Aviation Sustainability - Human Operators approach and considerations about the ATM component

Position paper by Professional Staff Organisations

ATCEUC
ECA
ETF
IFATCA
IFATSEA

Motivation for this paper

The task

SESAR JU under the contract PSO Lot, assigned the the task *to write a single Position Paper, produced jointly by all PSO LOTs, under the technical leadership of ECA*.
The Paper will provide a view of how the Green Deal Challenge Area and Roadmap (section 3.7 and Roadmap 7 in the Strategic Research and Innovation Agenda (SRIA) for the Digital European Sky (available here (https://www.sesarju.eu/sria) relate to the environmental sustainability vision of the organisations contributing to the Paper. It is important that all views are taken into consideration, even if there are differences in priority between individual LOTs; such differences should be reconciled as far as possible, but remaining differences should be recorded and laid down in an annex to this paper. The Paper should include consideration of the human dimension, i.e. how the humans can contribute, which challenges they see from the human dimension point of view, and particularly where any strategies may have an impact on safety.

The approach taken by the PSO

The PSO met several times by teams and discussed via email how to complete the task of the SJU. A first meeting did assess the task and a ppt was provided by IFATCA to explain what is outlined in the SRIA. Following this meeting a draft paper was circulated for comments and two further phone conferences were organised by ECA to finalise the proposed paper.

The SRIA, in particular section 3.7, were considered to be too complicated to be assessed by the PSO as they propose detailed changes which, from the PSO perspective, are solution-oriented and not covering the needs from a human contribution point of view. The Professional in the system need to be able to work according to the proposed new needs and challenges (e.g. Optimum green trajectories, new ways of flying, formation flights, advanced RNP green approaches and Environmentally optimized climb and descend operations or Non-CO2 impact of aviation).

Therefore, the proposed PSO Paper provides in the beginning a high-level overview of the impact of aviation on CO2 and non-CO2 elements using publications of other institutions.

All strategies to reduce aviation's impact on climate essentially focus on four pillars. The paper focusses on the fourth pillar: Improved infrastructure and operations (operational efficiency).

Environmental impact from ground infrastructure such buildings, lighting, heating etc. are not included in this paper.

Due to the different nature of the PSO not all organisations were able to endorse all the proposed contribution.

IFATSEA has identified that the contribution of outages of the existing and forthcoming CNS & ATM systems derived enabling services are not considered as a Performance indicator and utilised to improve delays, capacity resilience and Operational efficiency.

When it comes to systems and related services, unavailable Surveillance systems, Navigation systems at airports or even inefficient communications can lead to alternative routes flown thus more fuel burn and lower capacity or even total lack of service delivery e.g. NATS outages, recent Rhodes airport (Greece) total ground communication failures etc.

If delays due to CNS outages and ATM systems outages are minimized, delays can be minimized and improvements in fuel burn can be made. Thus, the Greening of aviation objective benefits.

Annex C to this paper further describes the recommendation in detail.

The recommendations from the PSO

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. Annex D to this paper further describes the recommendation details. A new metric on CNS availability and its' impact on Environment within the context of SRIA (3.7.AGD) is describe in there.

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.

Contents

1. Introduction

The objective[1] of net-zero greenhouse gas emissions by 2050 set by the European Green Deal, in line with the EU's commitment to global climate action under the Paris Agreement, requires accelerating the shift to smarter and more sustainable mobility. This implies the need for aviation to intensify its efforts to reduce emissions, in line with the targets set in Flightpath 2050. To this end, a set of operational measures to improve the fuel efficiency of flights will have to be put in place. At the same time, to ensure sustainable air traffic growth, it is necessary to speed up the modernisation of the air infrastructure to offer more capability and capacity, making it more resilient to future traffic demand and adaptable through more flexible air traffic management procedures and a charging scheme that does not make it interesting to fly unnecessary distance. Furthermore, reducing aircraft noise impacts and improving air quality will remain a priority around airports.

In this context, European research programmes are calling on all sectors to step up their combined efforts, as one of the cornerstones of the "Green Deal" for Europe, featuring much more ambitious objectives and investment.

Within the framework of the SESAR contract, the professional Staff Organisations (ATCEUC, ECA, ETF, IFATCA & IFATSEA) were tasked to deliver some views on the positive contribution the ATM component could play to decarbonise aviation and under which conditions, be it thanks to the delivery and use of breakthrough technologies or thanks to new, well-thought-through operational concepts. As organisations representing all the Staff in the Aviation sector, we would like to thank SESAR for providing us with this opportunity.

2. Preconditions

Aviation climate impact[2] originates from direct or indirect effects from emitting carbon dioxide (CO2), nitrogen oxides (NOx), particular matter (PM) and water vapour into the atmosphere.

Because of its long residence time in the atmosphere, CO_2 is a global issue irrespective when and where the emissions take place. Non-CO_2 effects of aviation have a much shorter lifecycle and depend on location and time which makes them much more complex to understand.[3]

Aviation is estimated to be responsible for around 2-3% of the total anthropogenic CO_2 emissions globally[4].

[1] Strategic Research Agenda
[2] PRC, FABEC env day
[3] Lee., D., et al., Greater fuel efficiency is potentially preferable to reducing NOx emissions for aviation's climate impacts
[4] ICAO, www.ourworldindata.org

In Europe (EU27+UK), aviation accounted for 4.3% of total GHG emissions in 2019 (latest year for which EEA data is available).

The steady growth of aviation has led to an increase of the GHG emission of aviation of more than 125% since 1990 in Europe.

