ICB

Industry Consultation Body

Evironment position paper

14/01/2022

Issue

Improving the environmental sustainability of European ATM:

Position Paper (Issue)

This paper discusses ATM related measures that can contribute to the improvement of verifiable environmental sustainability of aviation in terms of climate impact (CO_2 and non-CO_2), pollutants and noise emissions. These measures are related to ATM operations as well as to ground ATM/CNS infrastructure, which can foster more environmentally sustainable and efficient operations.

1 ENVIRONMENTAL CHALLENGES DEMAND ACTION

Reducing transport environmental impact, including that of aviation, has been set as a key contributor to reaching the European Green Deal objectives for the European Union. In particular, the EU Sustainable and Smart Mobility Strategy (SSMS)[1] lays the foundation for the EU transport sector to achieve its green and digital transformation and become more resilient to future crises. The Commission has also developed policy interventions as a part of its 'Fit for 55' programme and a taxonomy for Green investments in aviation, including identified ATM activities qualifying as 'Green investments' for public and private investment.

States Worldwide came together, at COP26[2] where the International Aviation Climate Ambition Coalition (IACAC)[3] was launched representing a group of 23 countries who "commit to working together both through ICAO and other complementary cooperative initiatives, to advance ambitious actions to reduce aviation CO_2 emissions at a rate consistent with efforts to limit the global average temperature increase to 1.5°C.". To achieve the global aspirational goals and to promote sustainable growth of international aviation, ICAO is pursuing a basket of measures, ICAO's Basket of Measures to mitigate climate change[4], which include optimisation of air traffic management and operational procedures[5].

In Europe, one of SES high-level goals is to enable up to 10% reduction in the effects flights have on the environment (ATM related aspects). This is an important responsibility for both European institutions and industry alike[6].

The ICB's vision for SES 2035[7] also recognises that every stakeholder, including non-flyers, expect the highest levels of safety and environmental protection from noise and emissions. Reducing environmental impact is a key objective of the industry's vision for SES:

> *"Within the ATM sector, industry's commitment is to minimise fuel consumption through all phases of flight, notwithstanding all other improvements from elsewhere in the aviation industry. Commitment from all stakeholders to reduce the environmental impact of civil aviation will be addressed thanks to new concepts such as Trajectory Based Operations, which supports greater fuel efficiency, along with continuous descent and climb, which will reduce both emissions and noise."* *(Quote from ICB Vision for SES 2035)*

[1] https://ec.europa.eu/commission/presscorner/detail/en/ip_20_2329

[2] https://ukcop26.org/the-conference/cop26-outcomes/page/2/

[3] https://ukcop26.org/cop-26-declaration-international-aviation-climate-ambition-coalition/

[4] https://www.icao.int/environmental-protection/Documents/EnvironmentalReports/2019/ENVReport2019_pg111-115.pdf

[5] "Optimization of air traffic management and operational procedures is a key element to avoid greenhouse gas emissions from aviation. (…) implementation of ASBU Block 0 and 1 modules by 2025 are likely to provide a total annual global fuel saving in 2025 of between 167 to 307 kg per flight, which corresponds to a reduction of the impact. In particular, it is expected that the reform of the Single European Sky will cut up to 10% of air transport emissionsReducing26.2 to 48.2 Mt of CO_2. (…) innovative e-tools, such as Airport Collaborative Decision Making tools, help to improve the overall efficiency of airport operations, especially turn-around and pre-departure sequencing (…)"

[6] European Green Deal – Sustainable mobility European Green Deal – Sustainable mobility

[7] http://icb-portal.eu//wp-content/uploads/2021/03/ICB-Vision-2019-Issue-2.pdf

In parallel to the work undertaken within the ATM Master Plan and SESAR Joint Undertaking to deliver "green technology", there are several other initiatives to identify how and where environmental improvements can be achieved, some specific to ATM, others more generally in the aviation sector. A non-exhaustive list of these activities and relevant reports is provided in the appendix. Of particular note is *Destination 2050 – A route to net zero European aviation*, a study built on independent research by NLR, the Royal Netherlands Aerospace Centre, and SEO Amsterdam Economics. It was co-developed by industry stakeholders – A4E, ERA, ASD, ACI EUROPE and CANSO. It sets out a pathway towards net zero CO_2 emissions from all flights within and departing the EU/UK/EFTA by 2050, and as such brings the ambition level of the European aviation industry in line with EU's target of climate neutrality by 2050.

In light of these activities, this ICB paper seeks to demonstrate the technical progress that has been made within the industry over the last decade and to outline ways in which the Commission can support the move towards a more environmentally efficient ATM network with a primary focus on reducing harmful emissions and aviation's climate impact, whilst always keeping safety as paramount. The emphasis of this paper is on a pragmatic approach, focusing on short-to medium term actions to enable swift change and mobilise momentum.

2 MEETING THE GREEN DEAL TARGETS NEEDS A COMPREHENSIVE AND COST-EFFECTIVE APPROACH TO TECHNOLOGY DEVELOPMENT AND DEPLOYMENT

The recent aviation crisis related to the COVID-19 pandemic compromised the financial capacity of industry stakeholders. Cost-effective solutions that promote the sustainable use of resources, and consequently reduce the environmental impact, are needed more than ever. In combination with the decrease in traffic levels this creates an opportunity for change, which will require cooperation and support between Government/Institutions and the industry players.

