Performance Review Body
Advice on the Union-wide target ranges for RP4

Annex I - Detailed analysis per KPA

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1 INTRODUCTION

1. Under Commission Implementing Regulation (EU) 2019/317 (herein referred to as the Regulation), the assistance to the Commission when setting the Union-wide performance target ranges is one of the primary tasks of the Performance Review Body (PRB). The legal basis for the setting of the Union-wide performance targets is defined in Article 9 of the Regulation.

2. This report is Annex I of the PRB advice on the Union-wide target ranges for RP4. This annex specifies, for each KPA, the methodology and calculation applied to set the target ranges.

2 SAFETY

2.1 Introduction to the target setting

3. Safety within the performance and charging scheme serves two roles:

- Safety as a key performance area (KPA) to monitor and drive further improvements; and
- Safety as a control mechanism to take into account the impacts from targets set on the other KPAs: Environment, capacity, and cost-efficiency.

4. As set out in the Regulation, the safety Key Performance Indicator (KPI) is the minimum level of the effectiveness of safety management (EoSM) to be achieved by air navigation service providers certified to provide air traffic services. The KPI measures an air navigation service provider's ability to implement and manage an effective safety management system (SMS) by measuring the level of implementation (maturity) of the following safety Management Objectives:

- Safety culture;
- Safety policy and objectives;
- Safety risk management;
- Safety assurance; and
- Safety promotion.

5. For the purpose of target setting, the Union-wide EoSM targets are set for the final year of the reference period (2029), where ANSPs are required to provide intermediate levels for each year of the reference period. The targets for the safety KPI have been developed by the PRB in close cooperation with EASA, as per Article 6 and 9 of the Regulation. The level of maturity (the target) for each of these Management Objectives is defined from level A to level D (D being the highest).

RP4 Safety KPI

6. In January 2022, the European Commission requested EASA to develop, together with the relevant stakeholders through a working group, a potential set of Safety (Key) Performance Indicators (S(K)PIs) for RP4. The technical report from the working group was published at the end of April 2023 and included a proposal for the continuation of the EoSM as the sole safety KPI. The EASA working group also proposed to:

- Revise the current EoSM questionnaire to better address the challenges expected during RP4, and to better address any potential negative impact on safety from other KPAs.
- Update the EoSM Management Objectives based on the CANSO Standard of Excellence (SoE) in safety management (revision from February 2023). As for RP3, the related questionnaire has been revised to reflect the modern safety management approaches.
- Create two versions of the EoSM questionnaire to reflect the applicability to both ANSPs and the Network Manager. This differentiation is needed to recognise the differing roles and responsibilities of these two respondent groups.
- Base the Network Manager EoSM questionnaire on a sub-set of the EoSM questionnaire applicable to the ANSPs.
- Align the scoring mechanism with the EASA Management System Assessment Tool to compare the results reported via the EoSM questionnaires and the intelligence gathered by EASA through their oversight.

7. The revised EoSM questionnaire is expected to be available in late 2023.

2.2 Analysis of the safety KPA

RP2 evolution

8. The EoSM targets for RP2 were set at level C for safety culture, and at level D for all the other safety Management Objectives. Out of the 31 ANSPs, 30 had already achieved the target for safety culture in 2015 (the first year of RP2) (Figure 1, next page). Similarly, 11 ANSPs achieved the targets for the other Management Objectives already in 2015.

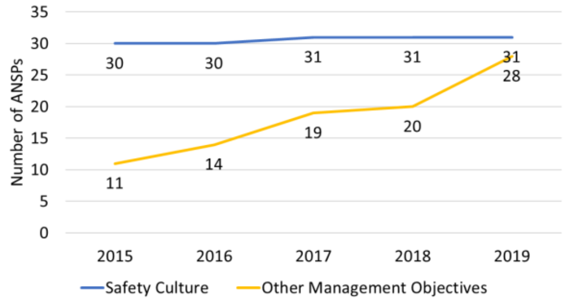

Figure 1 – Number of ANSPs achieving the Management Objectives during RP2 (source: PRB elaboration).

9. The analysis of the EoSM minimum maturity Level achieved by the 31 ANSPs shows that:

   - At the end of RP2 all ANSPs achieved the target for safety culture, being Level C or above for this Management Objective. Since all but one ANSPs had already achieved the target in the first year of RP2, no major challenge was observed in this Management Objective. 27 of the ANSPs exceeded the target by the end of RP2 (i.e. reach a higher level of maturity than the target).
   - 28 out of 31 ANSPs achieved the RP2 targets for all other Management Objectives, as they achieved level D or above. Three ANSPs (CYATS, LFV, LGS) failed to achieve the RP2 targets:
   - CYATS achieved the target for safety culture the first year of RP2, but needed to improve the other four Management Objectives by one level.
   - LGS needed to improve safety policy and objective by one level.
   - LFV needed to improve safety risk management and safety assurance by one level.

10. The Network Manager achieved the targets in 2018, one year ahead of the end of RP2.

11. The targets have been shown to be achievable. For some Management Objectives (e.g. safety culture) the targets were not challenging enough as they were reached by the majority of the ANSPs during the first year of the reference period. With the majority of the ANSPs achieving the targets by the end of RP2 and with the objective to continue the improvement of safety management, the EoSM needed an update if it was to be used in RP3.

RP3 evolution to date (2022)

12. The Regulation retained the safety Key Performance Indicator from the RP2 Regulation: The Effectiveness of Safety Management (EoSM) of air navigation service providers.[1] However, the EoSM questionnaire was substantially modified between RP2 and RP3 (among other changes) to align it with the CANSO SoE v.2, and to ensure consistency with the Commission Implementing Regulation (EU) 2017/373 (common requirements Regulation).[2] Therefore, the comparison of performance across reference periods should be viewed with caution. In general, the maturity levels were expected to fall by one level (e.g. if achieving level D during RP2, the same ANSP would be expected to achieve level C at the start of RP3).

13. The EoSM targets for RP3 were set at level D for safety risk management, and at level C for all the other safety Management Objectives. The targets were set to be achieved by the end of RP3, expecting the ANSPs to show a gradual improvement to reach the targets in 2024, at the latest. Since the more challenging target was set for Safety Risk Management, it was anticipated that ANSPs would reach this target later than for the other Management Objectives.

14. The revised Union-wide targets for RP3, following the exceptional measures Regulation, did not modify the safety targets that were originally set for the reference period.[3] The reason was that the EoSM is not designed to address individual safety

[1] Commission Implementing Regulation (EU) No 390/2013 of 3 May 2013 laying down a performance scheme for air navigation services and network functions.

[2] Commission Implementing Regulation (EU) 2017/373 of 1 March 2017 laying down common requirements for providers of air traffic management/air navigation services and other air traffic management network functions and their oversight, repealing Regulation (EC) No 482/2008, Implementing Regulations (EU) No 1034/2011, (EU) No 1035/2011 and (EU) 2016/1377 and amending Regulation (EU) No 677/2011, as amended.

[3] Commission Implementing Regulation (EU) 2020/1627 of 3 November 2020 on exceptional measures for the third reference period (2020-2024) of the single European sky performance and charging scheme due to the COVID-19 pandemic.

issues that fall outside the normal measuring and monitoring of the Safety Key Performance Indicator and other safety performance indicators (SPI) as defined in Regulation 2019/317. The management of safety is not assigned to the ATM performance scheme. As a result, particular issues were addressed by EASA through their Safety Risk Portfolio and ultimately the European safety risk management Process. In addition, despite the impact of the COVID-19 pandemic, the PRB still considered the target achievable and relevant for RP3. Safety remained the highest priority and changes to targets for other KPAs did not affect the safety KPA. ANSPs were expected to keep a focus on safety management, and ensure it was adapted/scaled to the particular situation.

15. Figure 2 shows the maturity levels planned by the ANSPs over RP3, and the achieved level in the first three years of the reference period. The ANSPs planned to achieve the target for safety risk management in the last years of RP3. However, ANSPs are currently ahead of their plans with 18 ANSPs having already reached the target (out of 36). For other Management Objectives, the achieved maturity levels follow closely the expected evolution over RP3, with 23 ANSPs achieving the target in the first year of RP3 and with two ANSPs planning to reach the target in the last year of RP3. The performance observed is better than originally anticipated when the RP3 targets were set. A total of 16 ANSPs achieved the targets for RP3 in 2022.

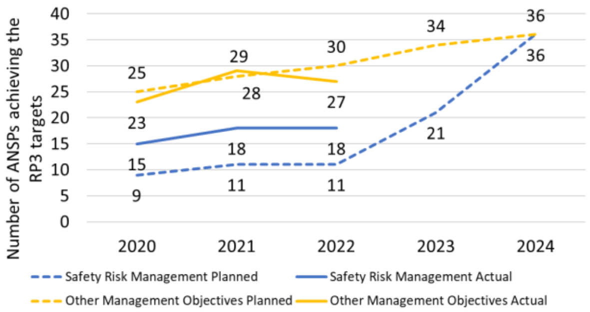

Figure 2 - Planned and actual number of ANSPs achieving the EoSM targets level during RP3 (source: PRB elaboration).

RP3 outlook (2023-2024)

16. In order to assess the expected situation at the end of RP3, it is important to analyse which improvements are still needed for those ANSPs not achieving the targets level (i.e. whether the current minimum level achieved is caused by one question only, or whether the ANSPs need to improve on several questions to achieve the target).

17. Figure 3 shows how many questions within each Management Objective need to be improved by the ANSPs currently not achieving the targeted maturity level. ANSPs marked with an asterisk are trailing behind the maturity level defined in their performance plans (i.e. CYATS, IAA, LPS SR, NAVIAIR, SJSC, skeyes and ANA LUX). Other ANSPs do not achieve the RP3 targets, but are still following their plan for intermediate maturity levels, i.e. plan to achieve the target later than 2022.