As a result of the COVID-19 pandemic and the dramatic drop in air traffic demand, CO_2 emissions from aviation in Europe in 2020 more than halved compared to 2019. Despite this reduction, it is clear that the environmental challenge for aviation will remain throughout the recovery phase and beyond.[5] The Performance Review Commission's assessment of the COVID impact on Environment performance has been added as Annex A.

3. Relevant Areas

The truth is that it will be extremely challenging to reduce aviation emissions quickly with current available technologies. All strategies to reduce aviation's impact on climate essentially focus on four pillars:
(1) Aircraft technology (airframes and engines),
(2) Sustainable Aviation Fuels (SAF)
(3) Market Based Measures (MBM)
(4) Improved infrastructure and operations (operational efficiency).

As this paper focuses on the Professional Staff Organisations' view it expands on point 4.

3.1. Improved infrastructure and operations (operational efficiency)

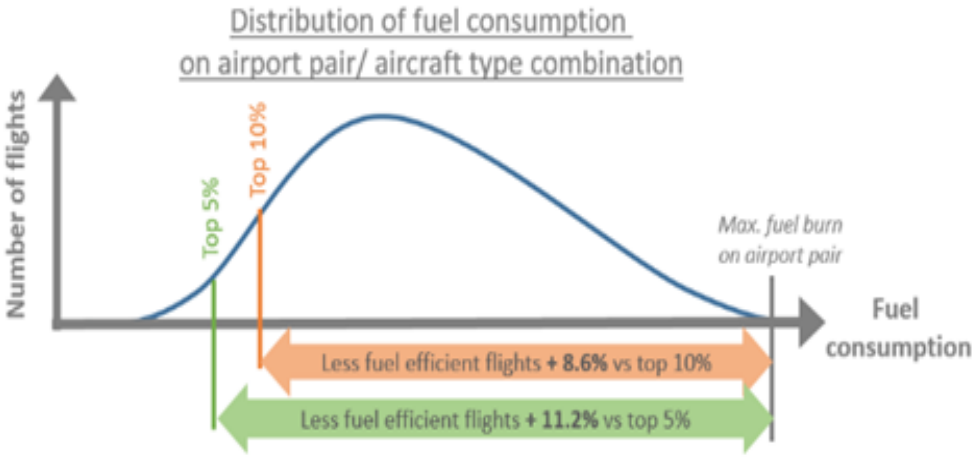
With benefits from aircraft technology and SAF only taking real effect beyond 2030[6], ATM can help reducing emissions by addressing operational inefficiencies in the ATM system already in the short to medium term. For every ton of fuel saved, an equivalent amount of 3.15t of CO_2 can be avoided.

In political discussions, ATM is frequently mentioned to be able to improve fuel efficiency by 10% or more. In reality, it is often not clear what measures are involved and how the results need to be interpreted.

There are many different studies aimed at quantifying fuel and flight efficiency. While those studies provide useful and valuable insights, the differences in scope and methodologies make direct comparisons often difficult if not impossible.

[5] Performance Review Report 2020
[6] Performance Review Commission

Previous PRC work [PRR 2019] has estimated that the benefit pool that can be influenced by ANS is approximately 6-8% of the total gate-to-gate fuel burn (emissions) in the ECAC area.



A recent study focusing only on flights within the EUROCONTROL area (long haul flights excluded) estimated the average fuel inefficiency from take-off to landing between 8.6% and 11.2%.

Most studies apply similar methodologies which compute efficiency gains compared to a theoretical reference which in reality cannot be achieved at system level.

There is clearly scope for further improvement in ANS operational performance. However, it is important to stress that the often-quoted benefit pools cannot be fully recovered nor can the inefficiencies be entirely attributed to ANS.
Full efficiency as envisaged is impossible due to technical and safety aspects (separation minima, adverse weather, avoidance of 'Danger Areas' and temporarily segregated areas) or tactical decisions (trade-offs).

In fact, environmental objectives for ANS can even be conflicting; for example, noise abatement procedures at airports might lead to longer trajectories and hence additional emissions.

ANS performance can help reducing the environmental impact of aviation which can be broadly divided into the impact on (i) global climate, (ii) local air quality (LAQ), and (iii) noise.

Generally, the management of noise is considered to be a local issue which is best addressed through local airport-specific agreements developed in coordination and cooperation with all relevant parties including ANS. Due to the complexity of those local agreements, there are presently no commonly agreed Europe-wide indicators specifically addressing ANS performance in the noise context.
Apart from the active support in noise management decisions, the areas where ANS can contribute to the reduction of aircraft noise are mainly related to operational procedures. Continuous climb (CCO) and descent operations (CDO), noise preferential routes and runways are all in the ANS portfolio and help to avoid unnecessary exposure to aircraft noise

The ATM-related impact on climate is closely linked to operational performance (fuel efficiency) which is largely driven by inefficiencies in the flight trajectory and associated fuel burn (and emissions). Hence, the focus has been traditionally on the monitoring of ANS-related operational efficiency by flight phase which served as a proxy for environmental performance since the distance or time saved by operational measures can be converted into estimated fuel and CO_2 savings.

