSIA, without double-counting of emissions reduction.

Annex 7: Developments following the 2016 ICAO Assembly

At the 39th ICAO Assembly agreed to implement a GMBM scheme in the form of the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) to address any annual increase in total CO_2 emissions from international civil aviation (i.e. civil aviation flights that depart in one country and arrive in a different country) above the 2020 levels.

On 27 June 2018, at the 10th meeting of its 214th session, the ICAO Council adopted the First Edition of Volume IV of Annex 16 to the Convention: the International Standards and Recommended Practices on Environmental Protection – Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA).

On 20 July 2018 the ICAO sent out State Letter AN 1/17.14 – 18/78 ('the State Letter'), requesting the contracting States to, first, notify any disapproval of any part of CORSIA before 22 October 2018 and, second, notify any differences between their national practices and CORSIA and the expected date for compliance before 1 December 2018.

In this context, the EU Member States notified differences[220] to the ICAO, pointing at the generic differences between the EU ETS and CORSIA, and aimed at preserving both the EU policy space as well as the EU level of climate ambition.

After a state letter consultation process, at its 216th session in March 2019, the ICAO council adopted the CORSIA Emission Unit Eligibility Criteria[221]. It also set up the Technical Advisory Body (TAB) tasked to assess offsetting programmes against the Emission Unit Eligibility Criteria in order to develop recommendations on CORSIA eligible emissions Units for the ICAO Council.

At its 217th Session in June 2019, the ICAO Council, approved the first edition of the ICAO document "CORSIA Sustainability Criteria for CORSIA Eligible Fuels", containing the sustainability criteria applicable during the pilot phase of CORSIA (2021 to 2023)[222]. After an ICAO Council request, the Committee on Aviation Environmental Protection (CAEP) worked on additional and strengthened sustainability criteria applicable from the start of CORSIA's first phase on 1 January 2024. The ICAO Council, at its 219th Session in March 2020, agreed to bring the amendments recommended by CAEP to the ICAO document "CORSIA Sustainability Criteria for CORSIA Eligible Fuels", for consultation with Member States through a State Letter. The result of the

[220] Council Decision (EU) 2018/2027.
[221] https://www.icao.int/environmental-protection/CORSIA/Documents/ICAO_Document_09.pdf
[222] https://www.icao.int/environmental-protection/CORSIA/Documents/ICAO%20document%2005%20-%20Sustainability%20Criteria.pdf

consultation have been deferred to the next ICAO Council Session in February-March 2021.

In September 2019, the 40th ICAO Assembly took place in Montreal in September / October 2019. Following reservations against the global market measures, a group of countries among which China, the Russian Federation and India, took positions which contested the compatibility of CORSIA with the Common but Differentiated Responsibilities principle, considered the scheme unfairly hinders the growth of the aviation sector in developing states and places an undue burden on them compared to states with developed aviation. The resolution proposed to the ICAO Council to the Assembly was subject to a vote in the ICAO Assembly, which confirmed the majority of states backing CORSIA. Resolution A40-19 Consolidated statement of continuing ICAO policies and practices related to environmental protection - Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) was adopted with 92 votes in favour and 25 votes against (the Resolution text is provided in the Annex 6 to the Impact Assessment).

This resolution contains a few modifications compared to the resolution A39-3, including the statement that CORSIA is "*the only global market-based measure to address emissions from international aviation*". Finland on behalf of the EU clarified its interpretation of this new insertion: "*Fully in line with our positions taken at the last Assembly and in our interventions in ICAO Council meetings, Paragraph 18 of Draft Resolution is to be read in light of the Chicago Convention as well as in line with certain Contracting Parties' legal obligations to pursue efforts to limit the temperature increase in line with the Paris Agreement on climate change. One of the principles of the Convention is that each Contracting State may apply on a non-discriminatory basis its laws and regulations to all aircraft operating within its jurisdiction. This principle also applies to environmental measures such as the ones we have in the EU and its Member States*".

At its 40th meeting, the Assembly as part of its resolution A40-18[223], also requested "*the Council to continue to explore the feasibility of a long-term global aspirational goal for international aviation, through conducting detailed studies assessing the attainability and impacts of any goals proposed, including the impact on growth as well as costs in all countries, especially developing countries, for the progress of the work to be presented to the 41st Session of the ICAO Assembly.*" This work is currently ongoing.

In March 2020, the ICAO Council adopted a first decision on CORSIA Eligible Emissions Units based on TAB recommendation. Following application by ten programmes in 2019, six of them were deemed eligible to generate CORSIA-eligible emissions units. The decision sets two important parameters: first units are eligible only for the 2021 – 2023 compliance cycle (eligibility timeframe) and second only for units

[223] Resolution A40-18: Consolidated statement of continuing ICAO policies and practices related to environmental protection - Climate change, https://www.icao.int/environmental-protection/Documents/Assembly/Resolution_A40-18_Climate_Change.pdf

issued to activities that started their first crediting period from 1 January 2016; and in respect of emissions reductions that occurred through 31 December 2020 (eligible unit dates). This decision was followed by a second one, adopted in November 2020 on the basis of a second cycle of programmes applications, submitted in 2020. The main parameters of the decision remained unchanged; one new programme was deemed eligible. In the end of 2020, following material changes to their rules and procedures by some of the programmes undertaken in the year 2020, one additional programme managed to satisfy the criteria. It was recommended eligible by the TAB for consideration at the 222nd ICAO Council session (February 2021), bringing to eight the eligible programmes[224], again with the eligibility unit dates and timeframe described above. Finally, one of the already eligible programmes, succeeded to respond to the criteria on double counting for post-2020 and the TAB recommended accordingly extended eligibility unit date for this programme to the end of 2023, subsequently decided by the ICAO Council. A third cycle of applications begun in January 2021.

Due to the COVID-19 crisis, at its 220th session in June 2020, the ICAO Council decided that 2019 emissions shall be used as baseline in the pilot phase instead of the average between 2019 and 2020 emissions[225]. This will impact the following three features: the annual Sector's Growth Factor (SGF), the annual offsetting requirements during CORSIA's pilot phase and the threshold for new entrants.

By 30 June 2020, States had to notify ICAO of their voluntary participation. ICAO published a document listing the 88 States that will participate in CORSIA from 1 January 2020[226]. The EU Member States notified their voluntary participation as of 1st January 2021 without prejudice to the differences filed[227] in this way preserving the European Union legal framework, including the legislator's latitude to decide on the future Union scheme. Notifications sent by States to ICAO have not been published.

In parallel, after the official launch[228] of the CORSIA Central Registry in June 2020, ICAO is updating available information[229].

According to paragraph 17 of Assembly Resolution A40-19, the ICAO Council will conduct a periodic review of the CORSIA every three years from 2022 onwards. During its 220th session, in June 2020, the ICAO Council decided to initiate the process to establish the first review cycle. The review parameters are detailed in paragraph 17 of the Assembly Resolution. This review will also examine the impact of COVID-19 on CORSIA on various issues, including the impact on the baseline beyond the pilot phase.

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[224] https://www.icao.int/environmental-protection/CORSIA/Pages/CORSIA-Emissions-Units.aspx
[225] https://www.icao.int/environmental-protection/CORSIA/Pages/CORSIA-and-Covid-19.aspx
[226] https://www.icao.int/environmental-protection/CORSIA/Documents/CORSIA_States_for_Chapter3_State_Pairs_Jul2020.pdf
[227] Council Decision (EU) 2020/954.
[228] https://www.icao.int/Newsroom/Pages/Continued-progress-toward-implementation-of-ICAOs-Carbon-Offsetting-and-Reduction-Scheme-for-International-Aviation-.aspx
[229] https://www.icao.int/environmental-protection/CORSIA/Pages/CCR.aspx

Annex 8: Integration of Aviation in the EU's Emissions Trading System

1. INITIAL FULL SCOPE INCLUSION

In view of the 2004 ICAO Assembly's unanimous decision not to develop a GMBM but to favour inclusion of aviation into open regional systems, the Commission proposed in 2006 to integrate aviation into the EU ETS covering emissions from flights to and from all EU Member States. Directive 2008/101/EC amended the EU ETS Directive 2003/87/EC and included aviation activities within the scope of the ETS:

- Total emissions are covered from intra-EEA flights and extra-EEA flights.
- The emission cap for aviation from 2013 onwards has been set at 95 % of the average historic aviation emissions (corresponding to the period from 2004 to 2006).
- Aircraft operators have been obliged to start emissions reporting in 2010 and full compliance – including surrendering of allowances – in 2012.