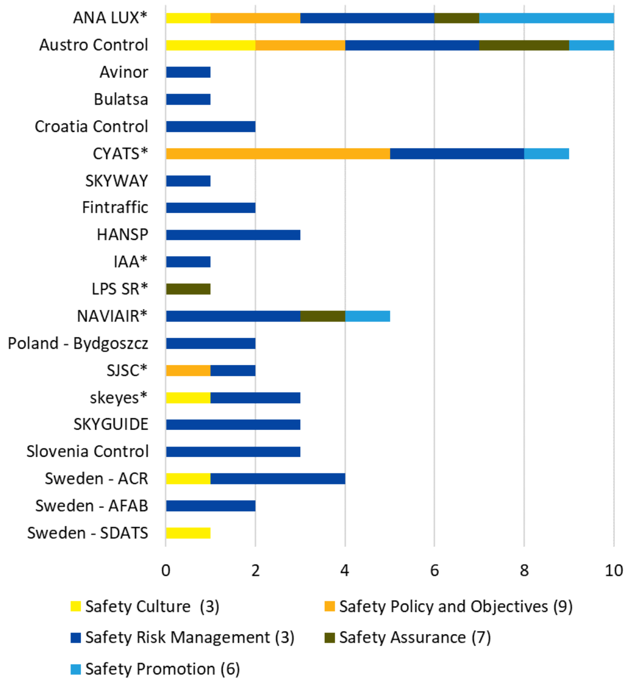

Figure 3 - Number of questions to be improved per Management Objective for each ANSP to reach the RP3 targets. The number of questions under the objective is shown in parenthesis (source: PRB elaboration).

18. Most of the ANSPs are in line to achieve the targets:

- Those ANSPs yet to achieve the targets are one maturity level below.
- 11 ANSPs need to improve performance in relation to one or two questions to achieve the targets.
- The main area requiring improvement is safety risk management, where eight ANSPs need to improve performance in all three

questions included under the Management Objective.

- 11 ANSPs need to improve in relation to safety risk management, while already achieving the targets for the other Management Objectives.

19. Through its annual monitoring reports, the PRB has recommended Member States to ensure that actions are taken to put in place measures needed to reach the RP3 targets. The PRB has also recommended that the verification of the achieved level of maturity must properly reflect the feedback received from the EASA and Member State standardisation oversight activities.

20. The maturity levels achieved by the ANSPs in 2022 and the maturity levels expected to be achieved at the end of RP3 are shown in Table 1 (RP3 target maturity levels are shown in bold). If an ANSP in 2022 exceeded the RP3 target, the PRB assumed it will retain this maturity level until the end of RP3. ANSPs planning to reach a minimum level C by the end of RP3, may have some questions where they are at level D already.

	RP3 maturity level		
Management Objective	Maturity	Achieved 2022	Expected 2024
Safety culture	B	5	
	C	20	25
	D	11	11
Safety policy and objectives	B	4	
	C	25	29
	D	7	7
Safety risk management	B		
	C	18	
	D	18	36
Safety assurance	B	4	
	C	23	27
	D	9	9
Safety promotion	B	4	
	C	24	28
	D	8	8

Table 1 – Number of ANSPs achieving maturity levels in 2022, and number of ANSPs expected to achieve a specific maturity level in 2024 (source: PRB elaboration).

21. With the developments observed up to 2022, combined with the planning of the ANSPs, the PRB expects that all ANSPs will meet the RP3 targets by the end of RP3. Two or three ANSPs run the risk of not achieving the targets, but only due to a lower maturity level for a few EoSM questions:

- ANA LUX plans to achieve the targets in 2023. However, it reported a reduced maturity on several questions between 2021 and 2022. ANA LUX will need to ensure planned measures are implemented and, where needed, ANA LUX will need to implement additional measures to reach the targets.
- AustroControl plans to achieve RP3 targets at the end of RP3 and hence is not behind its plan.
- CYATS planned to achieve the RP3 targets in 2021 and needs to ensure that its planned measures are implemented or additional measures put in place, in order to meet the RP3 targets.

22. The Network Manager has performed as planned over RP3 and is expected to reach the targets no later than by the end of RP3.

2.3 RP4 EoSM questionnaire

23. The EASA RP4 safety indicator Working Group, that proposed safety performance indicators for the coming reference period, recommended that the EoSM should be revised to reflect the revised CANSO SoE (revision February 2023). The working group also proposed that the revised EoSM address aspects such as human performance, cybersecurity, and consistency with Regulation 2017/373.In addition, an untargeted Management Objective related to Interdependencies is expected to be included. This additional Management Objective would address interdependencies between safety and the other three Key Performance Areas.

24. Compared with the previous version of the CANSO SoE (version 2), the revised version has been developed to:

- Align with the International Civil Aviation Organization's (ICAO's) Annex on Safety Management (Annex 19) 2nd Edition;
- Address feedback received from ANSPs and other industry bodies; and
- Include the latest developments in safety management thinking and practice.

25. The PRB and EASA have jointly performed a comparative analysis of the difference between the revised CANSO SoE and the RP3 EoSM to determine the expected level of maturity ANSPs should achieve at the end of RP4 applying the updated questionnaire. Tracing questions from the RP3 EoSM to the revised CANSO SoE indicated that some questions, which in the EoSM were allocated to a maturity level D (Assured), in the revised CANSO SoE would now be allocated to maturity level C (Managed). It also showed that additional questions were included in the revised CANSO SoE addressing new topics such as fatigue-risk management which were not covered in the current EoSM questionnaire. The main differences are:

- Safety culture: Further requirements related to Just Culture, planning, assessments and coverage of the organisation.
- Safety policy and objectives: Further requirements for integration of safety in the business planning process and adoption of and contribution to regional and international standards. Increased requirements related to emergency response procedures and planning.
- Safety risk management: Increased requirements to integrate fatigue-related risks management use of metrics and lessons learned from occurrences.[4] Requirements to change management extended.
- Safety assurance: Increased requirements related to human factors, systematic use of a risk classification process and explanatory factors and processes related to safety surveys. Requirements to change management extended.
- Safety promotion: Increased training requirements and the dissemination of safety data and lessons learned.

26. The aspects expected to be integrated in the RP4 EoSM, will increase requirements to achieve a certain level of maturity. Generally, an ANSP is assumed to start RP4 one level lower than when ending RP3. Hence:

- For safety risk management, ANSPs would start on level C, provided that the ANSPs had ensured some level of compliance with Regulation 2017/373 in respect of fatigue-risk management and human contribution to risks. Where such aspects have not been addressed, ANSPs would start at level B.
- For other Management Objectives, ANSPs would start on level B but would already probably satisfy several of the conditions to reach level C.
- ANSPs achieving a minimum maturity level C or D at the end of RP3 would need to implement improvements to retain the same level of minimum maturity using the updated EoSM questionnaire.
- ANSPs not achieving the targets for RP3 for Management Objectives other than safety risk management and with one or two questions still at maturity level B with the RP3 questionnaire, would start RP4 with the same maturity level.

27. The above has been used as the general assumptions, even though there can be particularities related to the implementation of safety management for an ANSP giving a higher or lower maturity level when starting RP4 (e.g. an ANSP may already have implemented fatigue-risk management as per regulatory requirements).

28. Following the recommendation to update the EoSM questionnaire for RP4 based on the revised CANSO SoE, EASA requested its standardisation oversight team to review the revised CANSO SoE. The review aimed at assessing if there were any requirements that would be considered excessive or too challenging for an ANSP to achieve during RP4. The EASA team concluded that the update would increase transparency and standardisation of the implementation across ANSPs. However, the EASA team also noted that some requirements would need additional effort by some ANSPs relating to:

- Increased involvement of internal and external stakeholders, use of external independent

[4] Consistent with Regulation (EU) 2017/373.

reviews, and routine coordination with external stakeholders;
- Increased requirements in relation to safety surveys (e.g. risk-based approach, observational techniques);
- Benchmarking or comparative analysis with other organisations, relating to topics such as Just Culture, Emergency Response Plans, and reporting and investigation processes;
- Inclusion of safety management and safety improvement activities in the annual ANSP business planning process; and
- Integration of more advanced Human Factor principles which may require additional expertise and potential research-type activities.

29. The EASA team also noted that some requirements may be too demanding for the maturity level allocated, and should potentially be allocated to a higher maturity level. In several cases, the comments relate to maturity levels which are not considered within the targets. The PRB concludes that the standardisation oversight team is supportive of the revised EoSM based on the CANSO SoE. The EASA team will consult with the standardisation oversight team when developing a revised EoSM to avoid unrealistically onerous requirements and to assist in defining requirements at the appropriate maturity level.

30. For the Network Manager, it is expected that the RP4 EoSM will also be more challenging than the current one. This means that while the EoSM in RP4 will be better tailored to the specifics of the Network Manager, the Network Manager is likely to start RP4 at a lower level of maturity.

31. Table 2 presents a simulation of achieved maturity level of ANSPs in 2022 and the level planned by ANSPs in 2024 using the RP3 EoSM, reducing the maturity level by one level (following the assumption described above).

	Comparable maturity level in 2022 and 2024 (updated EoSM)		
Management Objective	Maturity	Achieved 2022	Expected 2024
Safety culture	A	5	
	B	20	25
	C	11	11
	D		
Safety policy and objectives	A	4	
	B	25	29
	C	7	7
	D		
Safety risk management	A		
	B	18	
	C	18	36
	D		
Safety assurance	A	4	
	B	23	27
	C	9	9
	D		
Safety promotion	A	4	
	B	24	28
	C	8	8
	D		

Table 2 – Simulation of number of ANSPs reaching a specific Maturity level in 2022 and the planned level in 2024 assuming the application of the updated EoSM questionnaire (source: PRB elaboration).

2.4 Proposed targets

32. The targets for RP4 are defined considering the safety KPI being:

- A vehicle to improve the management of safety;
- A control mechanism for the impact from targets in the other KPAs;
- A control mechanism to manage the potential impact on safety from widespread implementation of changes to ATM functional systems;
- A support of the initiatives implemented by EASA under the EASA European Plan for Aviation Safety (EPAS); and
- A support to the progress ensuring regulatory compliance, namely with amendments to Regulation 2017/373.

Within each of these areas, there will be overlapping impacts.

Improved management of safety

33. The EoSM proposed by the EASA working group will include adjustments to the EoSM questionnaire to cater for recent developments in safety management thinking and practices and will support improvement of the management of safety.

Impact from other KPAs

34. The PRB priority for RP4 is environmental performance, which will need to be supported by greater capacity provision. With reference to the EASA safety working group on proposals for RP4 KPIs, and in particular the analysis related to interdependencies, the drive to achieve performance improvements in the environment and capacity KPAs may put pressure on established safety margins. In particular, some level of risk may emerge from changes to operating procedures in order to achieve KPA targets.