Figure 1-16: Distribution of flights and estimated CO2 emissions by distance category (2019)

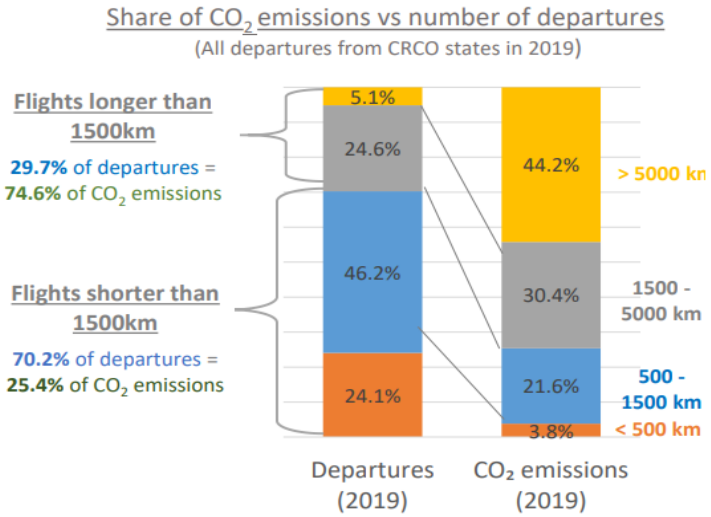


Figure 1-16: Distribution of flights and estimated CO_2 emissions by distance category (2019)

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 or contingency" is in fact necessary (separation minima, adverse weather, avoidance of 'Danger Areas') or even desirable (trade-offs). Using the theoretical upper ceiling, the ANS contribution to reduce emissions is limited to some 0.3-0.4% of the total CO2 emissions in Europe (SAF ≈ 3.8%).

Figure 1-17 (below) provides an overview of the various factors influencing aviation's CO2 efficiency, including a high-level estimate of the potential benefit pool for further improving environmental performance.

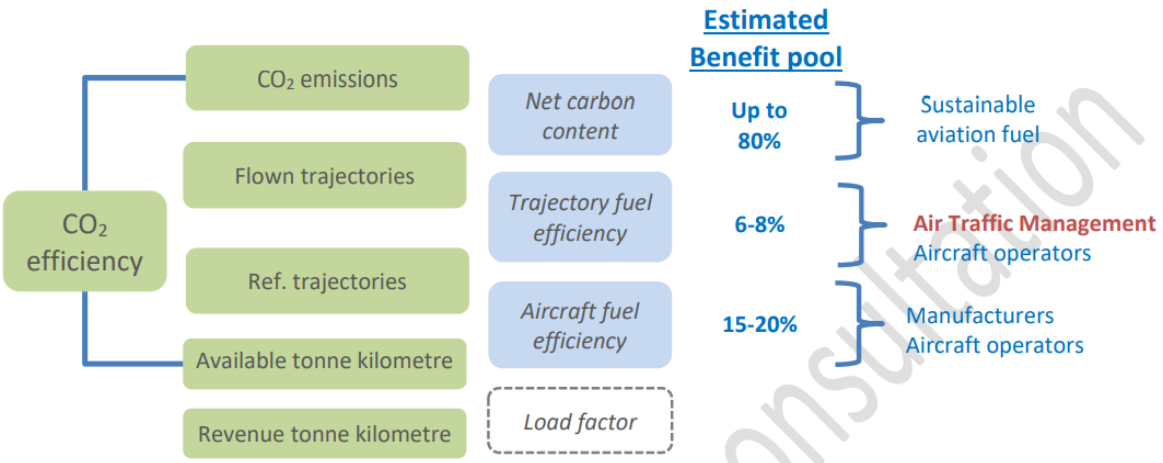


Figure 1-17: Factors affecting aviation CO_2 efficiency

3.2. So what can ATM do to help?

Increased operational efficiency leads to increased fuel efficiency and a subsequent reduction in emissions.

Figure 1-18 provides an overview of the gate-to-gate efficiency by phase of flight including an indication of the supporting ATM related projects/ enablers.

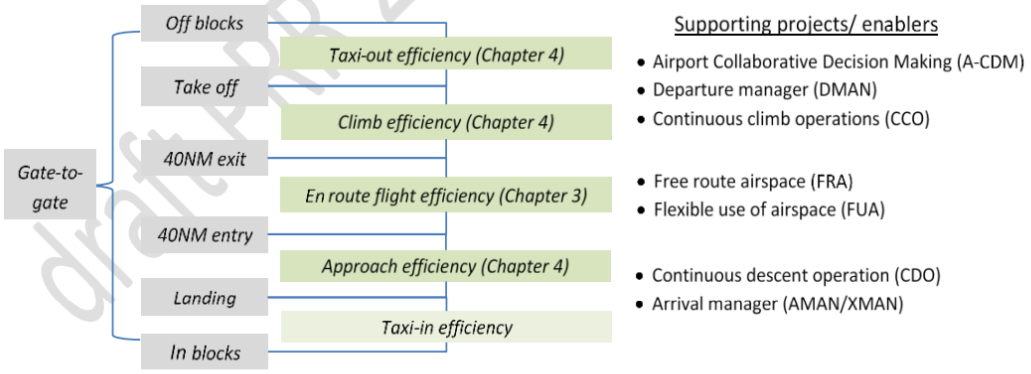


Figure 1-18: Gate-to-gate efficiency by phase of flight

Figure 1-19 provides an initial high-level summary of the evolution of the ANS operational metrics with environmental impact detailed in the respective chapters of this report and outlined in Figure 1-18.

Ground infrastructure as a contributor to the Greening of Operations through efficiency improvement.

ICAO, with the support of its Committee on Aviation Environmental Protection (CAEP), actively pursues its technical work on measures to reduce the environmental effects of aviation.