One of the ultimate goals for European ATM is for the pilot and supporting Flight Management Systems (FMS) to be able to fly the most environmentally friendly route[8]. This needs to be supported by enhanced, accurate and reliable information in support of a safe execution of a flight (e.g. MET information). This must be underpinned by:

(1) a network centric approach (short, medium and long term) to capacity planning – based on the airspace user needs providing transparency and predictability of investment needs for all stakeholders;

(2) an airspace structure that takes account of network-wide impacts / actions and restricts or impedes as little as possible a flight's most environmentally friendly trajectory[8];

(3) reduced impact on the flight by prohibited, restricted, danger, temporary restrictions or segregated areas, ensured by increased awareness and coordination between the actors/authorities responsible for military use of airspace, airspace users and ANSPs;

[8] The definition of the most environmentally friendly route will be discussed as part of the SES2+ trialogue negotiations, where the European Parliament proposes a similar term (Amendments by the European Parliament to the Commission proposal – recital 6d).

(4) an air traffic control service with minimum tactical intervention, fostered by the cooperation with aircraft operators and commitment of all actors/stakeholders to improve the alignment between the actual route flown and the flight plan, whilst maintaining the necessary operational flexibility to make adjustments.

SESAR aims to support this goal, as well as support better environmental performance of aviation, a goal that will be reinforced in SESAR 3, in which solutions' environmental benefits will be further stressed.

Below are listed important SESAR solutions that enable environmental benefits and feed CP1 and the Airspace Architecture Transition Plan. It should be noted that for the realisation and maximisation of these benefits the local context must be considered, as well as the revision of the concept of operations.

1. **Already available**: The following solutions are mature and available. They have not been fully deployed across Europe but have already shown to be achieving benefits where they are deployed. Stakeholders should not delay in the implementation of these solutions, where appropriate, bearing in mind local specificities.
    - Free Route Airspace (including full cross-border implementation)
    - Performance Based Navigation
    - Continuous Climb and Descent Operations
    - Flexible Use of Airspace
    - Extended Arrival and Departure Managers
    - Collaborative Decision Making (to improve the overall efficiency of airport operations and potentiate environmentally friendly solutions)
2. **To be industrialised:** The following have come through the research phase but require further industrialisation. These represent medium term goals for the industry.
    - System Wide Information Management - SWIM (as a key enabler for IOP, FF-ICE, etc. and as enabler to Trajectory Based Operations in the planning phase)
        - Including MET Information, SWIM services and new products/services
    - Initial Trajectory Information Sharing (reference CP1 AF-6) as key enabler to Trajectory Based Operations[9, 10] in the execution phase

[9] In the ATM Master Plan 2020 it is noted "By optimising aircraft trajectories, TBO also supports greater fuel efficiency. Its benefits will be further increased when combined with solutions such as continuous descent and climb, which will reduce both emissions and noise as well as, possibly, contrail formation.".

[10] https://www.sesarju.eu/index.php/sesar-solutions/trajectory-based-operations. "The idea behind trajectory-based operations (TBO) is to enable the ATM system to know and, where appropriate, modify the flight's planned and actual trajectory, before or during flight, based on accurate information that has been shared by all stakeholders. This will lead to efficiency gains for both individual aircraft and for the network as a whole.".

        - Initial trajectory information sharing enables the aircraft to fly its optimum top of descent, enables continuous descent operations, and enables eAMAN to reduce holdings (references SESAR projects DIGITS[11] and ADSCENSIO[12]
    - 3D weather radar
    - Common ADSPs, as enablers to
    - Virtual centres

The ATM Master Plan and associated SESAR activities aim to reduce by 2035 (compared to the baseline year of 2012) the additional gate-to-gate flight time and additional gate-to-gate CO_2 emissions by 3.2% and 2.3% respectively.

SESAR solutions are complemented by other industry activities, often local solutions required for a specific operating context, aimed at reducing the impact of aviation on the environment. However, there is no single 'silver bullet' solution, or specific combination of solutions, that will deliver the Green Deal targets. Firstly safety is paramount, secondly any local measure is likely to require a trade-off between emissions and noise. For example, whilst PBN routings can deliver more efficient and less noisy approaches and departures to/from airports, this is not necessarily the case when an increased concentration of flights occur over populated areas producing increased noise for local communities (either in terms of decibels or perceived noise)[13].

No single solution will deliver enough benefit to achieve the targets on its own. Ultimately, the ATM contribution to Green Deal targets will only be achieved through the combination of multiple incremental improvements.

SESAR Very Large Scale Demonstration projects (VLDs) contribute to the demonstration of the expected environmental benefits associated to new technologies and concepts of operations. As an example, the VLD DIGITS[11] has been awarded the "Enabling Technology" prize in 2020 ATM Awards, in recognition of its success in demonstrating initial trajectory sharing, bringing us one step closer to trajectory-based operations. Another example is VLD ALBATROSS[14], the project will demonstrate how the complementary use of some SESAR solutions (from alternative aircraft fuel to enhanced ATM and Airspace Users operations on the ground, TMA and en-route) can further reduce the environmental footprint of aviation towards a more sustainable mode of transportation.

[11] DIGITS – Demonstration of ATM Improvements Generated by Initial Trajectory Sharing. SESAR DIGITS4D-TBO: a new approach to aircraft trajectory prediction, https://www.sesarju.eu/news/sesar-digits-project-wins-top-prize-atm-awards-2020

[12] https://www.sesarju.eu/projects/ADSCENSIO

[13] "(…) the inherent accuracy of PBN provides many benefits, but this is not necessarily the case when an increased concentration of flights occur over populated areas. The introduction of PBN could bring potential benefits for those communities living in the vicinity of airports, whereby aircraft could be concentrated over non-residential areas. However, where this would not be possible, there could also be challenges (…)", CANSO, 'Use of Performance-Based Navigation (PBN) for Noise Management', February 2020, https://canso.fra1.digitaloceanspaces.com/uploads/2021/04/use_of_performance_based_navigation_pbn_for_noise_management.pdf

[14] ALBATROSS, the most energy-efficient flying bird. https://www.sesarju.eu/projects/ALBATROSS

There are challenges of moving solutions from research to deployment, which have been captured within the ICB's position paper on industrialisation[15]. Stakeholders should be incentivised and at the same time must pro-actively deploy solutions that can create environmental benefits at the earliest opportunity when they are feasible and mature. It will be through the continued cooperation and commitment of the industry to developing and deploying these solutions, whilst sharing knowledge and making use of best practices, that the target will be reached.