35. With respect to the setting of more demanding targets for other KPAs, targets using the improved EoSM would act as a control mechanism guarding against the potential impact on safety from changes implemented on a wider scale in the ATM functional system or in airport systems. Examples of wide-spread implementation of changes expected during RP4 are:

- Common Project 1 (System Wide Information Management (SWIM), Airport Safety Nets, Extended Arrival Management);
- Virtualisation;
- Digitalisation;
- Changes to Service Delivery Models;
- Dynamic Airspace Configuration; and
- Unmanned Aircraft Traffic System Management (UTM) & Unmanned Aerial Vehicles (UAV).

36. For these types of change, the regulatory approach should ensure that unacceptable risks at the ANSP level are not introduced. Nevertheless, the widespread implementation of many changes may be difficult to control and will require ANSPs to take actions such as strengthening and modernising the safety methodologies applied (adopting best practices), increasing the level of monitoring to detect degrading safety levels, and increasing the safety awareness by staff and stakeholders. The target setting for the Safety KPA should contribute to ensuring that the safety management systems of the ANSPs are improved to efficiently control the impact on safety, both during the transition of the changes and during the follow-on steady state operation.

37. The SDM provided a qualitative assessment of the potential safety benefits from the changes planned to be implemented during RP4 under CP1 (Annex IV of this report). The expectation is that, overall, the changes should support a reduction in the rate of occurrence of runway incursions and separation minima infringements. The SDM also notes that, "*without precise quantified justifications, the upmost importance of safety investments in the CP1 justifies that the target levels of safety should at least be maintained during RP4 like they were between 2014 and 2019*".

Impact of the Russian war of aggression

38. Russia's war of aggression against Ukraine is causing an increased pressure on safety management to alleviate the impact of changes caused by the war (e.g. diversion of traffic flows, increased operation of unmanned aerial vehicle and military flights, and increased cyber security risks). While it is not possible to predict the evolution of the conflict, ANSPs need to have an approach to safety management that is agile and adaptable to the impact of these changes and to effectively identify and control changes coming from the context in which the ANSP operates (change drivers). In this regard, the maturity of the safety management systems needs to continue to improve during RP4, in particular in safety risk management and safety assurance.

Initiatives from EASA's EPAS

39. The EASA RP4 safety indicator Working Group underlined the complementary nature of the performance scheme and the initiatives taken by EASA to address safety concerns. EASA Basic Regulation and the EPAS are the main instruments to manage and improve the safety of the aviation system in

Europe, including ATM/ANS.[5] Aviation safety is ensured not only through the application of minimum standards, but through a continuous cycle of challenging assumptions, investigating strengths and weaknesses and implementing system improvements. This cycle is the European safety risk management (SRM) process, and its output is the European Plan for Aviation Safety (EPAS). In this context, target setting complements the actions proposed under the EPAS. The PRB analysis of the EPAS 2022 – 2025 and the EPAS 2023 – 2026 identified the following actions (action number in brackets), which can be supported by the target setting and the revision of the EoSM questionnaire:

- Cyberattacks (SI-5017) (Amended Cybersecurity (SI-2013)); relating to the increase in cyberattacks that are associated with Russia's war of aggression against Ukraine. The proposed update of the EoSM will consider how to link safety and security, in particular related to safety risk management.
- Effectiveness of safety management system (SI-2026); aspects associated with the capability to detect and anticipate new emerging threats and associated challenges. The proposed update of the EoSM will increase the focus on adopting best practices to be used within the industry, carrying out comparative analyses, and assessing emerging risks (including disruptive technologies, drones, climate change, and urban mobility).
- New technologies and automation (SI-2015); addressing the relationship between humans and automation within the framework of a contemporary safety management system. The proposed update of the EoSM will increase focus on the human performance dimension of the safety management system.
- Understanding and monitoring system performance interdependencies (SI-2022); relating to the impact of external factors such as commercial pressure and demands associated with increasing capacity and environmental protection on the safety performance of ANSPs. The proposed update of the EoSM will consider this interdependency as a transversal area of the EoSM and strengthen the untargeted Management Objective of Interdependency already included in the RP3 EoSM.
- Flight route congestion (hotspots) (SI-5506) (New); covering potential increased ATCO workload and fatigue. The proposed update of the EoSM will increase the focus on human performance and fatigue-related risk management of the safety management system.
- Increased risk of airspace infringements by military unmanned aircraft systems (UAS), aircraft, or debris spilling over from conflict zones (SI-5515) (New) and other UAS related actions; aspects relating to airspace infringement by military UAS, increased presence of unresponsive and/or unidentified traffic and the unauthorised activity of drones in both take-off and approach paths of commercial airlines up to 5,000 ft. The pro-active nature of safety risk management and the increased involvement of relevant stakeholders in the safety management approach implemented by ANSPs under the improved EoSM will support this action.
- Reduced focus on, or prioritisation of safety (SI-5009). Using the Regulation and placing strengthened requirements on safety management through the improved EoSM and the associated targets should ensure that the necessary priorities and resources are allocated to safety performance.

40. The scope to address these areas is limited to their inclusion in the EoSM, where possible and appropriate.

Progressing regulatory compliance

41. The target setting should support the progress towards regulatory compliance on existing and proposed amendments to Regulation 2017/373,

[5] Regulation (EU) 2018/1139 of the European Parliament and of the Council of 4 July 2018 on common rules in the field of civil aviation and establishing a European Union Aviation Safety Agency, and amending Regulations (EC) No 2111/2005, (EC) No 1008/2008, (EU) No 996/2010, (EU) No 376/2014 and Directives 2014/30/EU and 2014/53/EU of the European Parliament and of the Council, and repealing Regulations (EC) No 552/2004 and (EC) No 216/2008 of the European Parliament and of the Council and Council Regulation (EEC) No 3922/91.

which relate to management of safety. The EoSM shall, where possible and appropriate, reflect regulatory requirements and the target setting shall reflect the minimum maturity level corresponding to ANSPs being compliant with the requirements.

42. Nevertheless, the EoSM goes beyond the basic requirements contained within the SES implementing regulations and the ICAO Annex 19 framework and aims for a high level of safety performance. EoSM, its updates, and the target setting processes aim to move beyond simply complying with regulations by, in addition, focussing on continuous improvement.

Targets

43. The PRB and EASA jointly concluded that, to ensure that safety levels are retained and where possible improved, targets need to be set to ensure continued improvements of safety performance. The safety targets proposed for RP4 are shown in Table 3. The same targets are proposed for the Network Manager, using the specific RP4 EoSM.

RP4 EoSM targets	
Management Objectives	2029 maturity levels
Safety culture	C
Safety policy and objectives	C
Safety risk management	D
Safety assurance	C
Safety promotion	C
Interdependencies	No target

Table 3 – Union-wide Effectiveness of Safety Management targets.

3 ENVIRONMENT

3.1 *Introduction to the target setting*

44. To define the environment target ranges, the PRB has relied on four pieces of evidence:

- The historical horizontal flight efficiency (KEA) performance and targets;
- The European Route Network Improvement Plan (ERNIP) ATS Route Network (ARN) benefit estimates;
- The study on the interdependency between the capacity and environment KPAs;[6] and
- The estimated quantification of Russia's war of aggression on Ukraine (Annex III).

45. Each piece of evidence contributes to an element of the stepwise approach established to propose a range for the RP4 environment targets.

3.2 *Evidence 1 – Analysis of historical KEA performance*

46. Since the adoption of KEA at the beginning of RP2, the KPI has remained relatively stable, with a series of decreases (improvements) and increases (deteriorations) against a background of increasing traffic levels. RP2 finished in 2019 with a KEA value of 2.84%, exceeding the target of 2.60% and being 0.01pp higher than at the start of the period. This was mainly attributable to high levels of delay.

47. The beginning of RP3 was marked by the COVID-19 pandemic, which led to low traffic and low delays. The latter enabled significant improvement in KEA and for targets to be met due to less congestion and fewer airspace restrictions. However, as traffic began to recover and delays increased, KEA followed a similar trend, exceeding target levels (Figure 4). Further deterioration to yearly KEA values was seen in 2022. This was driven by changes in traffic flows due to Russia's war of aggression against Ukraine combined with capacity provision not keeping pace with strong traffic recovery. This resulted in the targets being missed by a substantial margin in 2022.

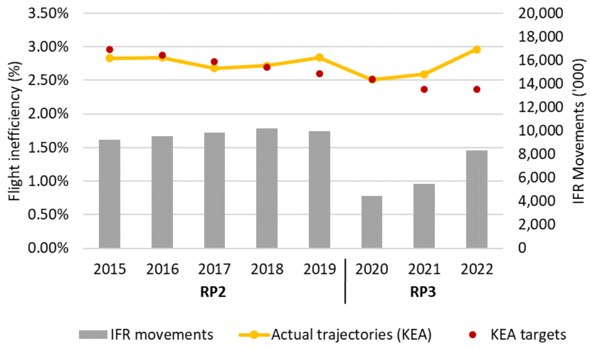

Figure 4 – Union-wide KEA performance and targets over RP2 and RP3 (source: PRB elaboration).

48. The analysis of Member State performance over RP2 and RP3 reveals a mixed evolution of local KEA values. While the methodology for measuring KEA is the same, comparing performance from one Member State to another can be challenging due to varying airspace characteristics (e.g. geographic layout, structure, traffic patterns, complexity, military activity, and ATM systems). Consideration of these characteristics are reflected in the reference values set out by the Network Manager in the European Route Network Improvement Plan (ERNIP). The relative evolution of each Member State's performance provides a better benchmark for progress. Table 4 (next page) shows the Compound Annual Growth Rate (CAGR) of each Member State for RP2 and RP3.[7]

49. Union-wide performance during RP2 achieved a CAGR of 1.3%, indicating a gradual deterioration of KEA during the reference period. In RP3, this increased to 8.6%, which represents the extent of degradations as a result of the combined traffic recovery and route extensions due to closures of Ukrainian, Belarusian, and Russian airspace to European traffic.

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[6] The interdependency between the environment and capacity KPIs of the performance and charging scheme of the Single European Sky (2023).