As it is stated in ICAO DOC 10013[7] "*Operational Opportunities to Reduce Fuel Burn and Emissions", significant fuel and emissions savings* ***can be realized by an efficient ATM system****. New and established technologies and concepts of operations in communications, navigation and surveillance (CNS) can provide opportunities to improve the efficiency of ATM. CNS/ATM can permit more direct routings and the use of more efficient flight conditions such as optimum altitude and speed. ;"*

Furthermore, it is stated in Chapter 6 ATM "New and established technologies and concepts of operations in communications, navigation and surveillance (CNS), such as data link communications, performance-based navigation (PBN), automatic dependent surveillance (ADS), flexible use of airspace (FUA) and airport collaborative decision making (A-CDM) can provide opportunities to **improve the efficiency of ATM**"

However, degraded or low Availability and Continuity of CNS Systems and services (e.g. at airports) can lead to alternative routes flown thus more fuel burn and lower capacity or even total lack of service delivery.
So, a new study of a new concept that analyzes the relation between CNS outages or systems unavailability with the impact on the environment and safety issues could help to arrive in the future at the elaboration of new useful metrics or KPIs as requested by SRIA.

4. Environmental performance in the ATM system

When balancing the requirements of safety, efficiency, capacity and the environment, the level of safety shall always be maintained or improved at all stages of the ATM system (operation, maintenance and development). Said in other words, respect to environment should not undermine respect for safety.

In case environmentally-driven procedures are introduced in the ATM System, these must take into consideration the increased complexity for the front-end users, namely controllers and pilots, especially the related human factor and HMI issues. This complexity must be managed at the appropriate, strategic level, never at tactical stage. A trade-off between environment and capacity must be considered as part of this management of complexity, as safety is paramount. Any environmentally driven procedure shall not expose the ATCOs and Pilots to undue liability issues.[8]

[7] (http://www.icscc.org.cn/upload/file/20190102/Doc.10013-EN%20Operational%20Opportunities%20to%20Reduce%20Fuel%20Burn%20and%20Emissions.pdf)
[8] As experienced in 2009. 2016 and 2017 by the Tower controller in Brussels, who were summoned by the prosecutor for an alleged misuse of new noise abatement routes (see BGATC publication 2017)

Individual environmental aspects shall be considered by an ATM environmental management system and documented in an ATM environment case[9] as part of an overall performance case. 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 level of emissions) of the various individual environmental contributors of new or existing procedures should be established in detail for transparency purpose;
- The interrelation of the various individual environmental factors should be identified and addressed.
- 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[10].
- IFATSEA proposes to add ANS/ATM systems, services, architecture and configurations are ensuring the required Resilience and QoS to enable Operational Efficiency and Green operations

[9] SESAR Environment Assessment Process PJ 19.4. 2019

[10] IFATCA policy

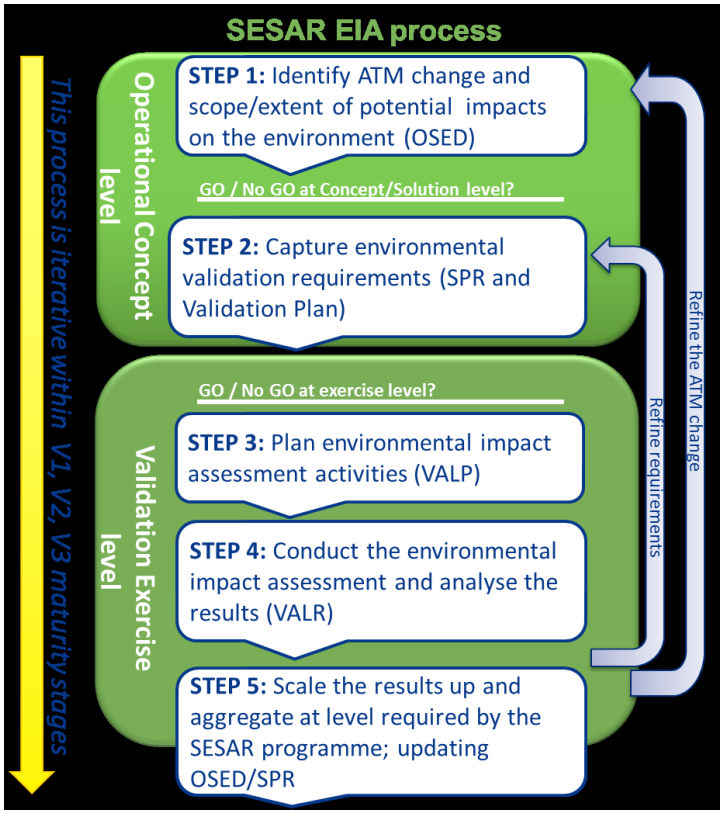


Figure 1 Environmental impact assessment process of SESAR

When talking about strategic level, the PSO understand the following conceptual approach from the 3 layered Conflict management in Air traffic management by ICAO. Annex B of this paper provides the ICAO description.