3 PERFORMANCE MONITORING IS KEY TO TRACKING PROGRESS

A performance monitoring system capable of identifying progress against the Green Deal targets is essential. Environmental performance is targeted and monitored through the SES performance and charging scheme and efforts to develop new (K)PIs within the key performance area of environment will need to be made alongside efforts to improve the charging scheme in general.

Only one environmental KPI exists during RP3 – the horizontal flight efficiency of the en-route flight's actual trajectory (KEA). Reported on a yearly basis, KEA is measured both at Union-wide and local levels. The horizontal flight efficiency of the last filed flight plan trajectory and of the shortest constrained trajectory are only PIs for monitoring purposes for which no targets are set.

It is important to acknowledge that the KEA indicator is a result of a past process involving several other stakeholders besides ANSPs: i.e. aircraft operators, CAAs/NSAs and the military. FIRs/ANSPs/countries related KEA results give insight related not only to service provision and airspace structures in the respective FIRs, along the flights' trajectories, but also related to aircraft operators' strategy/route planning. As the only environmental performance indicator with a Union-wide target in RP3, KEA provides an overview of overall environmental performance of air traffic.

Nonetheless, it should be noted that, the Shortest Constrained Route is not always the most fuel-efficient option for the planning phase, there are other aspects to be considered such as weather, vertical efficiency of the flight, etc.

Furthermore, KEA does not take into consideration other key aspects of a flight; for example, vertical flight efficiency (such as optimisation and stability of flight levels and time/speed management), non-CO_2 impacts (that have raised attention and interest only recently), noise and air quality impacts on local communities around airports, and other important local variables related to take-off and landing at airports.

As a result, there are already discussions on how to improve the environmental indicators. Related work is ongoing, e.g. through the EUROCONTROL-EASA joint working group which puts together ANSP expertise and experience. Furthermore, the ICB provided the opportunity for this Working Group to liaise with airspace users associations and have access to existing work and results from the airspace users' side, which is likely to enrich the work of this working group. Therefore, the need of further study and action around environmental performance indicators is obvious and outputs results from this working group are expected by the end of 2022.

[15] Issued on 4th August 2020 and available at the ICB Portal, https://tndk1009935.sharepoint.com/:b:/r/sites/sine/ICB/Publications/ICB%20Position%20Paper%20on%20Industrialisation%20(Issue).pdf?csf=1&web=1&e=awmyll

Notwithstanding whether KEA is the most appropriate indicator, it should be noted that, unlike capacity and delay, there are currently no mandatory environmental incentive schemes under the SES performance and charging schemes. While SES states have the option to implement an environmental incentive scheme, to date, only one state (the UK) has implemented one.

Other PIs monitored at local level include additional taxi out time (average number of additional minutes it takes to taxi benchmarked against unimpeded taxi time) and Additional time in ASMA (Arrival Sequencing and Metering Area – the difference between the ASMA transit time and the unimpeded time based on ASMA transit times)[16].

The accountability for each performance indicator can also be improved, in order to ensure that they better consider the individual contribution of relevant stakeholders, allowing to actively mitigate underperformance in those areas.

Other areas, highlighted by the PRB, which can influence performance in environmental metrics, include advancements in the route structure design, route availability, improved civil/military coordination and advanced ATCO training or airspace re-sectorisation. Better flight planning and incentivisation measures to promote the option for the most network-friendly route also need to be considered.

4 INDUSTRY COMMITS TO THE ENVIRONMENTAL GOALS

Whilst target-setting at Union level sets the global ambition, the ICB's vision for SES acknowledges that only the industry and stakeholders, coupled with local initiatives by regulators and Member States, can deliver change.

Industry engagement is evidenced by such initiatives as Destination 2050. As referred in section 1, A4E, ERA, ASD, ACI EUROPE and CANSO have recently co-developed 'Destination 2050 – A route to net zero European aviation', which sets recommended measures to be realised through collective policies and actions by governments and industry.

Below are highlighted the main ATM related measures proposed by Destination 2050 authors:

Industry should:

- *Continue to substantially invest in decarbonisation*
- *Implement the latest innovations in ATM and flight planning*

Governments should:

- *Support industry investments by direct stimuli or by reducing investment risk through a consistent and long-term policy framework*
- *Stimulate further development and deployment of innovations by funding research programmes and promoting carbon removal technologies*

[16] ASMA is being analysed by the ECTL/EASA Environmental Transparency WG in particular because it is not so compliant with the scope to intercept the Top of Climb / Top of Descent inside the 40 NM radius of the ASMA cylinder – a longer distance, of for example 100 NM, could be considered.

- *Work with the energy sector to ensure sufficient availability of renewable energy at affordable cost*
- *Contribute to optimising ATM, in particular by fully implementing the Single European Sky*

IATA has also recently released a General IATA Meeting Resolution[17], which demands that all industry stakeholders commit to addressing the environmental impact of their policies, products, and activities with concrete actions and clear timelines. In relation to ATM it demands: "*Governments and air navigation service providers (ANSPs) eliminating inefficiencies in air traffic management and airspace infrastructure.*".

Furthermore, Professional Staff Organisations, ATCEUC, ECA, ETF, IFATCA, IFATSEA, have developed a joint paper to the SESAR JU, in which they explain their understanding of the ATM contribution and existing opportunities with regard to aviation sustainability. In this paper they propose to look at the strategic management of ATM, recommend the creation of new KPI's and discuss the need of establishing realistic expectations related to the ATM contribution to aviation sustainability.