The inclusion of aviation into the EU ETS was based on the 2006 Impact assessment[230] that covered in detail the environmental, economic, and social impacts. It was based on an extensive public consultation. It concluded that the broadest possible geographic scope of all departing and arriving flights would give the highest environmental benefits without neither significantly affecting the demand for aviation services nor the competitive position of individual airlines.

2. INTERNATIONAL REACTIONS

The inclusion of aviation into the EU ETS led to diplomatic objections from a number of countries including China, India, and the US, which opposed the EU ETS alleging that the EU would have no competence to oblige their operators to participate in the EU ETS[231]. On 2 November 2011, the ICAO Council endorsed a statement by 26 of its 36 Member States repeating parts of these declarations[232]. Moreover, the Air Transport Association of America (ATA) and major US airlines challenged the legality of the EU ETS before the European Court of Justice (ECJ), which confirmed that the EU was entitled to extend the EU ETS to the full distance of flights which depart or arrive at EU airports[233].

3. DECISION NO. 377/2013/EC

Prior to the 2013 ICAO Assembly, the 2012 ICAO Council decided to set up a High-level Group on Climate Change (HGCC) that would develop guidance for a GMBM for

[230] SEC(2006) 1684.
[231] Joint Declaration signed on 30 September 2011 in New Delhi and Joint Declaration signed on 23 February 2012 in Moscow on the inclusion of international civil aviation in the EU ETS.
[232] 2012 ICAO Council Decision endorsing the Delhi Declaration, available at: http://ec.europa.eu/clima/policies/transport/aviation/docs/minutes_icao_en.pdf
[233] Case C-366/10.

international aviation emissions and a framework for national and regional MBMs. In recognition of this positive development, and in order to provide time for the 2013 ICAO Assembly to agree on a GMBM, the EU adopted the "stop-the-clock" decision to temporarily defer the enforcement of the EU ETS compliance obligations for flights to and from most third countries for 2012 unless airlines chose to remain with full scope (which a number of airlines chose to do, including airlines based outside the EEA), while maintaining the application of the system for all airlines in relation to intra-EEA flights[234].

4. THE 2013 ICAO ASSEMBLY

The EU's "stop-the-clock" decision was welcomed by many countries. The temporarily reduced scope of the EU ETS for aviation was instrumental to trigger the 2013 ICAO Assembly to move forward on the development of a GMBM. The 2013 ICAO Assembly adopted a roadmap, which had been proposed by the EU, to develop a GMBM by 2016 to be implemented from 2020[235].

5. REGULATION 421/2014

To take account of the outcome of the 2013 ICAO Assembly, Regulation (EU) No 421/2014 was adopted by the European Parliament and the Council, amending the EU ETS Directive 2003/87/EC. In order to sustain the momentum reached at the 2013 ICAO Assembly, the regulation introduced article 28a in the EU ETS Directive to temporarily derogate the application of the EU ETS to extra-EEA flights, as well as to intra-EEA flights to outermost regions between 1 January 2013 and 31 December 2016 period. It also required the Commission to report on the outcome of the 2016 ICAO Assembly to the European Parliament and to the Council and consider and, if appropriate, include proposals in reaction to the ICAO developments on the appropriate scope for coverage of emissions from extra EEA-flights from 2017 onwards.

6. THE 2016 ICAO ASSEMBLY

After several years of intensive negotiations the ICAO Assembly reached for the first time an agreement on an ICAO Resolution for the implementation of a global market based measure known as the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA), to address the growth in international aviation emissions globally from 2021 through an offsetting system aimed at stabilising them at 2020 levels.

7. REGULATION 2392/2017

Pending the development of the rules and modalities needed for the implementation of CORSIA, the EU ETS Directive was last revised in 2017 to extend the current geographical scope derogation until the end of 2023. This was intended to provide continued momentum to the international process in the light of the commitment. The 2017 revision notably requests the Commission to address the specific issues identified in Articles 3d, and 28b of the EU ETS Directive in a report. According to the revised Directive, the Commission is to present a report to the European Parliament and to the Council in which it shall assess CORSIA in relation to a set of features and consider (a) increasing the percentage of auctioning from the current levels and (b) ways to

[234] Decision No 377/2013/EU.

[235] 2013 ICAO Assembly Resolution A38-18, available at: http://www.icao.int/environmental-protection/Documents/A38-17_A38-18.pdf

implement CORSIA in Union law through a revision of the EU ETS Directive and, where appropriate, accompany this report with a legislative proposal that is consistent with the Union economy-wide greenhouse gas emission reduction commitment for 2030 with the aim of preserving the environmental integrity and effectiveness of Union climate action. This work will be considered in the context of the European Green Deal and the objective of enhanced climate ambition for 2030.

The EU ETS for aviation has been successfully implemented. Compliance with the system has been very close to 100% in terms of emissions. More than 100 commercial airlines based in third countries, including from those countries who initially opposed the full scope of the EU ETS in the past, have fulfilled their reporting and compliance obligations. Verified CO_2 emissions from ETS aviation activities between EEA airports amounted to 68.14 million tonnes of CO_2 in 2019.

8. Adoption of CORSIA SARPs

The First Edition of Annex 16 — Environmental Protection, Volume IV — Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA)[236] was adopted by the Council of ICAO on 27 June 2018. The adopted First Edition of Annex 16, Volume IV was shared with Contracting States through State letter AN 1/17.14 – 18/78 dated 20 July 2018, and made publicly available through the ICAO CORSIA website on the same date. The First Edition of Annex 16, Volume IV became effective on 22 October 2018 and became applicable on 1 January 2019.

9. Council Decision (EU) 2018/2027 - Filing of Differences

In accordance with the Article 38 of the Chicago convention, when a Contracting State finds it impracticable to comply with a Standard, to bring its own regulations or practices into full accord with any international standard, or which deems it necessary to adopt regulations or practices differing from the standard, it needs to file a difference to ICAO.

In light of the fundamental differences in nature between the EU ETS and CORSIA, with CORSIA relying on the nationality of the airline and the EU ETS being a route-based system with equal treatment ensured on routes, the Council adopted Council Decision (EU) 2018/2027. It laid down the position to be taken on behalf of the Union within ICAO in respect of the First Edition of the SARPs on CORSIA as regards differences to be notified. In accordance with that Decision, Member States notified differences to ICAO, highlighting the differences between the EU ETS and CORSIA and that the EU implementation of CORSIA would take place as appropriate through revision of the EU ETS. The objective was to preserve the legality of EU legislation and future policy space, as well as the EU level of climate ambition.

10. MRV Package

[236] https://www.unitingaviation.com/publications/Annex-16-Vol-04/

The EU has put in place a legally binding MRV framework based on the CORSIA SARPSs and the existing MRV framework under the EU ET. The 2019 MRV Package includes:

- Directive 2003/87/EC of the European Parliament and of the Council of 13 October 2003 establishing a system for greenhouse gas emission allowance trading within the Union and amending Council Directive 96/61/EC
- Commission Delegated Regulation (EU) 2019/1603 of 18 July 2019 supplementing Directive 2003/87/EC of the European Parliament and of the Council as regards measures adopted by the International Civil Aviation Organisation for the monitoring, reporting and verification of aviation emissions for the purpose of implementing a global market-based measure,
- Commission Implementing Regulation (EU) 2018/2066 of 19 December 2018 on the monitoring and reporting of greenhouse gas emissions pursuant to Directive 2003/87/EC of the European Parliament and of the Council and amending Commission Regulation (EU) No 601/2012
- Commission Implementing Regulation (EU) 2018/2067 of 19 December 2018 on the verification of data and on the accreditation of verifiers pursuant to Directive 2003/87/EC of the European Parliament and of the Council
- Integrated monitoring plan and annual emission report templates (published on DG CLIMA website)
- CORSIA Reporting Tool by Eurocontrol

11. Swiss linking

In 2020, the linking agreement[237] between the EU and Switzerland entered into force. In addition to the current scope, the EU ETS covers departing flights to Switzerland, while the Swiss ETS covers domestic flights and flights departing to the EEA. EU-regulated aircraft operators report CO_2 emissions and surrender allowances for the flights between the EEA and Switzerland and for Swiss domestic flights, while Swiss-regulated operators report and surrender in respect of the same scope as the EU ETS, together with domestic and departing flights from Switzerland to the EEA. Equal scope is ensured through the EU-Swiss Treaty that puts this arrangement into place.