[7] $CAGR = \left(\frac{KEA\ final\ year}{KEA\ first\ year}\right)^{\frac{1}{number\ of\ years}} - 1$

Member State	RP2 KEA CAGR	RP3 KEA CAGR
Austria	+0.7%	+4.3%
Belgium	-0.4%	+2.3%
Bulgaria	+17.6%	+13.4%
Croatia	+4.2%	+0.7%
Cyprus	+21.3%	+4%
Czech Republic	+3%	+8.2%
Denmark	+1.1%	+4.8%
Estonia	+1.3%	+112.4%
Finland	+2.9%	+93.1%
France	-0.9%	+0.5%
Germany	+1.5%	+7.9%
Greece	+7.3%	-3.7%
Hungary	+4.1%	+19.9%
Ireland	-1.0%	+0.4%
Italy	-2.1%	+2.3%
Latvia	+3.4%	+124.7%
Lithuania	+4.7%	+153.5%
Malta	+16.3%	-13.3%
Netherlands	+1.3%	+7.5%
Poland	+3.4%	+69.4%
Portugal	+5.7%	-7.9%
Romania	+20%	+24.4%
Slovakia	+5.4%	+34.9%
Slovenia	+0.6%	+6.7%
Spain	-1.5%	+3.3%
Sweden	+1.6%	+28.5%
Switzerland	-2.3%	+3.5%
Norway	+6.5%	-6.8%
Union-wide	+1.3%	+8.6%

Table 4 –Union-wide and local CAGR of KEA values for RP2 (2015-2019) and RP3 (2020 to 2022) (source: PRB elaboration).

50. In RP2, Cyprus, Romania, Bulgaria, and Malta had notably higher (poorer) CAGRs than others. This is mainly due to shifts in the south-east traffic axis, airspace reservations, geopolitical issues and – in summer 2018 and 2019 – the results of the network measures to minimise delay by adjusting traffic flows.

51. Switzerland, Italy, and Spain had notably lower CAGRs, although the scale of these improvements (negative values) were much smaller than the overall degradations (positive values). This highlights how Member States struggled to improve environmental performance with increasing traffic and delays.

52. In RP3 (up to end 2022), the CAGRs of Lithuania, Latvia, Estonia, and Finland were very high. This is because these States had low KEA values in 2020 (achieving the local reference values) but have been severely affected by the closure of Belarusian airspace to European carriers in 2021 and the subsequent closure of Ukrainian and Russian airspaces in 2022 (further detailed in Evidence 4).

53. Malta, Portugal, Norway, and Greece are the only Member States that have a negative CAGR (improving KEA) for RP3 thus far. This is due in part to airspace improvements and low impacts to traffic flows from the situation in Ukraine. These Member States show that it is possible to improve environmental performance despite the traffic recovery.

54. While the Union-wide RP3 targets were missed in all but one year, performance values during rolling years ending March 2021 and April 2021 (Table 5) demonstrate that ambitious targets for those years, based on the range proposed for the end of RP3, were achievable when sufficient capacity was provided.

Rolling year ending	Union-wide KEA
31 January2021	2.47%
28 February 2021	2.42%
31 March 2021	2.41%
30 April 2021	2.41%
31 May 2021	2.43%

Table 5 – Union-wide KEA values for rolling years ending 31 January to 31 May 2021 (source: PRB elaboration).

55. Since then (2020), the route network has been significantly improved. In 2022, route extension due to airspace design (RTE-DES) reduced to 1.84% from 2.22% in December 2020, a reduction of 0.38 percentage points.[8] This reduction means that trajectories throughout the route network can be closer to the great circle distance than in the past. If capacity can match demand, flights can make use of the improved route network and improve KEA. Therefore, the proposed target ranges for 2029

[8] The indicator used to measure this is RTE-DES (the route extension due to airspace design), which is calculated by measuring the difference between the shortest route length (from TMA exit and entry points) and the great circle distance, disregarding the route availability document (RAD) and assuming all conditional routes (CDRs) are open.

build on the original ambition for the end of RP3 (2024):

- 2.40% upper bound; and
- 2.20% lower bound.

3.3 Evidence 2 – Estimated benefit defined in the ERNIP

56. The ERNIP is a rolling plan established and implemented by the Network Manager in coordination with Member States and the operational stakeholders. The objective of the ERNIP Part 2 - ARN Version 2022 - 2030 is to improve ATM capacity, flight efficiency and environmental performance.[9] Projects include the implementation of Free Route Airspace (FRA), ATS route network developments, re-sectorisation actions, actions aimed at simplifying the usage of the ATS route network and civil/military airspace structures.

57. The ERNIP provides a network-consolidated picture of network and local projects and the evaluation of their contribution to the European network performance targets and local environment reference values. As a result, the Network Manager states that the performance targets will be met if the proposed measures are implemented and if further improvements take place with respect to flight planning.

58. The ERNIP estimates that the projects scheduled for implementation by 2030 will reduce the inefficiency of route network design from 2.18% in December 2020 to approximately 1.80% by 2030. This is measured by the RTE-DES indicator.

59. RTE-DES is not the same as KEA as it is a theoretical value. In reality, route availability document (RAD) restrictions, conditional routes (CDRs), weather, and airspace user preferences can all contribute to the higher values seen in KEA measurements. However, as both indicators are based on horizontal flight efficiency (measuring deviation from the great circle distance), route network improvements that are captured by RTE-DES should support improvements in KEA. However, this improvement does not always materialise because airspace restrictions, weather, ATFM measures, and airspace user preferences can hinder the benefits expected from route network improvements. The ERNIP shows how RTE-DES has gradually reduced from 2.29% in 2018 to 1.88% in 2022 because of continuous improvements to the network, which support improvements in KEA.

60. Table 6 (next page) shows that much of the reduction in route design efficiency anticipated by 2030 will be achieved by the end of RP3. This reduction is mainly due to the benefits from the deployment of free route airspace (FRA) which was implemented in most of European airspace by the end of 2022, and those of cross border FRA due to be implemented by end of 2025 as per Commission Implementing Regulation 2021/116 (i.e. the CP1 Regulation). In proposing the target ranges, the PRB assumes that the RTE-DES will reach 1.84% by the end of RP3. This value is a forecast for the end of 2023, provided by the Network Manager, and represents the best estimate for a baseline at the time of writing.[10]

61. Following the ERNIP forecast for 2030, the benefits expected to materialise over RP4 would yield a 0.04pp reduction (improvement) to the KEA performance, providing a value for the upper bound of the target ranges. The Network Manager estimates that the minimum achievable RTE-DES is approximately 1.75%.[11] This value would be achievable with a new ERNIP in response to ambitious performance targets, which would recommend further investment and improvement in the route network in RP4. The PRB proposes this benchmark for the lower bound of the target ranges. The benefits expected to materialise over RP4 are estimated to yield a 0.09pp reduction (improvement) to the historical KEA performance, providing a value for the lower bound of the KEA target ranges.

[9] Network Operations Report 2022, Eurocontrol (2023).
[10] Estimates provided by Network Manager in bilateral discussions.
[11] Estimates provided by Network Manager in bilateral discussions.

Year	RTE-DES
2018	2.29%
2019	2.24%
2020	2.22%
2021	2.14%
2022	1.88%
2023 (forecast)	1.84%
2030 (ERNIP forecast)	1.80%
2030 (optimum achievable)	1.75%

Table 6 – Union-wide RTE-DES values per year (source: Network Operations Report 2022, and bilateral discussions between PRB and Network Manager).

62. The Network Manager expects a gradual ramp up of the above benefits over RP4. This is replicated in the upper and lower bound decreases to the KEA target ranges for each year of RP4, as shown in Table 7:

- For the upper bound ramp up, the PRB proposes no improvements in 2025, followed by a linear decrease of KEA by 0.01pp per year starting in 2026, totalling a 0.04 decrease at the end of RP4.
- For the lower bound ramp up, the PRB proposes an initial KEA decrease of 0.01pp in 2025, followed by a 0.02pp decrease per year starting in 2026, totalling a 0.09 decrease at the end of RP4.

63. Stronger improvements are proposed in both bounds starting from December 2025, as cross border FRA is due to be fully implemented by the end of 2025 as per the CP1 Regulation.

Year	Upper bound ramp up	Lower bound ramp up
2025	0pp	-0.01pp
2026	-0.01pp	-0.03pp
2027	-0.02pp	-0.05pp
2028	-0.03pp	-0.07pp
2029	-0.04pp	-0.09pp

Table 7 – Yearly KEA decrease based on assumed ramp up of ARN benefits for the upper and lower bound of the target ranges.

3.4 Evidence 3 – PRB study on the capacity and environment interdependencies

64. The lower traffic during the COVID-19 pandemic provided evidence that KEA decreases (improves) with sufficient capacity. While traffic was at historical lows in 2020, ANSPs had an abundance of capacity due to the unplanned nature of the pandemic. This is demonstrated in Evidence 1 (Table 5) by KEA values for rolling years ending February 2021 and March 2021, of 2.41% over these 12-month periods. KEA increased (degraded) from May 2021 as traffic recovered and delays increased.

65. The PRB report on the interdependency between the environment and capacity KPIs, published in June 2023, quantified the interdependency between the environmental and capacity key performance areas and analysed the factors influencing such interdependency.[12] The analysis conducted in the study demonstrates that high ATFM delays from various contributing factors have a negative impact on horizontal flight efficiency, proving the existence of an interdependency between the environment and capacity KPIs of the performance and charging scheme. Moreover, the level of impact on horizontal flight efficiency is found to relate to both the cause and location of the delay.

66. Statistical models were developed to investigate the influence of different delay variables on horizontal flight efficiency. The results show that an increase of one minute of average en route ATFM delay per flight causes an increase of 0.14 percentage points to horizontal flight efficiency.

[12] https://wikis.ec.europa.eu/display/eusinglesky/Latest+Developments?preview=/44148878/90279580/230606_The%20interdependency%20between%20the%20environment%20and%20capacity%20KPIs_published.pdf

67. The targets for RP4 must account for this interdependency. The capacity targets have to be sufficiently challenging to minimise the impact of delay and to support the PRB's focus on environmental performance. Hence, the PRB proposes to minimise adjustments to the environment targets by setting ambitious, but realistic, capacity targets.

68. The adjustments to the upper and lower bounds of the environment targets are based on the ambitious capacity target ranges for RP4 (next section), which are shown in Table 8.

Year	Upper bound CAP target and ENV adjustments	Lower bound CAP target and ENV adjustments
2025	0.50min/flight	0.41min/flight
	+0.07pp	+0.06pp
2026	0.50min/flight	0.38min/flight
	+0.07pp	+0.05pp
2027	0.50min/flight	0.35min/flight
	+0.07pp	+0.05pp
2028	0.40min/flight	0.33min/flight
	+0.06pp	+0.05pp
2029	0.40min/flight	0.31min/flight
	+0.06pp	+0.04pp

Table 8 – Yearly KEA adjustments for the upper and lower bound of the target ranges due to interdependency with capacity.