The recommendations from the ATCEUC, ECA, ETF, IFATCA, IFATSEA in their joint paper "Aviation Sustainability - Human Operators approach and considerations about the ATM component"[18] are:

Provisions for an ATM environment management system *should comprise at least the following requirements:*

- *Ensure that the level of safety shall be maintained or improved when environmentally driven procedures are introduced.*
- *Ensure that all individual environmental factors are identified and considered while establishing procedures.*
- *The actual values (noise levels, fuel consumption and the amount of emissions) of the various individual environmental contributors of new or existing procedures should be established in detail for transparency reasons.*
- *The interrelation of the various individual environmental factors should be identified and addressed*
- *Ensure that the availability of ATM and CNS Systems is maximized, outages and restrictions in usage of said systems should not occur.*

Provisions for an environment case *should comprise at least the following requirements:*

- *An environment case is a documented body of evidence that provides argument that a certain procedure is optimised for all individual environmental factors as prioritised by the appropriate authorities.*
- *An environment case should provide a detailed overview to the appropriate authorities for the determination of priorities of the individual environmental factors on a strategic level.*

[17] https://www.iata.org/contentassets/dcd25da635cd4c3697b5d0d8ae32e159/iata-agm-resolution-on-net-zero-carbon-emissions.pdf

[18] https://www.atcguild.in/iwen/iwen4221/General/211006%20SJU%20PSO%20ENVI%20paper.pdf

Whatever the future actions, industry staffing levels and skills will have to be taken into account. The ATM industry is still a human centered one and environmental performance is closely linked to the level and qualification of staffing, so long term planning on staffing and training needs to be considered. The interdependencies between the different KPA are other aspect to weigh in, as cost efficiency targets can compromise the environmental performance of the ANSPs.

In line with the ICB vision, Destination 2050 recommendations, General IATA Meeting Resolution, PSOs joint paper, the objectives of CP1[19], the Airspace Architecture Transition Plan[20] and SESAR 3 Joint Undertaking[21], the industry is committed to implementing the following in support of the environmental goals:

1. **Management and implementation of airspace modernisation**: European airspace suffers from fragmentation and a lack of capacity. The use of PBN procedures have helped improve capacity in complex terminal areas and provide more environmentally friendly routings (noting that a trade-off with noise emissions is sometimes required). It also helps to reduce holdings and, supported by AMAN, contributes to reducing extra fuel burned and CO_2 emissions. FRA and FUA have enabled more direct flight paths to be flown. The move to a digitalised network is a steppingstone towards realising the virtual defragmentation of European skies, and ultimately economic sustainability through the rationalisation of infrastructure. This will need to be undertaken under strict conditions in terms of safety, security and the overall business case. Furthermore, automation of the industry – including the better use of data-driven technologies such as Artificial Intelligence – will also bring efficiency gains. However, the airspace is still in need of modernisation to help support further environmental improvements. It is the responsibility of the States and local actors to manage and deliver national airspace modernisation programmes. To achieve this, the Airspace re-configuration programme recommended by the AAS Transition Plan and undertaken by the Network Manager should be supported, taking into account local specificities[22].
2. **Implementing measures to reduce emissions on the ground**: Ground operations are a critical part of the network, and there are numerous activities to be undertaken such as replacement of ground support equipment which rely on fossil fuels, ACI EUROPE's *Airport Carbon Accreditation* programme, and Airport Collaborative Decision Making (ACDM) processes implementation. Measures are also required to provide more parking capacity and ground staff connected with the ground operations. Initiatives linked to CNS ground-based

[19] https://ec.europa.eu/transport/modes/air/sesar/deployment_en

[20] https://ec.europa.eu/transport/sites/default/files/2019-09-high-level-conference-future-of-ses-aas-transition-plan.pdf

[21] https://www.sesarju.eu/sites/default/files/documents/reports/SESAR%203%20JU%20-%20Memorandum%20of%20Understanding.pdf

[22] See "Milestone 2: Launch airspace re-configuration supported by Operational Excellence Programme" of the AAS Transition Plan Report, in page 69, https://ec.europa.eu/transport/sites/default/files/2019-09-high-level-conference-future-of-ses-aas-transition-plan.pdf

infrastructure evolution[23, 24] can also have a contribution, this topic is currently being studied by the enlarged CNS advisory group, with an action plan expected early 2022 to which the ICB is currently contributing, and by the EUROCONTROL Network Manager's Operational Excellence Programme[25] that is looking at how the CNS infrastructure should evolve, including its energy efficiency and carbon footprint. The outputs of this study will subsequently feed-in the work being developed by the EUROCONTROL/EASA Working Group on ATM/ANS Environmental Transparency. Already, a number of ANSPs are implementing actions and programmes to decrease their carbon footprint and can show substantial results. These efforts should be better known, promoted, and as appropriate serve as potential examples for other ANSPs.

3. **Optimising flight planning and the execution of optimal flight profiles**: The ideal scenario is for a pilot to fly the most environmentally friendly route unimpeded. However, constraints including airspace structures or other aspects, such as ANS charging, can result in routes that are not the most fuel or cost efficient ones. Nevertheless, an emissions improvement potential is foreseen to be delivered through improved flight planning, including the exchange of more accurate and reliable MET information and a move to trajectory-based operations. This measure has to walk together with a revision of traffic control concepts of operation, the concepts of the past will no longer be valid, aspects that are already noted in the multiannual work programme (MAWP) of the SESAR 3 Joint Undertaking[26]. It could also potentially impact ATCOs licenses and training.