[237] https://ec.europa.eu/clima/news/agreement-linking-emissions-trading-systems-eu-and-switzerland_en

Annex 9: Features of the EU ETS

The EU ETS is a cap and trade system where operators from different sectors (power generation, industry, aviation) annually report their GHG emissions and surrender a number of units (typically, EU allowances) equivalent to the amount of emissions they are responsible for.

Under the EU ETS, aircraft operators are responsible for the emissions generated by aviation activities covered by the EU ETS Directive. Emissions from all flights departing from or arriving at aerodromes in the European Economic Area (EEA) are covered by the EU ETS. However, between 2013 and 2016 the scope has been temporarily limited to flights between airports located in the EEA. Pending the development of the rules and modalities needed for the implementation of CORSIA, the EU ETS Directive was last revised in 2017 to extend the current geographical scope derogation for emissions taking place up to 2023. In 2020, the linking agreement between the EU and Switzerland entered into force. In addition to the current scope, the EU ETS covers departing flights to Switzerland, while the Swiss ETS covers domestic flights and flights departing to the EEA. In accordance with the EU-UK Trade and Cooperation Agreement reached in December 2020, the EU ETS shall continue to apply to departing flights from the EEA to the UK, while a UK ETS will apply effective carbon pricing on flights departing from the UK to the EEA.

Member States' competent authorities are responsible for administering aircraft operators. Each Member State administers operators to which they have issued the corresponding operating licence as well as those aircraft operators from third countries performing aviation activities in Europe attributed to them in accordance with the Directive. Competent Authorities approve monitoring plans from aircraft operators, receive their verified emissions reports and track compliance with their surrendering obligations.

Aircraft operators submit before 30 March their verified emissions reports corresponding to the previous year. Before 30 April they must surrender the equivalent amount of allowances. Emissions are electronically inscribed in the Union Registry, through which allowances are also surrendered by the operators.

Aircraft operators receive some allowances free of charge. Free allocation is distributed between aircraft operators on the basis of an efficiency benchmark. They can also purchase allowances from auctions. (See table below). Aircraft operators can use specific aviation allowances and general allowances from other sectors. Until 2020, they could also use an amount of international credits (Certified Emission Reductions from the Kyoto Protocol´s Clean Development Mechanism) up to 1.5% of their emissions.

Allowances can be traded. An aircraft operator can purchase allowances from other markets players and can sell its allowances if it has them in excess. This way, the EU ETS incentivises emission reductions: aircraft operators that are able to reduce emissions can obtain a benefit from selling their allowances, whilst those that increase their emissions will face higher compliance costs by having to purchase additional units.

Aircraft operators not complying with its EU ETS obligations face enforcement measures taken by Member States' competent authorities. If aircraft operators do not annually surrender the corresponding allowances they can be sanctioned with fines amounting €100 per tonne of CO_2 they are responsible for.

Key features of the EU ETS for aviation

EU ETS features	Description
Geographical coverage	European Economic Area (EEA) which includes the 27 EU Member States, Iceland, Norway and Liechtenstein. The 13 territories that are part of the EU are included in the EU ETS for aviation: Guadeloupe, French Guiana, Martinique, Reunion, the Azores, Madeira, the Canary Islands, Aland Islands, Akrotiri, Dhekelia, Ceuta, Melilla and Gibraltar All other territories of Member States that are not part of the EU are outside of the scope of EU ETS for aviation (e.g. Greenland or Channel Islands) The linking agreement between the EU and Switzerland entered into force in 2020. In addition to the current scope, Aircraft operators now need to report CO_2 emissions and to surrender allowances for the flights between the EEA and Switzerland and for Swiss domestic flights. In accordance with the EU-UK Trade and Cooperation Agreement, the EU ETS continues to apply to departing flights from the EEA to the UK.
Flights covered	All flights landing at or departing from EEA airports.
Surrendering requirements	All CO_2 emissions released during the whole flight.
Open or closed system	Aviation is regulated under the same rules as the general EU ETS i.e. as an open system, but allowances are specific to the aviation sector.
Aviation cap	95% of the average 2004-2006 aviation emissions From 1 January 2021 onwards, the number of allowances allocated to aircraft operators should be reduced annually in line with the linear reduction factor applicable to all other sectors in the EU ETS
Allocation of allowances	82% of allowances are allocated for free to operators based on a benchmark in line with their activity levels in 2010. 15% of allowances can be auctioned. A special reserve ensures access to the

	market for new aircraft operators and assists aircraft operators with a sharp increase in number of tonne-kilometres in the case of applications submitted before June 2015.
International credits	Aircraft operators may use Certified Emission Reductions and Emission Reduction Units for up to 1.5 % of the number of allowances they are required to use for compliance up to 2020.
Exclusions	Commercial airlines that operate fewer than 243 flights per period for three consecutive four-month periods or flights with total annual emissions lower than 10,000 tonnes per year. Activities performed by a non-commercial aircraft operator operating flights with total annual emissions lower than 1 000 tonnes per year. Other types of special purpose aircrafts are also excluded. A full list is in Annex I to the ETS Directive.
MRV approach	CO_2 emissions are based on applying an agreed emission factor (tCO_2/km) to fuel consumption measured by considering tank levels at specific points in time as well as fuel uplift at the airport. A simplified approach is available for small emitters with emissions considered as verified if the emissions were determined the small emitters tool approved under Regulation (EU) No 606/2010 and populated by Eurocontrol with data from its ETS support facility.

Annex 10: Assessment of CORSIA pursuant to Art. 28b of the ETS Directive

Article 28b(2) of Directive 2003/87/EC lists the elements that the European Parliament and Council require the Commission to examine when assessing the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA): "*the ambition and overall environmental integrity of the global market- based measure, including its general ambition in relation to targets under the Paris Agreement, the level of participation, its enforceability, transparency, the penalties for non-compliance, the processes for public input, the quality of offset credits, monitoring, reporting and verification of emissions, registries, accountability as well as rules on the use of biofuels*". These elements are further detailed below. This Annex reports on these elements, drawing principally on the more extensive study "Assessment of ICAO's global market-based measure (CORSIA) pursuant to Article 28b and for studying cost pass-through pursuant to Article 3d of the EU ETS Directive".

Ambition and accountability

This refers to the ambition and overall environmental integrity of CORSIA including its accountability to the targets under the Paris Agreement.

The Parties to the Paris Agreement signed up to strengthen the global response to the threat of climate change including "*by holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels*"[238]. The Parties also agreed to peak global emissions as soon as possible to "*achieve a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of this century*". The Paris agreement also calls for economy-wide absolute emission reduction targets by developed countries, while developing countries should move to economy-wide targets over time. Emissions from aviation are included in the EU's Paris Commitment, and need to be addressed to meet these objectives.

The IPCC Special Report on the impacts of global warming of 1.5 °C[239] emphasises the reduction in climate-related risks for humans and the natural system if global warming is kept to 1.5°C rather than 2°C. It also shows that pathways consistent with a 1.5°C scenario can bring multiple synergies with the Sustainable Development Goals (SDGs) and that these synergies can exceed the trade-offs.