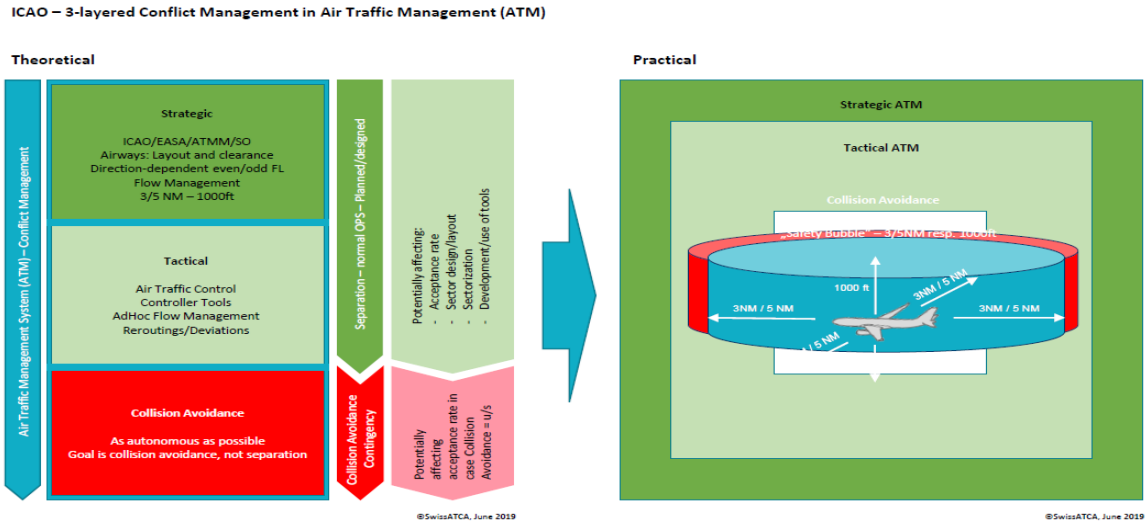


Figure 2 ICAO conflict layer management – conceptual approach source Swiss ATCA

The **Strategic Research Agenda** outlines in chapter 3.7.[11] what could be possible research and innovation needs and challenges.

Some of proposed R&D needs described in the SRIA are too detailed and propose solutions or air industrial conceptual ideas which might not be developed before 2050. The PSO would **support the need for the development of the assessment toolset** which shall enable the environmental case as outlined above.

Reference to the most efficient way of managing the impact of aviation on CO_2 and non-CO_2 is missing from the SRIA. By focusing too much on small benefit pools, the bigger picture might be missed.

As an example of the above, the Network Manager could be entrusted to create the most environmental-friendly trajectory for city pairs taking into consideration daily weather and wind conditions and the airlines shall be incentivised to use them. That will need to change some of the current "first comes first served" rules. Moreover, trajectory management must be put in place at political level. As it would be a fundamental change to todays' first come first served principles (to maybe best equipped best served), a transition phase would have to be introduced. Natural gaming to attract traffic and subsequent revenue streams for ANSP would have to be carefully taken into consideration during this transition phase. Competing for revenue or lesser impact of CO_2 by the ATM operations might create unwanted reactions by ANSP.

Research could assist decision-makers to have confidence that this is the right way to go. An increased level of transparency for all actors and stakeholders in the aviation system needs to be put in place. Again, research shall assist in achieving this transparency. CNS systems, for instance, can provide staff with the right tools in their daily job to reduce aviation environmental footprint. Such tools should be given special attention in research programmes to develop the CNS systems of the near future. This is further developed in Annex C.

It is also to be noted that trade-offs between KPIs and interdependencies are crucial parameters of the equation. For example, if priority is given to 'green trajectories' it is a political decision to be made transparently, also addressing openly all trade-offs and the related operational consequences of such a decision. Frankfurt airport is a striking example with strict noise abatement procedures generating extra CO2 emissions in contradiction with the objective to decarbonise aviation. In the same way a compromise will have to be found between carbon footprint objectives and other current priorities such as economic indicators. Some of the current KPIs might need to be reviewed to take into account the Green Deal objectives and that should also be reflected in the SES2+ legislative package.

[11] Strategic research agenda

5. The PSO position – conclusion

The PSOs are aware of the need to reduce emissions in aviation according to the objective of the European Green Deal and the EU's commitment to global climate action under the Paris Agreement.

Plans and measures need to be balanced in regard to the climate impact and in regard to aviation in the overall emission record. This includes a holistic approach which requires capacity, reliability and resilience of the aviation systems and availability and continuity of ATM and CNS services, to effectively implement emission reducing measures.

The PSOs welcome technological research and improvements to reduce emissions like SAF and aircraft engines with higher efficiency.

Programmes and measures of emission reductions should take into account:

- Safe operation has the highest priority and might require additional resources
- **Balancing of emission reduction with competing factors (e.g. noise reduction) needs to be finalised at organisational (strategical level) level and be transparent.** However, adjustments need to be possible in the tactical phase with the appropriate training of the concerned staff.
- **New procedures and tasks need to be in range of the normal workload and system changes need to enhance the assistance of the staff**, including the handling of congested situations.
- Information about emission reduction measures and training of the staff members involved is required to achieve optimal support.
- SJU is also requested to ***evaluate the recommendation for the development of a new Metric on CNS Availability and its' impact on Environment within the context of SRIA***.

The research and development of the SESAR projects will have to focus on considering the aspects that we have highlighted so far. Although we are aware of the need to aim for an ATM system that is increasingly attentive to emissions and environmental issues, **it is necessary to ensure that these objectives do not conflict with the highest safety standards**. F

Furthermore, it is necessary that any new procedures studied are not to further load the personnel involved with new tasks that could, in an already particularly congested situation, further aggravate the work of the operating personnel.

Annex A - Impact of COVID on Environmental performance

Following the dramatic drop in traffic due to the COVID-19 pandemic in March 2020 all operational metrics improved, with a positive effect on fuel burn and environmental impact. But even with record low numbers in Air Traffic and direct routings to all aircraft wherever it was possible, the horizontal flight efficiency could not be better than 97.5%.

This provides a unique opportunity for ANS to review and remove existing constraints in the ATM system, to further improve the efficiency of the ATM system and to maintain the achieved efficiency levels when traffic returns after the COVID-19 crisis, taking into consideration the impossibility to reach 100% HFE.

For example, at the top 30 airports in Europe the additional taxi-out time dropped by 2 minutes on average while airport holdings decreased by almost 1 minute in 2020. Vertical efficiency at the top 30 airports during approach, measured as average time flown level, decreased by 48 seconds compared to 2019. Achieving this performance with the traffic level of 2019 would have saved 3.2 million minutes (6.1 years) in level flight with the corresponding savings in terms of fuel and CO2 emissions (see Chapter 13 4 for more details).