5 RECOMMENDATIONS

Air transport plays a crucial role in the EU economy, because it is a major driver of economic growth and jobs allowing citizens and goods to travel within the EU and beyond, facilitating trade, tourism and foreign investment. Going ahead, the aim will be to foster the decoupling of economic growth from the use of natural resources and from an increasingly higher climate impact. At the same time, this transition must be just and inclusive.

Whilst the current activities are due to deliver improvements to ATM's environmental impact and sustainability in line with the ATM Master Plan vision – 2.3% reduction in gate-to-gate CO_2 emissions by 2035 (versus baseline, 2012) – there is still a long way to go to achieving the potential reductions required to meet the EU's climate objectives.

To this end, industry puts forward the following pragmatic recommendations to the European Commission, which will ensure a step-change towards the Green Deal targets.

[23] https://www.eurocontrol.int/publication/cns-infrastructure-evolution-opportunities

[24] https://www.sesarju.eu/sites/default/files/documents/events/wac2019/wac2019-day2-cns.pdf

[25] https://www.eurocontrol.int/project/operational-excellence-programme

[26] https://www.sesarju.eu/sites/default/files/documents/reports/SESAR%203%20JU%20MAWP%2030.06.2021.pdf

- **Recommendation 1: Incentivisation of early adopters of SESAR green solutions.** The ATM Master Plan prioritises a number of SESAR solutions based on their environmental performance. This will be most certainly reinforced under the SESAR 3 Programme. For now and the short-term, the highest priority should be given to mature and deployable solutions that can reduce the environmental impact of aviation, as identified in Section 2 "Already available". Early adopters of technology take on a risk, possibly without benefits in the ramp-up phase until a deployment critical mass is achieved (e.g. higher costs, no benefits due to lack network). For this reason, incentivisation is required for both:

SESAR 'Green' Solutions on network level	SESAR 'Green' solutions on a local level
For a number of solutions that have a network impact, there is indeed a risk of not achieving benefits without effective deployment synchronisation or difficulties in implementation. With the environment being such a crucial topic, incentivisation should be provided for early adopters where there is a clear, independently demonstrated environmental benefit to encourage and promote the uptake of such solutions. This should be applicable to both airborne and ground infrastructure.	There are also solutions that can create environmental benefits without requiring synchronised deployment on a network level[27]. Early adopters of this single deployment solutions should also be incentivised. Even though synchronised deployment is not required, while critical mass is not achieved (during the adoption phase), users will be less willing to invest due to higher costs and higher uncertainty. In these cases incentivisation will play an important role. This should be applicable to both airborne and ground infrastructure.

- **Recommendation 2: Access to financing 'Green Investments' facilitated to enable change.** Further to the SESAR 'green' solutions referred in recommendation 1, the Commission is developing a taxonomy for Green investments in aviation, in which are identified specific actions in the ATM industry (covering both R&D and operational activities) that support the Green transition. These and other measures (e.g. energy and water use rationalisation plans, switching to renewable energy supplies, building greener, etc.) that also contribute to the Green Deal Targets, should be promoted and implemented across the industry and will become more important as the COVID-19 pandemic has impacted the industry's ability to fund the changes required to meeting the Green Deal objectives.

  Funding from public and private sources will be needed to enable the transitions required by the industry in a timely manner. Incentivisation measures can also be applicable to overall ATM 'Green Investments'.

[27] Some examples include: AMAN/DMAN integration, Arrival Management Into Multiple Airports, GBAS operations, Dynamic Airspace Configurations (DAC), Advanced Optimised Descent Operations, etc.

Available incentivisation instruments that can be pursued further in support of **Recommendation 1** and **Recommendation 2** are:

- Continue to facilitate access to funding mechanisms for solutions that create network/local environmental benefits (e.g. through Horizon Europe and CEF[28] funds or access to credit). This should be facilitated by certain ATM activities being classified as Green investments in the Commission aviation taxonomy;
- Other instruments such as discounts to early adopters;
- Treating investment costs for enabling the transition to a more environmentally friendly industry as "restructuring costs" as classified in the SES Performance and Charging scheme;
- Supporting stakeholders in the identification and demonstration of the 'green' value of investments near banking/funding institutions;
- Supporting stakeholders in the assessment and definition of 'green' ATM and CNS roadmaps.

- **Recommendation 3: Provide support to help deliver Trajectory Based Operations enablers**. Providing greater synchronisation, gate to gate efficiency through increased en-route horizontal efficiency, supported by accurate and reliable MET information, is a top priority seen in the implementation of FRA and FUA across Europe. However, Trajectory Based Operations has not yet been achieved and should still be pursued. A main enabler for TBO in the planning phase (i.e. FF-ICE-1) is the implementation of SWIM profiles, in particular the SWIM Yellow Profile, for which deployment is ongoing in line with the CP1 requirements. Besides the SWIM services described in CP1, there are also ongoing R&D and standardisation activities related to SWIM. All these need to be successfully achieved in order to enable Trajectory Based Operations and deliver further environmental benefits (linked to improved shared information, of on-board trajectory, with ground services).

  The funding of development of appropriate standards and guidelines, and appropriate industrialisation, will further enable important concepts to be rolled out.

  Further to this, improved collaboration is required between the data providers and the trajectory planers. Processes for data sharing should be detailed (e.g. if MET data is required, it must be clear when and how this information is needed).