[238] https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement
[239] https://www.ipcc.ch/sr15/

CORSIA is designed as an "offsetting mechanism", which allows the aviation sector to continue to grow emission after 2020 in as far as emissions above the baseline, for the routes covered, should be offset through carbon credits (CORSIA Eligible Emission Units) until 2035. Before the COVID-19 crisis, ICAO had estimated that by 2040 international aviation emissions could rise by up to 150% compared to 2020[240]. The baseline for CORSIA was meant to be the global net CO_2 emissions from international aviation in 2020 so as to achieve the aspirational target of offsetting CO_2 emissions above 2020 levels, although in order not to rely on data for only one year the average of 2019-2020 emissions is used. Emissions under the baseline are left unaddressed by CORSIA, as well as domestic emissions, which represents 40% of passenger emissions from aviation. In June 2020, following the COVID-19 crisis, the ICAO Council decided to use 2019 emissions as baseline during the 2021-2023 pilot phase[241], less stringent compared to the average 2019-2020 emissions baseline, in order to take account of impacts arising from the COVID-19 crisis.

CORSIA is a route-based system. Both the departing states and arriving states need to participate in CORSIA for those emissions to be taken into account in the calculation of the offsetting requirements. This means that ambition is also directly influenced by the level of participation and continued implementation. Without full participation and continued implementation, CORSIA cannot on its own meet the carbon neutral growth goal set by ICAO.

CORSIA is designed to run until 2035, starting with a pilot phase from 2021 to 2023. It foresees a revision mechanism every three years starting in 2022 that involves the "*consideration of the scheme's improvements that would support the purpose of the Paris Agreement, in particular its long-term temperature goals; and update the scheme's design elements to improve implementation, increase effectiveness, and minimize market distortion, taking into account the consequential impact of changing the scheme's design elements, e.g., to MRV requirements*;"[242] Following the ICAO Council decision on the change of baseline during the pilot phase, this review will also examine the impact of COVID-19 on CORSIA on various issues, including the impact on the baseline beyond the pilot phase. The 2032 special review will consider the termination of the scheme, its extension or any other improvements of the scheme beyond the year 2035[243].

Latest modelling has shown that CORSIA could mitigate 0.4% of international aviation emissions in 2025 through offsetting (and biofuels) under full participation scenario on eligible routes, 4.6% in 2030 and 9.7% in 2035. Looking at total aviation emissions (including domestic aviation), these shares would range between 0.3% in 2025 and 6.3% in 2035. These impacts depend on the quality of the offset credits. These shares reflect the emissions that would actually be mitigated by CORSIA. The share of emissions

[240] ICAO, 2019. See https://www.icao.int/environmental-protection/Pages/ClimateChange_Trends.aspx
[241] https://www.icao.int/environmental-protection/CORSIA/Pages/CORSIA-and-Covid-19.aspx
[242] A40-19, §17b.
[243] A40-19, §17c.

covered by CORSIA is higher but a large share of the covered emissions are not addressed, because CORSIA only regulates the growth of emissions above the baseline on participating routes.

Level of participation

In the pilot phase (2021-2023) and first phase (2024-2026), participation of states in CORSIA is expressly voluntary, with the possibility to opt-in or out from the system. All countries should then participate in the second phase starting in 2027, except least developed countries, land-locked developing countries, small island developing states, and states with a small share of international aviation activity in 2018 (namely states whose individual share of international aviation activities in Revenue Tonne Kilometres (RTKs) was below 0.5 per cent of total RTKs; and states that were not part of the list of states that account for 90 per cent of total RTKs when sorted from the highest to the lowest amount of individual RTKs).

ICAO has published a list of the 88 states that have notified that they will participate in CORSIA from 1 January 2021[244], but it has not published any responses to the state letter on participation, which states were meant to reply to by 30 June 2020, and which would also show the terms of what they notified. The 88 states include all member states of the European Civil Aviation Conference (ECAC)[245], which notified participation subject to differences[246], as well as US, Canada and Japan among others. Notifications received from the states volunteering in the pilot phase have not been published by the ICAO Secretariat.

Latest analysis shows that CORSIA's current coverage of the aviation sector's global (domestic and international) CO_2 emissions across all CORSIA phases would be approximately 35 to 38 %[247] reflecting the 88 states listed as volunteering.

Currently, there are five states that have not notified their participation from 1 January 2021 and that are not exempt from the second phase starting in 2027. These states are China, Russia, India, Brazil, Vietnam, and ICAO has no legal powers to force them to participate. The first four of these states have made a number of reservations in recent years against CORSIA, considering the global aspirational goal of "Carbon Neutral

[244] https://www.icao.int/environmental-protection/CORSIA/Documents/CORSIA_States_for_Chapter3_State_Pairs_Jul2020.pdf
[245] ECAC is composed of 44 member states, including all EU member states. A complete list of its members is available on: https://www.ecac-ceac.org/member-states
[246] In view of the 30 June 2020 deadline, the EU adopted a decision on the notification of voluntary participation stating that "*This notification is without prejudice to differences, under Article 38 of the Chicago Convention, with the provisions of Annex 16, Volume IV to the Chicago Convention*" (Council Decision 2020/954/UE).
[247] Under nominal demand growth assumptions CORSIA would cover approximately 361 $MtCO_2$ of the total aviation sector emissions of 953 $MtCO_2$ in 2025 (or 38%); 390$MtCO_2$ of the total of 1,079 $MtCO_2$ in 2030 (or 36%) and 424 $MtCO_2$ of the total of 1,201 $MtCO_2$ in 2035 (or 35%).

Growth" from 2020 as going against the growth of international aviation in developing countries.

Enforceability and penalties for non-compliance

The legal instrument chosen by ICAO for CORSIA enforceability is a mix between "lower binding effect", or the so called "soft law" instruments, such as Assembly Resolutions (providing high level mandates and orientations by the ICAO Assembly on triennial basis), Standard and Recommended Practices (SARPs)[248] and technical provisions (Implementation elements[249]), thus avoiding uncertain ratification processes of a treaty or of an amendment to the Chicago Convention.

The Assembly Resolutions are not legally binding, but considered as "soft law". Their degree of legal strength is examined in a number of studies, and found to be dependant on several factors including the vocabulary employed (e.g. using terms such as "decides" rather than "invites"). For instance, in Resolution A39-3 adopted at the 39th ICAO Assembly in 2016, deciding to implement CORSIA, the word "decides" is used 13 times, demonstrating the wish of ICAO to give strong political "quasi law" force to the text.

As the SARPs are included in annexes to the Chicago Convention, they do not have the same nature or binding force as treaty provisions. They receive binding force through their implementation in national law. The stringency with which they are implemented may vary from one state to another. For instance, while the EU used a delegated regulation to implement the Monitoring, Reporting and Verification (MRV) provisions, ensuring CORSIA's MRV is binding in its entirety and directly applicable to all Member States of the EEA, this is not necessarily the case elsewhere.

While Article 37 of the Chicago Convention stipulates that each contracting state undertake to collaborate in securing the highest practicable degree of uniformity in regulations and standards in all matters in which such uniformity will facilitate and improve air navigation, Article 38 enables ICAO member states not to observe the SARPs if they find it impracticable to comply in all respects with any international standard or procedure, through the notification of differences. Article 38 of the Convention provides that each ICAO member state be required to notify any difference between a Standard and its own legislation. Illustratively, in 2018 EU Member States

[248] SARPs are the technical specifications adopted by the ICAO Council in accordance with Article 37 of the Chicago Convention in order to achieve "*the highest practicable degree of uniformity in regulations, standards, procedures and organization in relation to aircraft, personnel, airways and auxiliary services in all matters in which such uniformity will facilitate and improve air navigation*". Annex 16 of the Chicago Convention is dealing with Environmental Protection, and its Volume IV, with *CORSIA*. Today, ICAO manages not less than 12,000 SARPs across the 19 Annexes of the Chicago Convention.