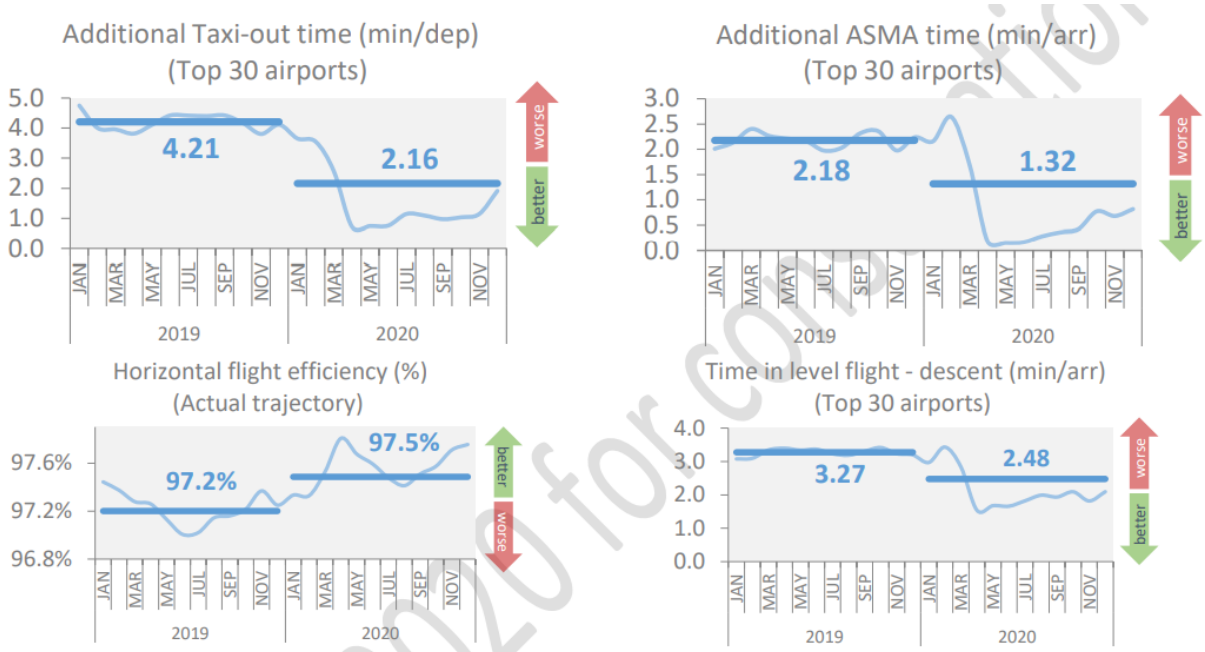


Figure 1-19: Flight efficiency improvements in 2020 – The big picture

Since the beginning of the COVID-19 pandemic in March 2020, NM - in collaboration with operational stakeholders - removed 1,200 Route Availability Document (RAD) measures in the network which enables more direct routings and hence more efficient flights. Horizontal flight efficiency improved by 0.3 percent points in 2020. Although this seems small, achieving the

2020 efficiency level with the traffic of 2019 would have saved a total of 29.7 million kilometers of additional distance flown (see Chapter 3 for more details).

Annex B - ICAO conflict management layer concept

Conflict management[12]

2.1.7 Conflict management will consist of three layers: strategic conflict management through airspace organization and management, demand and capacity balancing, and traffic synchronisation; separation provision; and collision avoidance.

2.1.8 Conflict management will limit, to an acceptable level, the risk of collision between aircraft and hazards. Hazards that an aircraft will be separated from are: other aircraft, terrain, weather, wake turbulence, incompatible airspace activity and, when the aircraft is on the ground, surface vehicles and other obstructions on the apron and manoeuvring area. Key conceptual changes include:

a) strategic conflict management will reduce the need for separation provision to a designated level;

b) the ATM system will minimize restrictions on user operations; therefore, the predetermined separator will be the airspace user, unless safety or ATM system design requires a separation provision service;

c) the role of separator may be delegated, but such delegations will be temporary;

d) in the development of separation modes, separation provision intervention capability must be considered;

e) the conflict horizon will be extended as far as procedures and information will permit; and

f) collision avoidance systems will be part of ATM safety management but will not be included in determining the calculated level of safety required for separation provision.