3.5 *Evidence 4 – The impact on Union-wide KEA of Russia's war of aggression against Ukraine*

69. In 2021, following the incident involving Ryanair Flight 4978, EASA Member States and the UK instructed aircraft operators with their principal place of business in their territories to cease operations in Belorussian airspace.[13] As a result of Russia's military aggression, in February 2022 Ukraine closed its airspace to civilian flights. As a consequence, the EU, Norway, Switzerland, and the UK, among others, put sanctions in place, closing their own airspace to Russian operated and owned aircraft. Russia soon implemented reciprocal measures.

70. As a result, Ukrainian, Belarusian, and Russian airspace is now fully closed to European traffic, meaning that flights previously flying over this airspace now need to take different, less direct routes, affecting KEA in multiple ways, notably:

- European flights to and from Asia, are now routing over Turkey and the Middle East, or north on polar routes via Alaska;
- Flights between Turkey and Russia continue, but are avoiding Ukraine, adding inefficiency to the Eastern SES and Baltic States;
- Belorussian and Russian flights to and from Kaliningrad are flying in SES airspace over the Baltic Sea, exercising freedom to fly over the high seas as per UN conventions;[14]
- International carriers still using Russian airspace are keeping further North, passing through Estonia and Latvia rather than Lithuania.

71. Considerable disruption has been caused to SES traffic flows and flight efficiency as a number of city pairs between SES States and the UK (overflying the SES) are, hence, considerably longer.

72. Eurocontrol estimates that this has led to a Union-wide KEA deterioration of approximately 0.24 percentage points. Annex III provides a detailed analysis of the calculations.

73. The analysis shows that not all Member States have been impacted, with the most affected seeing a year-on-year relative KEA increase of over 25% in 2022 (Table 9, next page). While it is not possible to predict the evolution of the conflict, when computing the local KEA reference values, the PRB will work closely with the Network Manager to ensure that any allowance for the impact of Ukraine is allocated to the Member States affected.

[13] EASA Safety Directive 2021-02.
[14] United Nations, Convention on the High Seas (1958).

Member State	Year-on-year KEA evolution In 2022
Finland	+326%
Lithuania	+306%
Latvia	+286%
Estonia	+282%
Poland	+106%
Slovakia	+76%
Sweden	+63%
Romania	+51%
Hungary	+32%
Bulgaria	+32%
Czech Republic	+26%

Table 9 – Member States most affected by route extensions due to Russia's war of aggression against Ukraine (source: PRB elaboration).

3.6 Combining the Evidence

74. The PRB proposes target ranges for 2029 that build on the original ambition for the end of RP3 (2024) (Evidence 1), while accounting for the benefits of recent and future improvements from ATM measures and ongoing updates to the European network (Evidence 2), for the interdependency between environment and capacity in the environmental target ranges (Evidence 3), and the impact of Russia's war of aggression against Ukraine (Evidence 4).

75. The four pieces of Evidence are combined to define the yearly target ranges of Union-wide KEA for RP4. The PRB priority for RP4 is to improve environmental performance, supported by the provision of sufficient capacity to meet demand.

76. The target ranges for 2029 are obtained following a stepwise approach. The PRB proposes to set the 2029 ambition starting from the target ranges as proposed for RP4 (Evidence 1):

- Upper bound 2029 (less ambitious): 2.40%; and
- Lower bound 2029: 2.20%.

77. The PRB proposes to factor in the benefits of recent and future improvements from ATM measures and ongoing updates to the European network, as shown in Evidence 2:

- Upper bound 2029: -0.04pp; and
- Lower bound 2029: -0.09pp.

78. The PRB proposes to adjust the KEA target ranges based on the interdependency with capacity, as described in Evidence 3:

- Upper bound 2029: +0.06pp; and
- Lower bound 2029: +0.04pp.

79. Considering Evidence 1, 2, and 3, the Union-wide KEA performance target range for 2029 provides a lower bound of 2.15% and an upper bound of 2.42%. The target ranges proposed are more ambitious than that for RP3.

80. While it is not possible to predict the evolution of the conflict, the PRB proposes to include the impact of Russia's war of aggression against Ukraine on KEA in both the upper and lower bound of the targets (+0.24pp in each year of RP4). However, when defining the local targets, the impact should only be considered for affected Member States (Evidence 4).

81. The resulting KEA ranges for 2029 adding the estimated impacts are:

- **Upper bound 2029 target range** (less ambitious): 2.42% + 0.24% = **2.66%**; and
- **Lower bound 2029 target range**: 2.15% + 0.24% = **2.39%**.

82. To set the target ranges for the years 2025-2028, the PRB proposes target ranges evolving based on the ramp up of ERNIP ARN improvement benefits (Evidence 2) and on the interdependency with capacity targets (Evidence 3) (Table 10, next page).

KEA (upper bound)	2025	2026	2027	2028	2029
Evidence 1 – Analysis of historical KEA performance (starting point)	*2.40%*	*2.40%*	*2.40%*	*2.40%*	*2.40%*
Evidence 2 – Estimated benefit defined in the ERNIP (yearly ramp up to -0.04pp)	*0pp*	*-0.01pp*	*-0.02pp*	*-0.03pp*	*-0.04pp*
Evidence 3 - PRB study on the capacity and environment interdependencies (yearly allowance for CAP targets)	*+0.07pp*	*+0.07pp*	*+0.07pp*	*+0.06pp*	*+0.06pp*
Evidence 4 - The impact on Union-wide KEA of Russia's war of aggression against Ukraine (flat allowance)	*+0.24pp*	*+0.24pp*	*+0.24pp*	*+0.24pp*	*+0.24pp*
Targets upper bound	2.71%	2.70%	2.69%	2.67%	2.66%

KEA (lower bound)	2025	2026	2027	2028	2029
Evidence 1 – Analysis of historical KEA performance (starting point)	*2.20%*	*2.20%*	*2.20%*	*2.20%*	*2.20%*
Evidence 2 – Estimated benefit defined in the ERNIP (yearly ramp up to -0.09pp)	*-0.01pp*	*-0.03pp*	*-0.05pp*	*-0.07pp*	*-0.09pp*
Evidence 3 - PRB study on the capacity and environment interdependencies (yearly allowance for CAP targets)	*+0.06pp*	*+0.05pp*	*+0.05pp*	*+0.05pp*	*+0.04pp*
Evidence 4 - The impact on Union-wide KEA of Russia's war of aggression against Ukraine (flat allowance)	*+0.24pp*	*+0.24pp*	*+0.24pp*	*+0.24pp*	*+0.24pp*
Targets lower bound	2.49%	2.46%	2.44%	2.42%	2.39%

Table 10 –Union-wide environment target ranges.

4 CAPACITY

4.1 Introduction to the target setting

83. To support the setting of the capacity target ranges, the PRB considered three pieces of Evidence:

- Historical capacity performance of ANSPs, especially focusing on delays with ATC capacity and ATC staffing reasons;
- Historical occurrence of non-ATC disruptions-related and adverse weather-related delays; and
- Capacity improvement plans included in the European Network Operations Plan 2023-2027 Edition April 2023 (NOP), the analysis conducted by the SESAR Deployment Manager on the expected benefits of the implementation of CP1 ATM functionalities, and the RP3 performance plans and monitoring reports submitted by the Member States.

84. The pieces of Evidence are analysed separately and then combined to form PRB's proposals for Union-wide RP4 target ranges for the average en route ATFM delay per flight.

4.2 Evidence 1 – Historical capacity performance

85. The PRB considers data on en route ATFM delays for the period of 2012-2022. During this period, the Union-wide target on average en route ATFM delays was only met in the two years affected by the COVID-19 pandemic: In 2020 and 2021.[15] In all other years, actual performance was consistently above the target level.

86. During the years of RP1 (2012-2014), the PRB notes that ANSPs were able to manage more IFR flights with significantly lower average delays than in 2022, almost achieving the 0.5 minutes per flight target. Figure 5 shows the capacity performance of the past ten years.

87. Despite ten years of capacity improvement measures and investments, it appears that ANSPs are offering less capacity than at the beginning of RP1. This suggests a clear lack of ambition and/or focus of ANSPs and it also shows that the 0.5 minutes per flight target is realistically achievable.

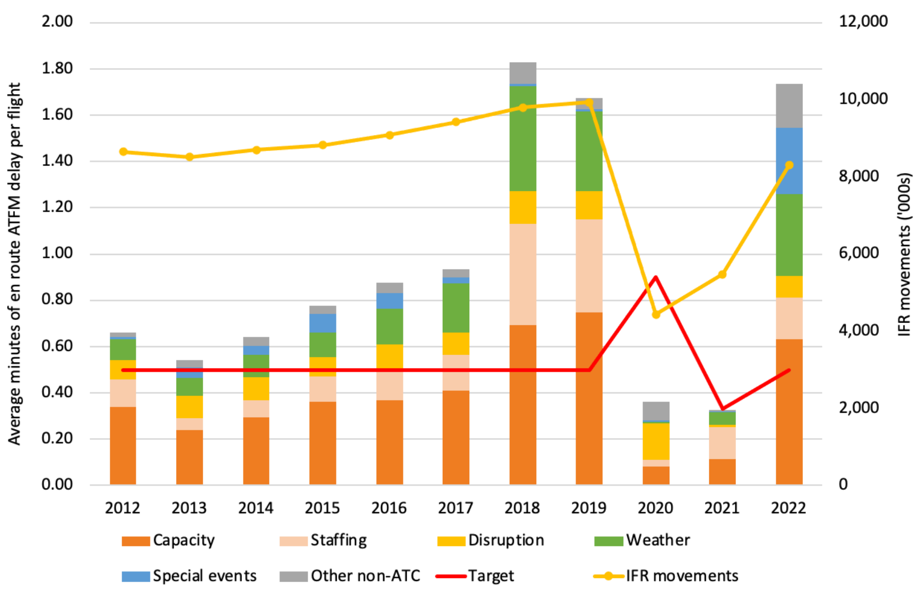

Figure 5 - Overview of the capacity performance of 2012-2022. The Union-wide capacity target was only met in 2020 and 2021, during the COVID-19 pandemic (source: PRB elaboration on data from AIU of Eurocontrol).