[249] Approved by the ICAO Council, but neither in the Assembly Resolution or in the SARPs. CORSIA includes in total 14 different ICAO documents finalized, approved and available online : https://www.icao.int/environmental-protection/CORSIA/Pages/implementation-elements.aspx

have notified ICAO that certain differences exist between the Directive 2003/87/EC and CORSIA[250]. Whilst the filing of differences can serve to highlight non-compliance with the CORSIA SARPs, ICAO has no instruments at its disposal to enforce compliance, and thus no penalties are envisaged by ICAO in case of non-compliance.

The enforceability and enforcement of use of Eligible Emissions Units or CORSIA Eligible Fuels (CEF) defined by ICAO is similarly difficult to sustain based on the nature of the above mentioned legal instruments, as noted in the Legal Study[251]. Reservations in this regard were made by number of countries (e.g. emphasised publicly by China[252]). The European Commission, recalled in a letter addressed on 1st March 2019 to the Secretary General of ICAO, that CORSIA will be effective only if the growth of aviation emissions from 2020 is effectively compensated by projects generating credits that represent real, additional, permanent and verified reductions of greenhouses gases that are accounted for only once towards any climate mitigation obligation or voluntary action. This emphasizes the importance of the quality of the eligible units for achieving the CORSIA goals.

There are additional challenges as the purchase, use and cancellation of offset credits is done at national level by the aeroplane operators themselves, who are due to report to their reporting state. This could imply potential disparities among ICAO member states. Those uncertainties are tackled better when it comes to the use of CORSIA Eligible Fuels (CEF), as the technical conditions to meet to constitute a CEF are directly provided by the ICAO and remain the same regardless of the aeroplane operator or the country concerned. The same goes for the life cycle emissions value for the CEF (default value or determined following an established methodology), where verification is undertaken by an independent verification body.

Transparency and processes for public input

ICAO does not have a freedom of information policy and has no global mechanism for public request of information. The lack of transparency in ICAO is due to some extent to the historic activities of the organization dealing with issues like safety and technology.

The ICAO Assembly Resolutions are made available to the public, as well as any reservations to those. At the same time, neither the public nor the press, and even ICAO member states in some cases, have access to more specific documents as the aeroplane operators annual use of alternative fuels (for other operators than the ones of the given member state), cancelled offsets, CORSIA compliance obligation and compliance status. The ICAO Council meetings, deliberations and decisions are also not public.

[250] Council Decision (EU) 2018/2027.
[251] https://ec.europa.eu/clima/sites/clima/files/transport/aviation/docs/gmbm_legal_study_en.pdf
[252] https://www.icao.int/Meetings/a40/Documents/Resolutions/china_EN.pdf

The Council decisions represent the majority of rules with regard to CORSIA. Once adopted, the SARPs, representing the majority of the relevant technical specifications for the functioning of the instrument, are accessible for online consultation (they cannot be printed or saved for offline consultation) but can be purchased. All Implementation elements, accompanying the SARPs, are available for download on the CORSIA web pages of ICAO[253]. Before adoption by the ICAO Council, the decisions pertaining to CORSIA are negotiated and prepared by the Committee on Aviation and Environmental Protection (CAEP) and its working groups and task forces, as well as by the Technical Advisory Body (TAB), when it comes to recommendations on Emissions Units eligibility. CAEP working documents are not public, neither are the CAEP "directives", adopted by the ICAO Council to guide CAEP work. Furthermore, while ICAO Council members are elected in a transparent manner by the Assembly every three years, the selection process of the 23 ICAO members for the CAEP is done in secret, as it is for the 19 members of the TAB.

There is high degree of transparency when it comes to the proceedings of the TAB, established in March 2019 by the ICAO Council. The Terms of Reference, the TAB procedures, the annual timeline for its work, the non-confidential sections of programme applications (representing most of the applications material), the public inputs to those applications, as well as a redacted form of the TAB recommendations (excluding internal operational arrangements of the TAB), are made available to the public on the ICAO website. The public comments period lasts for 30 days and it is so far the unique space to gather public input under CORSIA[254].

Quality of offset credits

For Eligible Emissions Units to effectively offset the CO_2 that aircraft release into the atmosphere, it is critical that they offer a solid guarantee that they represent emission reductions that would not have occurred otherwise (concept of additionality); are accurately measured, reported, and verified (MRV); are permanent; ensure that they will not lead to any increase in emissions elsewhere (carbon leakage); and are only claimed once towards any climate target (avoidance of double counting/claiming). Consideration of the "quality" of carbon credits reflects the extent to which they are likely to fulfil this guarantee.

[253] https://www.icao.int/environmental-protection/CORSIA/Pages/default.aspx

[254] Illustratively, the documents made available pertaining to TAB for its 2020 cycle of work can be found under : https://www.icao.int/environmental-protection/CORSIA/Documents/Forms/AllItems.aspx?RootFolder=%2Fenvironmental%2Dprotection%2FCORSIA%2FDocuments%2FTAB%2FTAB%202020&FolderCTID=0x0120001E0668FDCEB3914CB43AEE6773BAE9C0&View=%7B2F6075F3%2D7C75%2D4DEA%2D9C62%2D37A41C41848A%7D#InplviewHash2f6075f3-7c75-4dea-9c62-37a41c41848a=RootFolder%3D%252Fenvironmental%252Dprotection%252FCORSIA%252FDocuments%252FTAB%252FTAB%25202020

To evaluate the eligibility of the units, the TAB was established as an expert body reporting to the ICAO Council. It uses the Emission Unit Eligibility Criteria[255,] as well as the Guidelines for Criteria Interpretation[256] developed by CAEP in recent years and approved for formal use in March 2019 by the ICAO Council. In order to carry out the evaluation, the TAB, which has limited resources (cf. 19 experts), has formed five thematic sub-groups of experts to focus analytical work on clusters of eligibility criteria (governance, additionality, MRV, permanence, double counting), thus ensuring experts will not focus on only one or few programmes.

From April 2019 to January 2020, the TAB undertook the evaluation of the first (14) applicant programmes. At its meeting in October 2019 and after the finalisation of the initial analysis by experts, TAB engaged in live discussions (either face-to-face or remote) with programmes to clarify the outstanding issues. The TAB requested additional evidence and information from programmes. These efforts fed into the TAB's technical assessments which formed the basis for the TAB recommendations on CORSIA eligible emission units, finalised at the TAB meeting in January 2020. In March 2020, the ICAO Council took a decision on eligible units, following the recommendations made by the TAB.

The first TAB report issued in February 2020 contains two types of recommendations to the Council:

(i) specific recommendations on the eligibility (six programmes were recommended for immediate eligibility)
(ii) general recommendations applying to all programmes, such as the starting date of recognition of their units (*eligibility unit date*: issued to activities that started their first crediting period from 1 January 2016[257]; and in respect of emissions reductions that occurred up until 31 December 2020) and the duration of such recognition (*eligibility timeframe* : eligible for cancellation for use toward CORSIA offsetting requirements in the 2021-2023 compliance- cycle).

The second TAB report corresponding to the TAB's second round of work (April 2020 — September 2020) added a single programme to the above list of six programmes delivering eligible offsets, while keeping the same general eligibility unit date and timeframe.

In the end of 2020, following material changes to their rules and procedures by some of the programmes undertaken in the year 2020, one additional programme managed to satisfy the criteria. It was recommended eligible by the TAB for consideration at the

[255] https://www.icao.int/environmental-protection/CORSIA/Documents/ICAO_Document_09.pdf
[256] https://www.icao.int/environmental-protection/CORSIA/Documents/TAB/TAB%202021/Programme_Application_Form_Appendix_A_Supplementary_Information_2020.docx
[257] According to the crediting period start date specified at the time of registration.

222nd ICAO Council session (February 2021), bringing to eight the eligible programmes, again with the eligibility unit dates and timeframe described above.

Finally, one of the already eligible programmes, succeeded to respond to the criteria on double counting for post-2020 and the TAB recommended accordingly extended eligibility unit date for this programme to the end of 2023, subsequently decided by the ICAO Council.