[28] The European Climate, Infrastructure and Environment Executive Agency (CINEA) has launched a new call under the Connecting Europe Facility, containing provisions for a series of pilot SESAR JU Digital European Sky Demonstrators in the areas of green aviation and urban air mobility. A total budget of EUR 60 million is earmarked for the demonstrators, which are expected to be launched in 2022 and to run until 2025. https://www.sesarju.eu/news/called-launched-series-pilot-digital-sky-demonstrator

- **Recommendation 4: Further progress on the definition of alternative metrics to better support environmental performance improvement**. Whilst actual horizontal flight efficiency, based on great circle distance, is currently targeted and measured within the performance and charging scheme, new CO_2 and non-CO_2 impact metrics are needed to better measure, monitor, and potentially set innovative environmental performance targets as from RP4 (2025). These new metrics should follow a new paradigm which should not be based on artificial constructs like the great circle distance. Following Recommendation 3 this would mean that the optimum trajectory – most environmentally friendly route[8] – becomes the goal. Hence, indicators need to monitor deviations from this goal, as well as deviations from the ideal most environmentally friendly route. This will lead to further improvements in all areas of planning and operations, including those outside of ANSP remit.

  Furthermore, particular attention is required to trade-offs between interdependent environmental parameters of noise, CO_2 and non-CO_2 impacts, as well as interdependencies with other KPAs. As an example, safety will always remain paramount.

  Other potential metrics include indicators related to:

  - trajectory based indicators such as vertical flight efficiency;
  - CCO and CDO (although recognising these cannot be targeted at Union-wide level due to local particularities);
  - Availability and Continuity of CNS Services (including ATM systems or the Functional system);
  - The outputs of the work currently carried out by the EUROCONTROL/EASA Environmental Transparency working group. This work should continue and its findings need to be made available for other stakeholders' evaluation, to allow feedback and the integration of possibly new ideas / proposals that may come from the airspace users or airports communities.

  These metrics must have clear traceability back to the Green Deal targets and the use of big data analysis and machine-learning can support the monitoring of these metrics (as mentioned in SRIA context[29]).

APPENDIX

Aviation and ATM related initiatives to identify how and where environmental improvements can be achieved:

- **SESAR 3 Joint Undertaking Multiannual work programme:** The SESAR 3 JU supports several important policy initiatives of the European Union. First among them is the Single European Sky (SES), which seeks to reform the European air traffic management (ATM) system with the aim of improving its performance in terms of capacity, safety, efficiency and environmental impact. The draft Multiannual Work Programme document of the SESAR 3 JU, for the period from 2021 to 2031, contains the components of the work programme and budget allocation principles for the SESAR 3 JU's activities over that period.

[29] https://www.acare4europe.org/sria

- **Destination 2050 report**: A route to net zero European aviation, a study built on independent research by NLR, the Royal Netherlands Aerospace Centre, and SEO Amsterdam Economics. It was co-developed by industry stakeholders – A4E, ERA, ASD, ACI EUROPE and CANSO. It sets out a pathway towards net zero CO2 emissions from all flights within and departing the EU/UK/EFTA by 2050, and as such brings the ambition level of the European aviation industry in line with EU's target of climate neutrality by 2050.
- **Aviation Sustainability - Human Operators approach and considerations about the ATM component**: Professional Staff Organisations, ATCEUC, ECA, ETF, IFATCA, IFATSEA, have developed a joint paper to the SESAR JU, in which they explain their understanding of the ATM contribution and existing opportunities with regard to aviation sustainability.
- **EASA, EUROCONTROL and NATS ATM/ANS Environmental Transparency Working Group**: A primary aim of this group is to develop proposals on how ATM/ANS providers can increase environmental transparency and demonstrate their efforts to support the industry reduce negative environmental impacts.
- **Aviation Round Table Report**: Joint aviation stakeholder document outlining ways in which the industry can recover sustainably and resiliently. The document includes a commitment to reach net zero CO_2 emissions from all flights within and departing from the EU by 2050, subsequently reaffirmed by the Destination 2050 report, and calls for EU leaders to join and support an *EU Pact for Sustainable Aviation*, covering the environmental and social dimensions of sustainability.
- **European Continuous Climb and Descent Operations Action Plan:** Through collaboration with industry stakeholders, this action plan provides practical advice on the implementation of CCO/CDO, along with best practise and how barriers can be overcome.
- **ACI EUROPE *Airport Carbon Accreditation* programme:** supporting airports in reducing their CO_2 emissions since 2009. While it is primarily focused on emissions under direct control of airport operators, at the higher levels of accreditation, third party emissions, including those from aircraft operations, have to be addressed as well.
- **Network Manager's Operational Excellence Programme**: The Operational Excellence programme will be run under the Network CDM process, using the current working arrangements and resources, while taking into account the legal framework covering the NM functions and tasks. The need for consistent and harmonised application of ATFM, airspace design, operational procedures, airspace management, flight planning, etc. are covered by the Network Functions Implementing Rule. The Operational Excellence Programme is managed by the NDOP and NDTECH and reports to the Network Management Board (NMB).

Other relevant reports produced in recent years related to this paper topic:

- **European Commission-EASA Report**: This report provides an updated analysis of the non-CO_2 climate impacts of aviation and makes recommendations for policies to address them.
- **EUROCONTROL Environmental Assessment**: This study analyses the potential CO_2 benefits that could be achieved through eliminating fuel inefficiency in the European Air Traffic Management network.