[15] For the years of RP1 (2012-2014) there was no binding capacity target defined at Union-wide level.

Analysis of delay reasons

88. When analysing the distribution of delays across the different delay reasons, ATC capacity and staffing are the two leading delay reasons. Despite the fact that these two delay reasons are under the direct influence of ANSPs, these types of delay have consistently increased since 2014, with the exception of 2020 and 2021. Resolving ATC capacity and staffing issues and thereby eliminating these delays (to the extent possible) would already result in a capacity performance close to or under the 0.5-minute-per-flight threshold.

89. In addition to ATC capacity and staffing, weather-related delays also increased during the observed period, being especially high in 2018, 2019, and 2022. These delays are analysed in detail in Evidence 2, together with non-ATC disruptions.

90. The results also show that en route ATFM delays in 2022 were impacted by the outbreak of Russia's war of aggression on Ukraine, in addition to some system transition projects which had strong network effects. This indicates that the level of delays in 2022 may have been higher than would normally be expected. Most of these impacts are reflected in the unusually high levels of delays related to special events and other non-ATC causes.

91. The impact on en route ATFM delays from Russia's war of aggression on Ukraine was most significant in the months following the outbreak of the war. During this period, military operations in the SES area ramped up, and civilian ANSPs had to adapt to the altered traffic flows and new complexities. Following this initial adaptation period, en route ATFM delays due to the impact of the war subsided.

92. The European Aviation Crisis Cell was activated in relation to the outbreak of the war between 24th February and 23rd May 2022. NSAs reported a total of 379,043 minutes of ATFM delay exclusively due to this exceptional event, which corresponds to a 0.05 minute per flight correction to the Union-wide average en route ATFM delay per flight, resulting in an adjusted value of 1.69 minutes per flight.

Contribution of ANSPs

93. The analysis of the contribution of ANSPs to en route ATFM delays reveals that during the past ten years, most of the delays were generated by a relatively small number of ANSPs: On average, 66% of delays were generated by the top three contributing ANSPs, and some 77% generated by the top five contributing ANSPs. When considering only the average of the last five years, an even higher concentration ratio can be observed: 72% and 79% for the top three and top five contributors, respectively. The evolution of the concentration ratio of delays is shown in Figure 6.

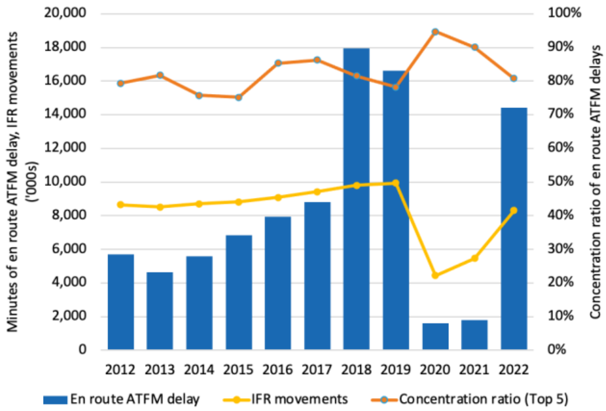

Figure 6 - Evolution of the top 5 concentration ratio of en route ATFM delays, showing that a relatively high share of delays has been generated by the five largest contributing ANSPs (source: PRB elaboration).

94. Table 11 (next page) shows the average contribution of ANSPs to en route ATFM delays during the past five and ten years. DSNA, DFS, and ENAIRE were the top three contributors in most years. Between 2012 and 2022, HASP, MUAC, and DCAC Cyprus also had contributions of at least 10% in one or more years. ANS CR, PANSA, and HungaroControl had outlier years when their contribution was significantly higher than their respective averages, but never higher than 10%.

ANSP	Average delay contribution past five years (ten years)
DSNA	36% (35%)
DFS	26% (21%)
ENAIRE	10% (10%)
HASP	4% (4%)
HungaroControl	3% (2%)
Austro Control	3% (2%)
MUAC	2% (5%)
Skyguide	2% (2%)
Croatia Control	2% (2%)
NAV Portugal	2% (3%)
ANS CR	2% (1%)
PANSA	2% (4%)
DCAC Cyprus	1% (5%)
Skeyes	1% (1%)
ENAV	1% (1%)

Table 11 - Average contribution of ANSPs to en route ATFM delays in the past five and ten years shown in brackets (source: PRB elaboration).

95. While the delay contribution of most ANSPs was relatively stable between 2012 and 2022, there were notable examples where ANSPs managed to significantly improve their capacity performance and eliminate most of their en route ATFM delays. Such examples are MUAC and DCAC Cyprus, both being able to reduce their contribution of delays from around 10% to 1-3% during the period. There were other ANSPs which managed to improve their performance and keep their contribution decreasing over time.

96. While the analysis of the contribution to en route ATFM delays shows an important aspect of capacity performance, it is noted that ANSPs with higher numbers of IFR movements would have a higher contribution to delays even if all ANSPs performed at the same average level. Therefore, it is important to analyse how the rank of each ANSP in delay contribution compares to its rank in relation to the number of IFR movements (Table 12).

97. Table 12 shows the difference between the rankings of each ANSP in delay contribution and the number of IFR movements. A positive number indicates that the delay contribution ranking of the ANSP is lower (i.e. it has lower delay contribution) than the IFR movements ranking. In other words, the delay contribution of the ANSP is lower than ANSPs with lower number of IFR movements. On the other hand, a negative number indicates that the contribution of delays for the ANSP is higher than that of ANSPs with less IFR movements.

98. There are no differences in the rankings of the top three contributors but there are several ANSPs where the rankings are significantly different. For ENAV, MUAC, Skyguide, and PANSA the delay contribution ranking is lower than the IFR movement ranking. For DCAC Cyprus, NAV Portugal, Croatia Control, skeyes, HASP, HungaroControl, and Austro Control, the figures are negative, indicating a higher delay contribution ranking than the respective IFR movement ranking.

99. Considering that ENAV, MUAC, and ENAIRE have a comparable number of IFR movements, and their delay contribution rankings are still highly different, the amount of IFR movements controlled cannot be an explanation for delay contribution.

ANSP	Rank difference
DSNA	0
DFS	0
ENAIRE	0
HASP	-4
HungaroControl (EC)	-4
Austro Control	-1
MUAC	3
Skyguide	2
Croatia Control	-5
NAV Portugal (Continental)	-6
ANS CR	-1
PANSA	1
DCAC Cyprus	-10
Skeyes	-5
ENAV	10

Table 12 - Difference between the rank of the ANSP in delay contribution and the number of IFR flights as average of the last 5 years) (source: PRB elaboration).

Sector-opening gaps and delays

100. In addition to an analysis of delay reasons and delay contribution, the PRB assessed how en route ATFM delays correlated with sector-opening gaps of ANSPs in 2022. For the calculation of the sector-opening gap, the maximum number of sectors that were open at the same time over the year

was calculated for each ACC. This value was compared to the daily maximum number of concurrent sectors. The difference between the two figures, expressed in the percentage of the yearly maximum number of sectors, is defined as sector-opening gap.[16]

101. The PRB measured the sector-opening gap for each ACC for each day in 2022 and aggregated the results to the level of ANSPs (the number of sectors and thus sector-opening gaps are additive). These ANSP level results were then compared with the daily en route ATFM delay minutes generated by the ANSP under the delay reasons ATC capacity and ATC staffing.[17] The maximum number of sectors an ANSP was able to open during a year indicates an important aspect of its realistic maximum capacity (or the maximum that was required to meet traffic demand). If delays occurred when the ANSP was not able to offer its yearly maximum number of sectors, it indicates issues in the pre-tactical planning and tactical execution of capacity provision, rather than general capacity constraints.

102. In addition to calculating the minutes of delays which occurred on days when the ANSPs had a sector-opening gap (sector-opening gap delays, SOG delays), the ratio of such delays (SOG ratio) within the total minutes of en route ATFM delay was also calculated for each ANSP for 2022. The SOG metrics can be interpreted as the amount (or the ratio) of delays that can be resolved or avoided in a relatively short time frame. In other words, delays could be resolved without requiring extensive investment or large-scale efforts in recruiting and training controllers.

103. Table 13 shows the results of the 2022 SOG metrics calculation per ANSP and at Union-wide level. There are significant differences in both the total SOG delay minutes and the SOG ratios of ANSPs. LFV had the highest SOG ratio in 2022, however the impact was negligible on the network level. On the other hand, DSNA had a relatively low SOG ratio of 26% but was a top contributor to total delays (see also previous section), and had the second-highest value of SOG delays.

104. At Union-wide level, 43% of all en route ATFM delays were identified as SOG delays (6.16 million minutes). These are the delays that could have been avoided if pre-tactical planning and tactical execution issues were resolved. Had these delays been avoided in 2022, the average en route ATFM delay per flight would have been 1.00 minutes per flight, instead of 1.74 minutes per flight. The PRB considers the delays which were not related to sector-opening gaps as base delays. Base delays may be associated with longer term issues, which require more time to be resolved. These are the delays which can be regarded as the basis for longer-term capacity improvement measures. Clearly, the level of base delay is an important factor in the setting of RP4 capacity targets.

ANSP	SOG delay minutes	2022 Total delay minutes	SOG ratio
DFS	3,269,616	5,634,773	58%
DSNA	1,137,622	4,342,492	26%
ENAIRE	410,527	598,463	69%
PANSA	341,227	799,668	43%
HungaroControl	271,377	480,956	56%
Croatia Control	267,769	407,715	66%
Skyguide	138,784	241,643	57%
ENAV	99,308	253,695	39%
HASP	85,390	138,090	62%
NAV Portugal	65,349	404,196	16%
Austro Control	33,699	78,166	43%
LFV	17,086	22,147	77%
MUAC	9,855	137,573	7%
ANS CR	8,039	798,202	1%
Avinor	1,492	3,266	46%
NAVIAIR	130	762	17%
Union-wide	6,157,270	14,454,970	43%

Table 13 – 2022 sector-opening gap (SOG) delays and ratio in total en route ATFM delays, ANSPs and Union-wide level. ANSPs without SOG delays are not shown (source: PRB elaboration).

[16] For example: If the maximum number of sectors on any day in the year was 10, than a day when the ACC only had 8 sectors open at the same time had a 20% sector-opening gap.