After more than two years of continuous work of the TAB, certain shortcomings that could have undermined the quality of the units approved, are to be noted, amongst which the most prominent are:

- The EUC are used by the TAB at programme level, rather than focusing on individual projects (understandably provided the limited human resources capacities of the TAB), making more use of the Programme Design Elements set of the EUC, and making less use of the Carbon Offset Credit Integrity Assessment Criteria part of the EUC. Furthermore, it appears that TAB assesses if a certain programme has an approach or rule to address an issue, but not so much if these approaches and rules are efficient in their intended purpose. For instance regarding safeguards, even the programmes that were found to fulfil the criteria are highly heterogeneous and offer a wide variety of safeguards and approaches to avoid and mitigate environmental and social risk.
- The TAB consideration of recommendation to only allow emissions reduction units generated from activities until 31 December 2020 suggests that TAB made an interpretation of the drafted EUC that narrows the scope of the EUC to only consider NDCs as the type of mitigation obligation for which emission units should avoid double counting with states' commitments (post-2020). However at least 36 non-Annex 1 countries pledged mitigation actions under the Copenhagen Accord[258], and more countries communicated pledges in Cancun in 2010 for emission reductions in the period to 2020. Studies estimate that 77% of CDM credits generated between 2013 and 2020 came from countries with a target or a pledge made in Copenhagen or Cancun[259].

While one of the eligible programmes fulfils the post-2020 double counting EUC, Parties to the Paris Agreement have not concluded on accounting rules for the use of CORSIA offsets. This means that absence of UNFCCC decision on robust accounting and adjustment may lead to emission reductions being used and counted twice, or more than twice, leading to higher than perceived global greenhouse gas emissions, despite the existence of a CORSIA eligible unit criterion against double counting. Additionally,

[258] OECD 2010. http://www.oecd.org/environment/cc/45441364.pdf
[259] https://www.atmosfair.de/wp-content/uploads/sei-pr-2017-using-the-clean-development-mechanism.pdf

liability under CORSIA, to the extent possible of its limited enforceability, lies with the programmes (and not with states).

Environmental integrity under the Paris Agreement requires going beyond the traditional concept of additionality, to ensure that there are measures in place to avoid double counting but also to ensure that the market-based mechanisms generating the credits are in line with host parties' NDCs and long-term strategies. Use of offsets in a way that may undermine the host country's NDC or path to climate neutrality will make it more difficult for host countries to meet current and future more ambitious targets.

MRV and registries

Common rules regarding the monitoring, reporting and verification of emissions (MRV) under CORSIA are crucial to ensure accuracy of emission reports and consistency. The MRV processes and standards of the EU ETS and CORSIA are similar, because ICAO took account of the EU's experience in this area: flight by flight monitoring, annual reporting of CO_2 emissions based upon a state's approved monitoring plan, annual third party verification, similar estimation methods and approaches for closing data gaps, etc. It is important to note, however, that CORSIA MRV first has to be transposed into national legislation, hence leaving room for potential differences in implementation between states (cf. section above on enforceability).

In terms of outstanding MRV elements proper to CORSIA, the MRV has been applicable from 1 January 2019 onwards to all aeroplane operators producing annual CO_2 emissions greater than 10 000 tonnes from international flights conducted by aeroplanes with a maximum certificated take-off mass greater than 5 700 kg. Verified data started to be reported since May 2020. Under CORSIA, operators with annual CO_2 emission of less than 500 000 tonnes are eligible for a simplified monitoring in the baseline period (through the CORSIA Estimation and Reporting Tool – CERT[260]). From 2021, operators with annual CO_2 emissions from international flights subject to offsetting requirements of less than 50 000 t CO_2, are eligible for simplified monitoring. Under CORSIA, the monitoring methods for the determination of the fuel consumption are subject to review and approval by the state. The SARPs allow jurisdictions to choose which methods the administered operators may use from the five methods included in the SARPs (including besides Method A and B used in the EU ETS, the monitoring methods Block-off/Block-on, Fuel uplift and Fuel Allocation with block hour[261]).

In order to assist states in building their national capacities to implement CORSIA, starting with the MRV, the ICAO Council encouraged the establishment of the CORSIA

[260] Further details on the CERT is to be found under : https://www.icao.int/environmental-protection/CORSIA/Pages/CERT.aspx

[261] For further detail on these methods, refer to pages 24 to 29 of the following presentation : https://www.icao.int/Meetings/RS2018/Documents/2_1_CORSIA%20MRV%20System_Monitoring.pdf

Buddy Partnerships among states as part of the ACT (Assistance, Capacity-building and Training) initiative[262]. Through these partnerships, for 2020 (3rd phase of the partnerships, the second and first one taking place in 2019 and 2018 respectively) 16 donor states assisted 115 recipient states to build their national capacity to implement CORSIA MRV rules.

Launched in mid-2020, the CORSIA Central Registry (CCR) is one of the key Implementation elements underpinning the CORSIA system. States need to transmit an annual emission report to the CCR, containing details such as total annual CO_2 emissions per state pair aggregated for aeroplane operators and per each operator per state, emissions unit cancellation, and CORSIA eligible fuels use. Here again the enforceability is key. A robust system will depend on the implementation of MRV rules across states to ensure correct reporting of emissions data. To prevent potential data gaps due to the lack of implementation of MRV rules, Article 2.5 of Annex 16, Volume IV provides a clear set of provisions to enable ICAO to estimate relevant items where data has not been reported.

Rules on the use of biofuels

ICAO developed a comprehensive framework to reduce offsetting requirements under CORSIA through the use of eligible aviation fuels subject to compliance with sustainability criteria. Based on the sustainability criteria, CORSIA Eligible Fuels (CEF) include Sustainable Aviation Fuels (SAF, a renewable or waste-derived aviation fuel) and in principle but not yet operational, Lower Carbon Aviation Fuels (LCAF, a fossil-based aviation fuel). As for now, no LCAF and only SAFs have been identified as eligible fuels.

CAEP is tasked with developing strengthened sustainability criteria specifically applicable to LCAF to apply beyond the pilot phase. LCAF are not operational under CORSIA until a sustainability framework and an accounting methodology have been adopted for their use. From a technical standpoint, a small portion of GHG emission of fossil-based aviation fuels is attributed to the fuel production stage while most of the GHG emissions come from burning the fuels. Thus, there is little room for improving the carbon intensity of fossil fuels. There are some technologies that allow the production of fossil fuels with a smaller carbon footprint, such as flaring, CCS and the use of renewable energy in oil refineries. As LCAF relates to reductions in emissions associated with the production of the fuel, there is an important risk that the use of LCAF leads to double counting as these reductions could be used under CORSIA and appear in the inventories reported to the UNFCCC.

[262] https://www.icao.int/environmental-protection/CORSIA/Pages/CORSIA-Buddy-Partnerships.aspx

ICAO established three sustainability criteria (achieve net greenhouse gas emissions reductions of at least 10% compared to the baseline[263], limitations and additional quantification requirements for feedstock grown on land converted after 1 January 2008) for CEF applicable during the pilot phase of CORSIA (2021-2023). Additional sustainability criteria stemming from 10 additional sustainability themes (e.g. water, soil, air, conservation, waste and chemicals, human and labour rights) have undergone state consultation and have been formally adopted by the ICAO Council at its 222nd session for application from 1 January 2024 (a decision regarding Themes 3 to 7 will be made upon approval of the ICAO Document CORSIA Sustainability Criteria for CORSIA Eligible Fuels and the relevant guidance material).

Under CORSIA, the Sustainability Certification Schemes (SCS) are organizations that certify economic operators according to the sustainability criteria and ensure that economic operators calculate actual life cycle emissions values (if default values are not applied) using the agreed methodology by controlling and auditing the documents and records and monitoring their operations. CORSIA has a thorough description of responsibilities for the SCS on how to evaluate the economic operators against sustainability criteria and certify the fuels.