[12] ICAO doc 9854

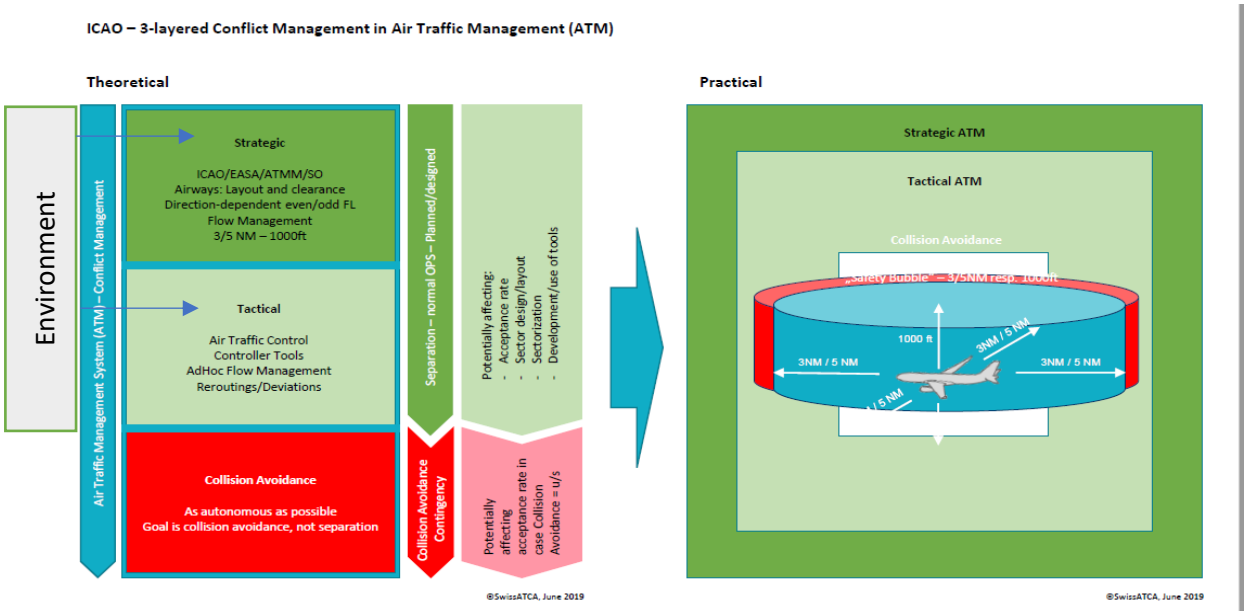
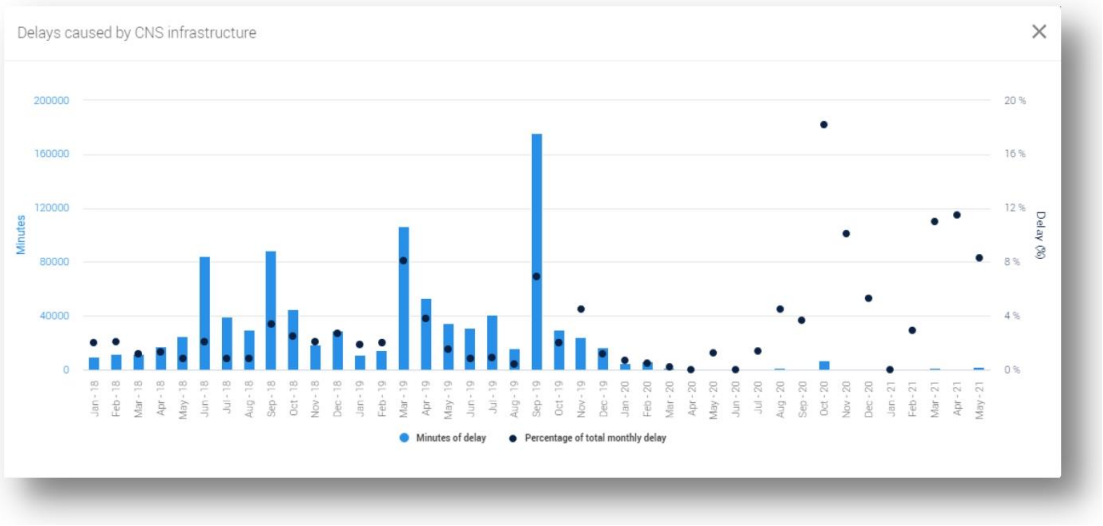


Figure 3 schematic representation of Environmental requirements integrated in the conflict management

Annex C - IFATSEA recommendation elaboration

As it is stated in the **Aviation Green Deal** side notes, *"However, in order to minimise the impact of flights on the climate, ATC maneuvers may, from time to time, lead to a slight increase in fuel consumption"*. All ATM/ANS operations are directly linked to the performance of ATM/CNS systems in terms of at least availability and continuity of their services. As final enablers, they are transversal contributors to the efficient operation of the whole ATM/ANS system and thus the greening of the whole Aviation sector.

However, in order to plan for improvements for greener operations one must maintain and build on the current Performance baseline of all the Aviation systems components. The table below (source: Eurocontrol[13]) shows and describes the contribution of CNS infrastructure to the delays and hence extra fuel burn of 160000 minutes in the years 2018-2019.



One may also note the high contribution of CNS outages as a percentage to the total delays. These figures lead to the conclusion that if delays due to CNS infrastructure and ATM systems outages are minimized, overall delays can be minimized and consequently **improvements in fuel burn can be made, resulting in some** Greening of aviation. However, this contribution, although part of the ICAO Doc (para. 1.3.2), is not yet considered in Europe.

Within chapter 3.7 AVIATION GREEN DEAL(AGD) and inside the DESCRIPTION OF HIGH-LEVEL R&I NEEDS/CHALLENGES (p.60), there is mentioning of research towards the **development of new metrics** for the Environmental impact assessment methodology and new metrics and the Environmental Dashboard. These metrics will also be integrated into the Environmental Dashboard and into the Environment Impact Assessments toolset mentioned above.

[13] https://www.eurocontrol.int/communications-navigation-and-surveillance

So fully in line with the objectives of the AGD, the PSO recommend the SJU to research into the **"development of a new Metric on CNS availability and its' impact on Environment within the context of SRIA para. 3.7**"

Proposal:
Consider the introduction of a new metric "Monitoring the Availability and Continuity of CNS Services (inc. ATM systems or the Functional system)"

The adoption of the above proposal, especially in view of the proliferation of Automation, in relation to the item Environmental impact assessment methodology and new metrics of SRIA (p.60).
Then, with the use of big data analysis and machine-learning, could lead to the development of new environmental metrics that will be used to monitor environmental impacts as mentioned in SRIA context while the ultimate aim is to contribute to the delivery of the Green Deal.

a. Contribution of the Human in greening operations

Every time an aviation professional, a Pilot, an ATCO or an ATSEP makes an operational decision, this decision and action impacts areas of the aviation system. Of course, that is their job, and they must perform to the highest standards. These standards are reflected in regulations and procedures.