[17] Sector-opening data is based on the DDR AIRAC datasets. Daily en route ATFM delays are taken from the non-post-ops adjusted dataset of the AIU of Eurocontrol.

4.3 Evidence 2 – Delays related to non-ATC disruptions and adverse weather

105. Annex I point 3.1.(c) of Implementing Regulation (EC) 2019/317 stipulates that the capacity KPI of average en route ATFM delay per flight covers all IFR movements and all delay causes excluding exceptional events. This means that en route ATFM delays due to adverse weather and disruptions caused by non-ATC stakeholders (such as airports) are included in the calculation of the KPI.

106. As these delays have an impact on the functioning of the network, they are important aspects of Union-wide capacity performance but are not under the direct influence of ANSPs. For this reason, the PRB considers that an allowance for these delays should be included in the target ranges for capacity.

107. The PRB proposes to exclude from consideration the allowances related to events such as equipment failure or industrial actions at ANSPs. These factors fall within the remit of the management of the ANSP, and can be subject to management and improvement measures.

Allowance for delays due to non-ATC disruptions

108. The PRB calculates the allowance for non-ATC disruptions on the basis of the respective delay reason group. The non-ATC disruptions delay reason group includes five delay reason codes (Table 14).[18] These reasons are considered as exogenous factors from the perspective of the operation of the ANSPs and cannot be resolved through capacity improvement measures or specific investments.

Delay code	Main delay reason
A	Accident/incident
E	Non-ATC equipment failure
N	Non-ATC industrial action
O	Other reason
NA	Reason not specified/available

Table 14 - Delay codes included in the non-ATC disruptions delay reason group (source: AIU of Eurocontrol).

109. For the calculation of the allowance, the PRB considers the evolution of non-ATC disruptions from 2012 to 2022. The delays covered by this group can occur anywhere in the network and they are not attributable to any ANSP or Member State. Therefore, the analysis is only conducted at Union-wide level (Figure 7). While the level of such delays varies from one year to another, there appears to be an increasing level of volatility in the network due to non-ATC disruptions. The outlier value in 2022 is largely due to the impact of Russia's war of aggression on Ukraine (Figure 7).

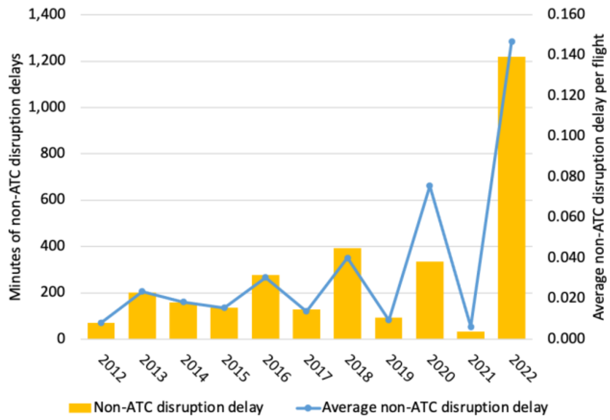

Figure 7 - Evolution of Union-wide non-ATC disruption en route ATFM delays between 2011 and 2022. The network was more volatile in later years (source: PRB elaboration on data from AIU of Eurocontrol).

110. The PRB considers that the delay allowance for non-ATC disruptions should reflect the expected value of such delays during the years of RP4. To this end, a range for the allowance is defined as follows:

- Non-ATC disruption allowance for the upper bound of target ranges is based on the overall average of non-ATC disruption delays per flight (i.e. average over entire period of 2012-2022). The value equals to 0.033 minutes per flight.
- Non-ATC disruption allowance for the lower bound of target ranges is based on the median value of the average non-ATC disruption delays per flight (i.e. median of the yearly averages). The value equals to 0.018 minutes per flight.

[18] The PRB uses the categorisation of the AIU of Eurocontrol as defined in the datasets published on http://ansperformance.eu/.

111. The PRB proposes to adjust downwards the allowance for the lower bound to 0.01 minutes per flight, as in six out of the ten years actual values were around 0.01 minutes per flight. In a similar way, the PRB proposes to adjust the allowance for the upper bound to 0.030 minutes per flight, noting that the average is highly affected by the outlier value of 2022 (without 2022, the overall average would be 0.022 minutes per flight). While it is not possible to predict the evolution of the conflict, this approach reflects the operational status considering the effects of Russia's war of aggression against Ukraine without inflating the allowance beyond a historically reasonable value. The allowance ranges are shown Table 15.

	Statistical value (min/flight)	Proposed value (min/flight)
Upper bound	0.033	0.030
Lower bound	0.018	0.010

Table 15 - Proposed allowance for non-ATC disruption delays (source: PRB elaboration).

Allowance for delays related to adverse weather

112. Weather phenomena such as thunderstorms, turbulence and icing may affect the level of capacity an ANSP is able to offer. When traffic demand is already high and ANSPs operate at or close to their maximum capacity, these weather phenomena can generate high en route ATFM delays. Similarly to non-ATC disruptions, weather phenomena are outside the remit of ANSPs, and while ANSPs might be able to increase their capacity to mitigate some of the impacts, delays due to adverse weather are inevitably part of the operation of the network.

113. In order to allow for such delays in the capacity target ranges, the PRB analysed the evolution of weather-related en route ATFM delays between 2012 and 2022. This analysis was performed at ANSP level, as weather phenomena tend to have a systematically different impact on the operations of ANSPs depending on their geographical locations.

114. Weather-related delays are captured under two delay codes: 'W' for weather and 'D' for de-icing.[19] The PRB analysed delays recorded under these codes for all ANSPs in the SES area during the past ten years.

115. The minimum/maximum values for each ANSP were calculated, as well as the average values over the entire period. DFS, Austro Control, DSNA, Croatia Control, and MUAC had the highest impact when looking at the average values of ten years. When considering only the past five years, the overall impact is much bigger and HungaroControl emerges as the ANSP with the fifth highest weather impact instead of MUAC.

116. The effects of climate change are apparent in the changes in frequency, duration, and location of severe weather phenomena, and this tendency is expected to worsen as global temperature rises. To reflect this scenario, the PRB proposes that allowance for weather-related delays for the upper bound of the target ranges is calculated on the basis of averages of the past five years, while for the lower bound on the basis of the entire period average.

117. In order to estimate the total minutes of en route ATFM delay due to adverse weather on the Union-wide level, the PRB projected both the ten-year and the five-year average values of each ANSP on the forecast IFR movements (STATFOR March base forecast) for the period of RP4. The values obtained were then divided by the forecast number of Union-wide IFR movements to calculate the Union-wide average weather delay allowance range.[20]

118. The result for the upper bound is 0.27 minutes per flight using the average of the past five years, while for the lower bound the result is 0.20 minutes per flight (based on the average of the ten years).The values estimated are in line with the calculations made by the Network Manager in the NOP for 2023 where the Network Manager estimated weather-related en route ATFM delays to be on average 0.22 minutes per flight. The summary of the analysis is shown in Table 16 (next page).

[19] The PRB uses the categorisation of the AIU of Eurocontrol as defined in the datasets published on http://ansperformance.eu/.
[20] Detailed calculations are not shown for the sake of brevity. They can be provided upon request to prb-office@prb.eusinglesky.eu.

119. The PRB proposes that 0.27 and 0.20 minutes per flight are used for the upper and lower bounds of the Union-wide target ranges.

ANSP	Minimum - Maximum	Average of last 10 years	Average of last 5 years
ANS CR	0 - 0.11	0.03	0.06
Austro Control	0 - 0.65	0.14	0.22
Avinor	0 - 0	0.00	0.00
BULATSA	0 - 0.01	0.00	0.00
Croatia Control	0 - 0.32	0.11	0.16
DCAC Cyprus	0 - 0.05	0.01	0.01
DFS	0 - 0.47	0.18	0.24
DSNA	0 - 0.33	0.12	0.16
EANS	0 - 0.02	0.00	0.00
ENAIRE	0 - 0.17	0.06	0.08
ENAV	0 - 0.14	0.02	0.04
Fintraffic ANS	0 - 0	0.00	0.00
HASP	0 - 0.06	0.01	0.02
HungaroControl	0 - 0.3	0.07	0.13
IAA	0 - 0	0.00	0.00
LFV	0 - 0.04	0.01	0.01
LGS	0 - 0.01	0.00	0.00
LPS	0 - 0.08	0.02	0.03
LVNL	0 - 0.03	0.02	0.02
MATS	0 - 0	0.00	0.00
MUAC	0 - 0.28	0.09	0.08
NAV Portugal	0 - 0.02	0.01	0.01
NAVIAIR	0 - 0	0.00	0.00
Oro Navigacija	0 - 0	0.00	0.00
PANSA	0 - 0.07	0.02	0.02
ROMATSA	0 - 0.08	0.01	0.02
skeyes	0 - 0.07	0.03	0.03
Skyguide	0.01 - 0.17	0.05	0.08
Slovenia Control	0 - 0	0.00	0.00

Table 16 - Analysis of weather-related en route ATFM delays for the period 2012-2022 (source: PRB elaboration on data from the AIU of Eurocontrol).

4.4 Evidence 3 – Capacity improvement plans

120. The third piece of Evidence considered by the PRB in the capacity KPA is collated from three different sources:

- The capacity improvement plans of ANSPs in the NOP;
- The calculation of the SESAR Deployment Manager regarding the capacity benefits of implementing the ATM functionalities included in the CP1 package; and
- The RP3 performance plans and monitoring reports submitted by the Member States.

Capacity improvement plans of ANSPs in the NOP

121. During the preparation of the NOP, the Network Manager and the ANSPs participate in an iterative Collaborative Decision-Making (CDM) process in order to plan and improve the future operation of the European ATM Network. In doing so, a set of capacity improvement measures for each ACC was defined, indicating the planned future sector-opening schemes. This serves as the basis for the Network Manager to calculate capacity profiles and delays forecasts.

122. The latest version of the NOP covers the period of 2023-2027 and only includes the first three years of RP4. Another limitation in the use of the NOP for target setting is that reference profiles (the capacity profiles required to meet the reference value for average en route ATFM delay for each ACC) are only calculated for 2023 and 2024, as these calculations are based on Union-wide targets for en route capacity and cannot be calculated prior to defining the targets. Nevertheless, the plans included in the NOP and the delay forecast are valuable information for establishing the target ranges for RP4.