[263] The GHG emissions reduction requirements defined by CORSIA are 10% meaning that the GHG emissions (life cycle basis) of eligible fuels should be ≤ 90% of fossil aviation fuel. While the 10% sustainability threshold enables CORSIA to potentially include a wide variety of biofuels as eligible fuels (provided that they meet the entire set of sustainability criteria), it could be seen as setting a low sustainability threshold. However, it should be noted that the CORSIA mechanism for CORSIA Eligible Fuels allows airlines to claim benefits (reduction of offsetting requirements) only in proportion to the GHG performance of the CORSIA Eligible Fuel used. This means that airlines are encouraged to use CORSIA Eligible Fuels which achieve major GHG emissions reductions, in order to consequently reduce their offsetting requirements. In that sense, CORSIA ensures that actual emission reductions can be claimed in order to create incentives for the uptake of fuels with higher GHG savings.

Annex 11: Study of cost pass-through pursuant to Art. 3d of the ETS Directive

The EU ETS Directive Art. 3d(2) requires that the Commission shall undertake a study on the ability of the aviation sector to pass on costs resulting from CO_2 emissions to its customers, in relation to the EU ETS and to the global market-based measure developed by ICAO (CORSIA). The study is included in European Commission publication "Assessment of ICAO's global market-based measure (CORSIA) pursuant to Article 28b and for studying cost pass-through pursuant to Article 3d of the EU ETS Directive".

Cost pass through is typically described as the percentage of the input cost change that is passed through to customers – so for example, in a 100% cost pass-through scenario every €1 increase in the price of inputs is passed through as a €1 increase in the price seen by the customer. In the air transport industry, the estimated ability of airlines to pass-through cost changes varies significantly. Many factors impact airlines' pricing decisions, including:

- Market conditions based on infrastructure and airline network constraints, slot shortage and allocation
- Variations in the price elasticity of demand, which can be segmented along multiple dimensions, but often includes length of haul and/or leisure and business travellers
- Level of competition, determined by the number of airlines flying on a specific route, frequency of flights
- Product differentiation, including seat pitch, catering, loyalty scheme
- Imperfect information
- Barriers to entry such as high capital costs, slot constraints making it challenging for young players in the industry.

The study focuses on the operating costs and policy options related to EU-ETS and CORSIA. Cost pass-through is defined as the ability to pass on the costs of required allowances to cover the carbon emissions or offsetting requirements. These costs include both *out-of-pocket costs*, ie costs of paying for the emissions deficit by acquiring EU ETS allowances or CORSIA Eligible Emissions Units, and *opportunity costs* ie foregone earnings that could have been made had the airline not made the flight and sold the allowances.

The cost pass-through analysis was conducted building on literature findings as well as data and analysis specific to aviation carbon costs.

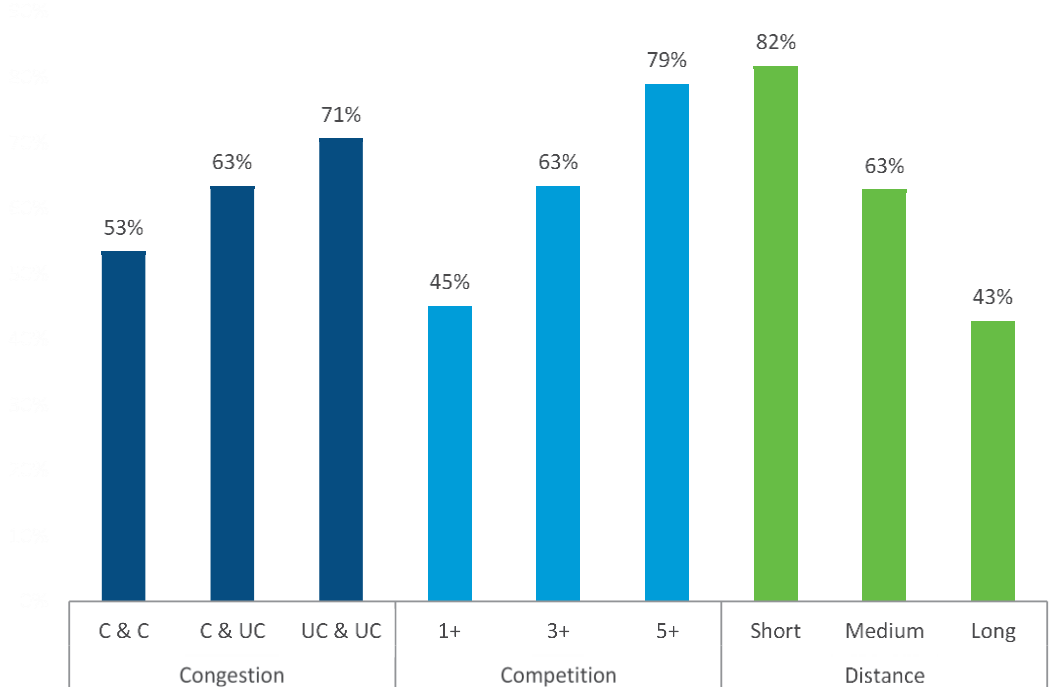
Literature analysis indicates that the following factors have a significant impact on carbon emissions cost pass-through:

- *Market Conditions.* The air transport industry is marked by an intense degree of competition among airlines in many markets and routes around the world. Albeit counter-intuitive, intense competition is a factor that may enhance the ability of airlines to pass-through an additional cost.
- *Market infrastructure.* Market infrastructure can be defined by the level of airports congestion in the air transport industry. For uncongested airports, the allowance/credit price is passed through to passengers in the ticket price, resulting in a loss of profit margin and volume, whereas for congested airports the costs are not passed through in the ticket price, avoiding volume loss, but resulting in higher loss of profit margin.
- *Price elasticities.* Price elasticity refers to the degree to which supply or demand of a product responds to a change in price. Both demand and supply of aviation services are price sensitive.
- *Exposure to international trade.* The impact of international trade for EU airlines is limited as any EU or non-EU airline operating a given route will be subjected to the same rules (i.e. EU ETS charges incurred on intra-EEA and exempted extra-EEA routes). However, at a network level, airlines operating intra-EEA routes will incur higher costs compared to airlines operating extra-EEA routes exclusively. Airlines operating a mixed network can therefore disadvantage the overall company's cost base and profitability.
- *Carbon costs distribution.* Relative difference in carbon cost is likely to influence the cost-pass through. Unequal carbon costs for competing airlines on a route tend to lead to lower average pass-through for the most affected airlines and/or profit increases for the less-affected airlines.

Among the five factors above, three main factors were selected for the quantitative assessment both for their relevance and data availability:

- *Airport congestion.* Congested airports were defined as the top ten airports with the most delayed traffic. Each intra-EEA route was defined by one of the following options: congested airport to congested airport (C & C); congested airport to uncongested airport (C & UC); and uncongested to uncongested airport (UC & UC).
- *Competition intensity.* The number of airlines operating between two points was used as a proxy to determine the competitive intensity on each route.
- *Demand elasticity and substitution*. Route distance was used as a proxy for demand elasticity between two airports on each route to analyse how it affects cost pass-through opportunities.

These factors were used in an analysis of the percentage of fuel cost variations that were passed through to passengers in the form of ticket prices. All flight routes within the European Economic Area were categorised into 27 route categories. The results demonstrate that for these parameters the fuel cost pass-through ranged from 15% on long range routes connecting two congested airports with low competition, to 100% on short haul routes connecting two uncongested airports with high competition.



Carbon cost is likely to account for a smaller portion of cost compared to fuel, representing between 0.2% and 1.3% of total operating costs. The study demonstrates that the magnitude at the passenger level will be limited to an upper range of €2 on intra-continental routes. These two results illustrate the potential for airlines to pass-through additional regulatory costs emanating from their emissions.

Out-of-pocket costs

In aggregate, the pass-through estimations resulting from modelling are:

1. Initial average pass-through rates of around 74% for intra-EEA flights;
2. Initial average pass-through rates of around 75-82% for extra-EEA flights, depending on the type of carbon cost applied;
3. Initial average pass-through rates of around 77% for other routes; and
4. Initial average pass-through rates on routes to and from EU outermost regions of 74-77%, depending on the type of carbon cost applied.