- **EUROCONTROL Performance Review Report 2019**, which assesses the performance of air traffic in key performance areas as the Environment (chapter 1.5) before the air traffic crunch.
- **EUROCONTROL Performance Review Report 2020,** which assesses that the level of operational inefficiencies in the European ATM network is estimated to be between 6-8% of the total gate-to-gate fuel burn (2019). Although there is clearly scope for further improvement, it is important to point out that the inefficiencies cannot be reduced to zero nor can they be attributed entirely to ANS. A certain level of "inefficiency" is in fact necessary (separation minima, adverse weather, avoidance of 'Danger Areas') or even desirable (trade-offs). Taking the theoretical upper ceiling, the ANS contribution to reduce emissions is limited to some 0.3-0.4% of the total CO_2 emissions in Europe (SAF ≈ 3.8%).
- **EUROCONTROL study on climate change risks for European aviation**, which assesses how existing weather trends have impacted aviation in recent years, factoring in climate change impacts that are emerging faster than expected. It forecasts growing disruption both on the ground and in the air: airports and their surrounding transport infrastructure face a rising risk of flash flooding and rising sea levels, while flight operations are set to be increasingly delayed by violent storms that will increase delays, raise fuel burn and lead to higher emissions.
- **Sustainable Finance Taxonomy for the Aviation Sector:** Following the adoption of the EU taxonomy delegated act on 21 April 2021 the Commission published a report by Steer to define a common language for sustainable investments in the aviation sector. This study identifies four sectors for potential inclusion in the taxonomy: i) aircraft ii) fuel production, storage and distribution, iii) air traffic management iv) airports. The relevant screening criteria for inclusion of ATM-related activities in the taxonomy are: (1) any activities or investments that are categorised by SESAR as consistent with the ATM Master Plan scenarios and solutions delivering environmental benefits; or (2) any activities or investments that are in line with the implementation of Free Route Airspace (FRA) and cross-border FRA.
- **EUROCONTROL Think Paper #11 – Plane and train: Getting the balance right:** in this paper is argued that transport investment should be balanced between both industries (air and rail), building on natural complementarities and working towards the transport industry's emissions reduction goals, making the optimal solution more "plane and train" rather than "plane vs train".
- **EUROCONTROL Think Paper #13 – Greening European ATM's ground infrastructure: What could ANSPs achieve over the next decade?**: in this Think Paper EUROCONTROL makes a very first assessment of the extent of Europe's ATM ground infrastructure, and use this to assess its potential to contribute to the overall goal of aviation decarbonisation.

Key EU policy initiatives related to this paper topic:

- **The European Green Deal for EU:** It resets the Commission's commitment to tackling climate and environmental-related challenges that is this generation's defining task. 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. It must put people first, and pay attention to the regions, industries and workers who will face the greatest challenges. This package includes:

  - **European Climate Law**: This Regulation establishes a framework for the irreversible and gradual reduction of greenhouse gas emissions and enhancement of removals by sinks regulated in Union law. This Regulation sets out a binding objective of climate neutrality in the Union by 2050 in pursuit of the long-term temperature goal set out in the Paris Agreement, and provides a framework for achieving progress in pursuit of the global adaptation goal established in Article 7 of the Paris Agreement.
  - **European Climate Pact**: The European Climate Pact is an EU-wide initiative inviting people, communities and organisations to participate in climate action and build a greener Europe.
  - **2030 Climate Target Plan**: With the 2030 Climate Target Plan, the Commission proposes to raise the EU's ambition on reducing greenhouse gas emissions to at least 55% below 1990 levels by 2030. The new proposal delivers on the commitment made in the Communication on the European Green Deal to put forward a comprehensive plan to increase the European Union's target for 2030 towards 55% in a responsible way. It is also in line with the Paris Agreement objective to keep the global temperature increase to well below 2°C and pursue efforts to keep it to 1.5°C.
  - **EU Adaptation Strategy**: The European Commission adopted its new EU strategy on adaptation to climate change on 24 February 2021. The new strategy sets out how the European Union can adapt to the unavoidable impacts of climate change and become climate resilient by 2050. The Strategy has four principle objectives: to make adaptation smarter, swifter and more systemic, and to step up international action on adaptation to climate change.

- **Sustainable & Smart Mobility Strategy (SSMS)**: In 2020, the European Commission presented its 'Sustainable and Smart Mobility Strategy' together with an Action Plan of 82 initiatives that will guide our work for the next four years. This strategy lays the foundation for how the EU transport system can achieve its green and digital transformation and become more resilient to future crises. Objectives include:
  - increasing the uptake of zero-emission vehicles;
  - making sustainable alternative solutions available to the public & businesses;
  - supporting digitalisation & automation;
  - improving connectivity & access.
- **'Fit for 55': delivering the EU's 2030 Climate Target on the way to climate neutrality**: The European Commission has launched the first tranche of its 'Fit for 55%' measures that will support Europe's climate policy framework and put the EU on track for a 55% reduction in carbon emissions by 2030, and net-zero emissions by 2050. The package is comprised of thirteen proposals; eight of them are revisions to existing laws and five are new initiatives, which cover areas of

climate, land use, energy, transport and taxation. Regarding Aviation there are two proposals:

- **Revision to the EU Emission Trading Scheme**, to lower the overall emissions cap per economic sector, phase out free emission allowances for aviation, and include shipping for the first time. The objective of this revision is to strengthen the EU ETS in its current scope in order to provide the appropriate contribution to an overall target of at least -55 % GHG emissions compared to 1990. Here is *stressed the need for* greater efforts from aviation operators to reduce their emissions at global level. In July 2021, the Commission published a 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. The proposal introduces an amendment to aviation rules in the EU ETS to implement Member States' notification to EU-based airlines of the offsetting for the year 2021 under the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) of ICAO.
- The **ReFuelEU Aviation Initiative** to oblige fuel suppliers to blend more sustainable aviation fuels in jet fuel, including e-fuels. The Commission is also proposing to promote the uptake of sustainable fuels in the aviation complementing the ETS for the aviation sector which makes polluting fuels more expensive for suppliers. The upcoming zero emission aviation Alliance will complement this work to ensure market readiness for disruptive aircraft configurations (e.g. hydrogen, electric).
- **Revision of the Energy Taxation Directive (ETD)** to align the taxation of energy products with EU energy and climate policies, promote clean technologies and remove outdated exemptions and reduced rates that currently encourage the use of fossil fuels.