However, contributions of the Human pillar ATSEP, ATCO and Pilots are an important ingredient of reducing emissions. For example:

Pilots can use an onboard calculation tool to reduce the fuel burn for the actual flight. This may include as an example to choose the most economic flight level taking into account the actual weather parameters, weight and balance, performance and level availability (via ground information and aircraft systems information). To improve environmental sustainability the calculations could reflect further parameters like contrail build up and prevention

ATCOs can be trained to use the most environmentally friendly procedures to assist pilots to reduce fuel burn.

ATSEPs take care of ATM/ANS systems and equipment which if not regularly maintained and calibrated, will impact the ATM/ANS systems with an evident degradation side effect on the nominal ANS services provision and related operations and thus the corresponding effects in CO2 pollution.

It is obvious that as soon as a e.g. Navigational aid like an ILS goes out of service at an airport and especially when weather is bad, the airport capacity will change with a consequent impact on fuel burn and thus the environment.
It is worth noting that during the COVID crisis, when ATSEP could not reach CNS installations for flight calibration (EU 2017/373 Annex VIII) and preventive maintenance, ICAO after many years, produced a special document advising on the issue.

In other words, in order to aim for improvements for greener operations one must maintain and build on the current Performance baseline of all the Aviation systems components and is often taken for granted.

The Human factor is there and needs to be trained, competent and licensed where required. Technology can and will bring further greening opportunities, but the Human is always the last resort to the total aviation system. A common understanding of the measures and their impact on reducing emissions of all involved staff members ensures to act in concert to reduce emissions.

b. Ground infrastructure

As it is stated in the Aviation green deal side notes, "However, in order to minimize the impact of flights on the climate, ATC maneuvers may, from time to time, lead to a slight increase in fuel consumption". All ATM/ANS operations are directly linked to the performance of ATM/CNS systems in terms of at least Availability and Continuity of service. As final enablers, they are transversal contributors to the efficient operation of the whole ATM system and thus the greening of the whole Aviation sector as they exist today for their resilience and as improvement when new concepts and technologies are integrated.
It is worth noting that in PJ19.04: Performance Framework (2019) Table 7: SESAR2020 Mandatory PIs, there is useful information on the capacity degradations and Resilience but most importantly in the Human Performance, HP2- Suitability of technical system in supporting the tasks of human actors linked to the Availability of CNS&ATM services.

Also, the expected rigorous increase in the introduction of automation, networking and in accordance with SRIA, Virtualization and cyber-secure data sharing; the need for extra help with advanced technical and operational tools in the decision-making process which in turn drives service delivery efficiency, is essential to safeguard and expand and improve the Human performance levels for the benefit of greener operations.
This improvement will come from the Advanced technological solutions, currently being researched in SESAR that will provide from one hand a complete system awareness and from the other will assist the ATCO and ATSEP when it comes to the optimum decision for handling compromised situations. This will drive and ensure the sustainability, the resilience and optimum ANS operations that are also properties of critical importance for the green deal.

When it comes to systems and related services, unavailable Surveillance systems, Navigation systems at airports or even inefficient communications can lead to alternative routes flown thus more fuel burn and lower capacity or even total lack of service delivery.

Moreover, demanding objectives such as 4D trajectory exchanges and Advanced RNP green approaches for a Connected and automated ATM; can also materialize and be resilient, driving in effect in the Greening of aviation. The resilience of the CNS services as enablers for all the challenges for concepts as those included in SRIA “DESCRIPTION OF HIGH-LEVEL R&I NEEDS/ CHALLENGES” p.59.
Please note that degradation of Automation performance in the SESAR and AAS era will lead to the cascade reduction of performance of the enabled interoperable and distributed Services (VCs, ADSPs etc.).

Environmental impact assessment methodology and new metrics (Ref: SRIA):

As it is indicated in the above EUROCONTROL pictures, on Delays caused by CNS infrastructure, PSOs (IFATSEA) believe(s) that “by improving Availability and Continuity of CNS Services provided “delays and hence fuel burn, will be reduced, thus greening of the aviation operations with a consequent environmental benefit.
Recommendation:

Consider the introduction of a new metric “Monitoring the Availability and Continuity of CNS Services (inc. ATM systems or the Functional system)” especially in view of the proliferation of Automation. The adoption of the above proposal, in relation to the Environmental impact assessment methodology and new metrics, with the use of big data analysis and machine - learning, could be extended to the development of new environmental metrics that will be used to monitor environmental impacts as mentioned in SRIA context while the ultimate aim is to contribute to the delivery of the Green Deal.

Innovative solutions that are coming from the pipeline of SESAR are also positive contributors when deployed. There are many exploratory solutions, and other at a maturity stage, that have the potential to play a serious role on the Environmental impact of aviation. As it is stated in SRIA, AI will enable the optimization of aircraft trajectories, allowing a potential reduction in the aviation environmental footprint, .i.e. Trajectory prediction.

Trajectory prediction is an essential component of Air Traffic Management systems capability but is hampered by route uncertainty because of air traffic controller clearances during the tactical phase. By augmenting traditional trajectory prediction logic with machine learning, a considerable improvement to accuracy may be achieved.
Also, low visibility solution designed to Enhance operations at low visibility weather at airports. In this solution with the aid of artificial intelligence (AI) in an exceptional manner we can recover lost capacity caused by low clouds and reduced visibility.

Even efforts on reducing the energy consumption of CNS/ATM installations a e.g. using solar panels discussed in other fora (Joint CNS Stakeholder Platform) is a welcome step in the greening toolkit.