The results of the study demonstrate that many airlines will pass on the majority of the additional carbon costs to passengers, manifesting as higher air fares. This increase is however likely to be small compared to the total expenditure of a holiday or business trip, and if applied on an industry level is likely to have a low impact on aggregate demand, although it may impact the market share of the airlines depending on their comparative ability to accommodate such a cost increase.

From the airlines' perspective, the costs represent a significant gross expenditure, even if the net expenditure may be lower due to the cost-pass through potential described in this analysis.

On an aggregate basis, a cost pass-through range from 0% to 100% would affect airlines' operating margin from -1pt to +1pt (i.e. a 7% total operating margin would decrease to 6% in case of 0% cost pass-through, and increase to 8% in case of 100% cost pass-through).

In conclusion, the analysis suggests that on average airlines are able to pass-through a significant percentage of industry-level cost increases to passengers. However, the dynamics are complicated, and the capacity of airlines to pass through the costs will significantly vary between routes, with up to a 100% variation. Individual airlines will consequently be affected differently, which will introduce comparative advantages and disadvantages between market participants.

Annex 12: 2030 Climate Target Plan policy conclusions

The Communication on stepping up Europe's 2030 climate ambition - the Climate Target Plan (CTP)[264] and its underpinning impact assessment are the starting point for the initiatives under the Fit for 55 package.

The plan concluded on the feasibility - from a technical, economic and societal point of view - of increasing the EU climate target to 55% net reductions of greenhouse gases (GHG) emissions by 2030 compared to 1990. It also concluded that all sectors need to contribute to this target.

In particular, with energy supply and use responsible for 75% of emissions, the plan put forward ambition ranges for renewables and energy efficiency, which correspond in a cost-efficient manner to the increased climate target. The climate target plan also established that this increase in climate and energy ambition will require a full update of the current climate and energy policy framework, undertaken in a coherent manner.

As under the current policy framework, the optimal policy mix should combine, at the EU and national levels, strengthened economic incentives (carbon pricing) with updated regulatory policies, notably in the field of renewables, energy efficiency and sectoral policies such as CO_2 standards for new light duty vehicles. It should also include the enabling framework (research and innovation policies, financial support, addressing social concerns).

While sometimes working in the same sectors, the policy tools vary in the way they enable the achievement of the increased climate target. The economic incentives provided by strengthened and expanded emissions trading will contribute to the cost-effective delivery of emissions reductions. The regulatory policies, such as the Renewable Energy Directive (RED), the Energy Efficiency Directive (EED), the Regulation on CO_2 standards for vehicles supported by the Directive on the alternative fuels infrastructure, and the Re(FuelEU) aviation and maritime initiatives, aim at addressing market failures and other barriers to decarbonisation, but also create an enabling framework for investment, which supports cost-effective achievement of climate target by reducing perceived risks, increasing the efficient use of public funding and helping to mobilise and leverage private capital. The regulatory policies also pave the way for the future transition needed to achieve the EU target of the climate neutrality. Such a sequential approach from the CTP to the Fit for 55 initiatives was necessary in order to ensure coherence among all initiatives and a collective delivery of the increased climate target.

With the "MIX" scenario, the impact assessment included a policy scenario that largely reflects the political orientations of the plan.

[264] COM (2020) 562 final.

The final calibration between the different instruments is to be made depending, *inter alia* on the decision on the extension of emissions trading beyond the maritime sector and its terms.

The *Table 1* below shows the summary of the key CTP findings:

Table 1: Key policy conclusions of the Climate Target Plan

POLICY CONCLUSIONS IN THE CTP	
GHG emissions reduction	• At least 55% net reduction (w.r.t. 1990) • Agreed by the European Council in December 2020 • Politically agreed by the European Council and the European Parliament in the Climate Law
ETS	• Corresponding targets need to be set in the EU ETS and the Effort Sharing Regulation to ensure that in total, the economy wide 2030 greenhouse gas emissions reduction target of at least 55% will be met. • Increased climate target requires strengthened cap of the existing EU ETS and revisiting the linear reduction factor. • Further expansion of scope is a possible policy option, which could include emissions from road transport and buildings, looking into covering all emissions of fossil fuel combustion. • EU should continue to regulate at least intra-EU aviation emissions in the EU ETS and include at least intra-EU maritime transport in the EU ETS. • For aviation, the Commission will propose to reduce the free allocation of allowances, increasing the effectiveness of the carbon price signal in this sector, while taking into account other policy measures.
ESR	• Corresponding targets need to be set in the Effort Sharing Regulation and under the EU ETS, to ensure that in total, the economy wide 2030 greenhouse gas emissions reduction target of at least 55% will be met.
LULUCF	• Sink needs to be enhanced. • Agriculture forestry and land use together have the potential to become rapidly climate-neutral by around 2035 and subsequently generate removals consistent with trajectory to become climate neutral by 2050.
CO2 standards for cars and vans	• Transport policies and standards will be revised and, where needed, new policies will be introduced. • The Commission will revisit and strengthen the CO_2 standards for cars and vans for 2030. • The Commission will assess what would be required in practice for this sector to contribute to achieving climate neutrality by 2050 and at what point in time internal combustion engines in cars should stop coming to the market.
Non-CO2 GHG emissions	• The energy sector has reduction potential by avoiding fugitive methane emissions. The waste sector is expected to strongly reduce its emissions already under existing policies. Turning waste into a resource is an essential part of a circular economy. Under existing technology and management options, agriculture emissions cannot be eliminated fully but they can be significantly reduced while ensuring food security is maintained in the EU. Policy initiatives have been included in the Methane

	Strategy.
Renewables	• 38-40% share needed to achieve increased climate target cost-effectively. • Renewable energy policies and standards will be revised and, where needed, new policies will be introduced. • Relevant legislation will be reinforced and supported by the forthcoming Commission initiatives on a Renovation Wave, an Offshore Energy strategy, alternative fuels for aviation and maritime as well as a Sustainable and Smart Mobility Strategy. • EU action to focus on cost-effective planning and development of renewable energy technologies, eliminating market barriers and providing sufficient incentives for demand for renewable energy, particularly for end-use sectors such as heating and cooling or transport either through electrification or via the use of renewable and low-carbon fuels such as advanced biofuels or other sustainable alternative fuels. • The Commission to assess the nature and the level of the existing, indicative heating and cooling target, including the target for district heating and cooling, as well as the necessary measures and calculation framework to mainstream further renewable and low carbon based solutions, including electricity, in buildings and industry. • An updated methodology to promote, in accordance with their greenhouse gas performance, the use of renewable and low-carbon fuels in the transport sector set out in the Renewable Energy Directive. • A comprehensive terminology for all renewable and low-carbon fuels and a European system of certification of such fuels, based notably on full life cycle greenhouse gas emissions savings and sustainability criteria, and existing provisions for instance in the Renewable Energy Directive. • Increase the use of sustainably produced biomass and minimise the use of whole trees and food and feed-based crops to produce energy through inter alia reviewing and revisiting, as appropriate, the biomass sustainability criteria in the Renewable Energy Directive,
Energy Efficiency	• Energy efficiency policies and standards will be revised and, where needed, new policies will be introduced. • Energy efficiency improvements will need to be significantly stepped up to around 36-37% in terms of final energy consumption[265]. • Achievement of a more ambitious energy efficiency target and closure of the collective ambition gap of the national energy efficiency contributions in the NECPs will require actions on a variety of fronts. • Renovation Wave will launch a set of actions to increase the depth and the rate of renovations at single building and at district level, switch fuels towards renewable heating solutions, diffuse the most efficient products and appliances, uptake smart systems and building-related infrastructure for charging e-vehicles, and improve the building envelope (insulation and windows). • Action will be taken not only to better enforce the Energy Performance of

[265] The Impact Assessment identifies a range of 35.5% - 36.7% depending on the overall design of policy measures underpinning the new 2030 target. This would correspond to a range of 39.2% - 40.6% in terms of primary energy consumption.

	Buildings Directive, but also to identify any need for targeted revisions. • Establishing mandatory requirements for the worst performing buildings and gradually tightening the minimum energy performance requirements will also considered.