- **Sustainable finance package**: The European Commission adopted on 21 April 2021 an ambitious and comprehensive package of measures to help improve the flow of money towards sustainable activities across the European Union. By enabling investors to re-orient investments towards more sustainable technologies and businesses, these measures will be instrumental in making Europe climate neutral by 2050. This package includes:
  - **Taxonomy Regulation, Regulation[30]**: The Taxonomy Regulation establishes six environmental objectives:
    - Climate change mitigation;
    - Climate change adaptation;
    - The sustainable use and protection of water and marine resources;
    - The transition to a circular economy;
    - Pollution prevention and control;
    - The protection and restoration of biodiversity and ecosystems.

[30] (EU) 2020/852 of The European Parliament and of the Council, of 18 June 2020, on the establishment of a framework to facilitate sustainable investment, and amending Regulation (EU) 2019/2088

  - Proposal for a **Corporate Sustainability Reporting Directive (CSRD)**[31]: The Commission adopted a proposal for a Corporate Sustainability Reporting Directive (CSRD), which would amend the existing reporting requirements of the NFRD. The proposal:
    - extends the scope to all large companies and all companies listed on regulated markets (except listed micro-enterprises);
    - requires the audit (assurance) of reported information;
    - introduces more detailed reporting requirements, and a requirement to report according to mandatory EU sustainability reporting standards;
    - requires companies to digitally 'tag' the reported information, so it is machine readable and feeds into the European single access point envisaged in the capital markets union action plan.
  - **Implementing and delegated acts**

- **Horizon Europe**: Horizon Europe is the EU's key funding programme for research and innovation with a budget of €95.5 billion. It tackles climate change, helps to achieve the UN's Sustainable Development Goals and boosts the EU's competitiveness and growth. The programme facilitates collaboration and strengthens the impact of research and innovation in developing, supporting and implementing EU policies while tackling global challenges. It supports creating and better dispersing of excellent knowledge and technologies.
- Council regulation establishing **nine Joint Undertakings under Horizon Europe (COM(2021)0087 – C9-0166/2021 – 2021/0048(NLE))**: This regulation establishes nine individual joint undertakings including the SESAR 3 JU. By teaming up with both the public and private sectors, European partnerships help speed up new solutions, particularly those that can decrease greenhouse gas emissions by 2030 in line with the European Green Deal targets, and help achieve the green and digital transitions. The joint undertakings complement the existing Horizon Europe framework by addressing global challenges and priorities that require critical mass and long-term vision.
- **SES 2+ Proposal**: The Single European Sky (SES) initiative aims to improve the overall efficiency of the way in which European airspace is organised and managed through a reform of the industry providing air navigation services (ANS). The first package was delivered in 2004 (SES I), followed by a second package in 2009 (SES II). On 22 September 2020, the Commission tabled an amended proposal (SES 2+), to account for the European Green Deal and also the recommendations of the Wise Person's Group. A separate proposal to amend the EASA Basic Regulation was also put forward.
- **ATM Masterplan**: The European ATM Master Plan is the agreed roadmap that connects ATM research and development activities with deployment scenarios to achieve the performance objectives of the Single European Sky. With the growth in air traffic come concerns about its environmental and health impacts. These concerns in Europe and worldwide are prompting the aviation industry to step up its efforts to address the environmental sustainability of air travel to reach the EU's carbon neutral goal by 2050. In support of this environmental goal, the

[31] Proposal for a DIRECTIVE OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL amending Directive 2013/34/EU, Directive 2004/109/EC, Directive 2006/43/EC and Regulation (EU) No 537/2014, as regards corporate sustainability reporting COM/2021/189 final

SESAR project has prioritised solutions that will gradually contribute to the elimination of environmental inefficiencies due to the underlying aviation infrastructure.

- **Commission Implementing Regulation (EU) 2021/116 on the establishment of the Common Project One** supporting the implementation of the European Air Traffic Management Master Plan provided for in Regulation (EC) No 550/2004 of the European Parliament and of the Council: The Common Project One ('CP1') is established to support the implementation of the European Air Traffic Management ('ATM') Master Plan. Common projects shall identify the ATM functionalities and their sub-functionalities based on SESAR solutions addressing the essential operational changes defined in the European ATM Master Plan. Furthermore, the Common Projects are also required to be consistent with and contribute to the European Union-wide performance targets or demonstrate an improved environmental performance.
- **Airspace Architecture Study**: The European Commission entrusted the SESAR Joint Undertaking in collaboration with the Network Manager with the preparation, launch and management of such a study stressing the need to ensure consistency with the objectives of the SESAR project and in particular, the vision developed in the European ATM Master Plan. The airspace architecture study proposes a progressive transition strategy towards the Single European Airspace System in three 5 year-periods, while building on known good practices and quick wins, as well as existing initiatives such as SESAR. The aim is to enable progressively additional capacity in order to cope with the significant growth in traffic, while maintaining safety, improving flight efficiency and reducing environmental impact.

Glossary of Abbreviations for reference:

Abbreviation	Full Term
ADSP	ATM Data Service Provider
AMAN	Arrival Manager
ASMA	Arrival Sequencing and Metering Area
ATCO	Air Traffic Control Officer
CCO	Continuous Climb Operations
CDO	Continuous Descent Operations
CP	Common Project
EASA	European Union Aviation Safety Agency
ECTL	EUROCONTROL
FIR	Flight Information Region

Abbreviation	Full Term
FMS	Flight Management System
FRA	Free Route Airspace
FUA	Flexible Use of Airspace
ICB	Industry Consultation Body
KEA	Key performance Environment indicator based on Actual trajectory
KPI	Key Performance Indicator
NSA	National Supervisory Authority
PI	Performance Indicator
SAF	Sustainable Aviation Fuels
SES	Single European Skies
SESAR	Single European Skies ATM Research
SWIM	System Wide Information Management
TBO	Trajectory Based Operations