123. For the definition of target ranges in the KPA of capacity for RP4, the PRB considered three key topics included in the NOP:

- The delay forecast for each ACC and for the network;
- The forecast growth of IFR movements for each ACC; and
- The capacity profile plans of each ACC and their relation to the reference profiles.

124. The NOP forecast of the network level delay is shown in Table 17. The forecast level of average delays is significantly higher than the RP3 Union-wide targets (for 2023, 2024, and 2025), but the figures show a 45% reduction in average delays per flight over the five years.

Average en route ATFM delay per flight				
2023	2024	2025	2026	2027
1.78	1.47	1.28	1.19	0.97

Table 17 - Delay forecast for the Eurocontrol NM area with estimations of industrial actions and technical failures inlcuded at the statistical level of 0.15 minutes per flight. 2023 value shown without NM measures (source: NOP 2023-2027 Edition April 2023).

125. The NOP also provides the forecast average en route ATFM delays per flight for each ACC for each year within the period of 2023-2027. In order to understand how each ACC would contribute to the Union-wide delay performance, these figures are projected on the ACC-level forecast of IFR movements for the same period. The NOP provides this forecast as a percentage growth compared to 2022. By combining the forecast average delay, the forecast traffic growth, and the actual number of IFR flights in 2022 for each ACC, the forecast number of en route ATFM delays can be calculated.

126. Figure 8 (next page) shows the resulting figures for the ACCs which have at least a 5% contribution to en route ATFM delays in one or more years between 2025 and 2027. The nine ACCs shown correspond to only six ANSPs, which is consistent with the analysis of Evidence 1 of the capacity KPA. The figure shows a significantly decreasing contribution from Karlsruhe UAC, and an emerging contribution from Brest and Bordeaux ACCs and Zürich ACC. The contributions of Bremen ACC, Budapest ACC, Vienna ACC, and Zagreb ACC show relatively small changes compared to the other top contributing ACCs. The calculation of the forecast delay minutes and the contributions to the Union-wide delay minutes is also in line with the analysis of delay concentration under Evidence 1 of the capacity KPA.

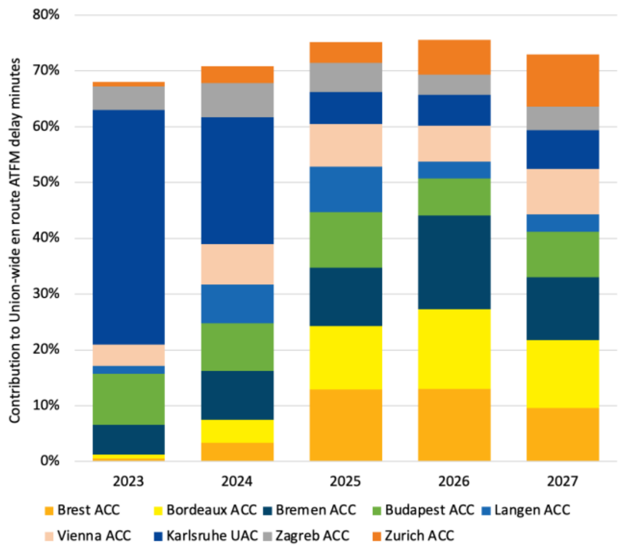

Figure 8 - Forecast contribution of ACCs to Union-wide en route ATFM delay minutes during 2023-2027. Source: PRB elaboration on NOP data. Only ACCs with a contribution greater than 5% in RP4 years are shown (source: PRB elaboration).

127. The PRB notes that these delay forecasts are based on measures which the ANSPs planned and committed to undertake during the preparation of the NOP. The example of Karlsruhe UAC shows that ANSPs are willing to commit to ambitious capacity improvement plans and to consider realistic a significant delay reduction over a relatively short period of time (i.e. two years). This is further emphasised by the example of Reims ACC, which was a top contributor of en route ATFM delays in previous years but is not included in Figure 8 following the transition to the new ATM system.

128. The forecast growth of traffic and the measures planned by the ANSPs to enhance capacity are combined in the NOP into capacity profiles. Capacity profiles are expressed as hourly movements in the airspace of the ACC, and are a metric for the theoretical maximum capacity an ACC is able to sustain over a longer period of time. Capacity profiles cannot be directly tied to delay figures or other indicators used for capacity measurements, as their calculation is based on a set of iterative simulations by the Network Manager. Despite this, capacity profiles are useful when analysing how ANSPs are planning to increase capacity, and how that increase compares to traffic growth.

129. The NOP contains the capacity profile plans of all ACCs in the SES area for the period of 2023-2027. During the last three years of RP4, ACCs are expected to increase their capacity on average by 2.4% to follow traffic growth and avoid capacity gaps. A detailed summary of the required capacity increase is shown in Table 18.

Required Y-o-Y increase	2025	2026	2027
Average	+3%	+2%	+2%
Minimum	0%	0%	0%
Maximum	+5%	+5%	+4%

Table 18 – Overview of the required year-on-year increase of capacity profiles of ACCs in the SES area between 2025-2027 (source: PRB elaboration on NOP data).

130. The highest required year-on-year increase of any ACC is +5% during 2025-2027, while the minimum requirement is 0% in all three years. For most of the ACCs, the required growth is between 2 and 3%, as shown in Figure 9.

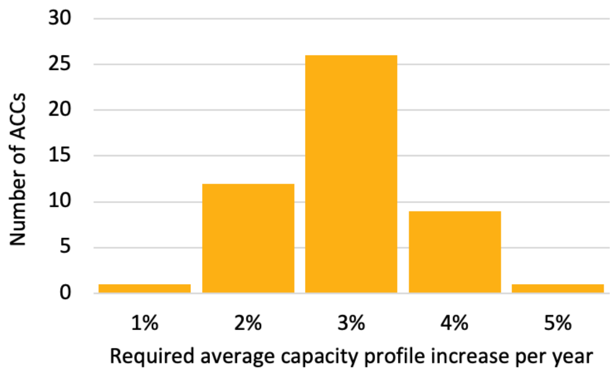

Figure 9 - The distribution of ACCs across their required average annual increase of capacity profiles. Most of the ACCs have a required average annual growth between 2-3% (source: PRB elaboration on NOP data).

131. The required average annual increase can be compared with the planned increase of the capacity profiles for each ACC. This comparison reveals that most ANSPs plan to improve their capacities to cope with traffic growth between 2025-2027. There are only nine ACCs out of the 49 in the SES area which consistently plan a lower increase than required by traffic growth. At the same time, these ACCs are forecast to have a significant capacity surplus in 2023 and 2024 which will cover the growth without resulting in a capacity gap. This indicates that if ANSPs can close existing capacity gaps by 2025, the forecast traffic growth should not require major step changes in capacity, but rather a steady improvement of performance.

132. The analysis of capacity profile plans and their comparison with the reference profiles (which are required to meet capacity targets) shows that there are 6 and 7 ACCs with a significant capacity gap in 2023 and 2024, respectively. All other ACCs have either a minor capacity gap (i.e. smaller than -5%), or have capacity profile plans which are aligned with or above the reference profiles. A more detailed view of capacity gaps and surpluses is shown in Table 19.

Capacity gap/surplus	2023	2024
<-10%	2	2
<-5%	4	5
<0	7	10
<5%	15	11
<10%	12	13
>=10%	9	8

Table 19 - Number of ACCs in each capacity gap/surplus category. A gap/surplus greater than 5% in absolute value is considered significant (source: PRB elaboration on NOP data).

133. These figures also confirm the analysis conducted under Evidence 1 of the capacity KPA, which found that significant capacity issues are concentrated in a small number of ACCs/ANSPs.

134. Reference profiles for RP4 are not calculated until the Union-wide capacity targets are set, therefore the NOP does not contain information on capacity gaps/surpluses for the years 2025-2027. Nevertheless, based on the gap/surplus information provided for 2024, the forecast traffic growth, and the increase planned by the ANSPs, it is possible to estimate if the planned capacity profiles will be sufficient to accommodate traffic growth. As shown in Table 20, the ACCs with the highest forecast contribution to en route ATFM delays between 2025 and 2027 are generally planning to significantly reduce their capacity gaps by 2027. Differently, out of the nine ACCs with a contribution greater than 5% in RP4, Brest and Bordeaux ACCs do not plan a significant reduction (although both ACCs plan to implement new systems at the end of the period), and Zürich ACC shows an increase in the capacity gap over the three years.

135. The PRB notes that these figures are based on the plans included in the current version of the NOP, and may be subject to revision by ANSPs in the coming years. However, the PRB considers it reasonable to assume that all the significant capacity gaps can be resolved at the latest by 2027, based on the current plans of the majority of the ACCs.

ACC	2025	2026	2027
Brest	-8%	-8%	-8%
Bordeaux	-9%	-9%	-8%
Bremen	-16%	-23%	-12%
Budapest	-9%	-6%	-4%
Langen	-7%	-3%	0%
Vienna	-6%	-4%	-4%
Karlsruhe	0%	3%	6%
Zagreb	-5%	-2%	-2%
Zurich	-4%	-6%	-8%

Table 20 – Estimated capacity gaps/surpluses of ACCs with the highest contribution to en route ATFM delays between 2025-2027 (source: PRB elaboration on NOP data).

Expected benefits of implementing CP1 functionality

136. The CP1 package includes a set of ATM functionalities that are expected to deliver significant benefits to the network in terms of capacity performance. The SESAR Deployment Manager (SDM) closely monitors the implementation of CP1 projects which have been funded by the European Union. As part of its planning and monitoring procedures, the SDM also calculates the expected benefits and monitors the actual benefits of each project in its portfolio. The results of these calculations are summarised in Annex IV of this report.

137. The SDM calculates the benefits of the projects as avoided minutes of ATFM delay or delay savings. The original estimation dating from 2015 has been updated to factor in the impact of the COVID-19 pandemic, which slowed the ramp-up of savings. The current calculation provided by the SDM estimates yearly delay savings in the range of 24-27 million minutes for RP4. These calculations are made against a theoretical ‘do-nothing’ scenario, and thus are not directly applicable to the delay forecast or other calculations performed within the target setting exercise. Nevertheless, the data provided by the SDM shows that the ATM functionalities included in the CP1 package should

deliver a significant improvement in capacity performance over the course of RP4.

138. Further to this, the PRB notes that the benefits estimated by the SDM are realised as network effects stemming from the synchronised implementation of the functionalities and as such are not factored into the capacity improvement plans of the ANSPs.

RP3 performance plans and monitoring reports of Member States

139. While the RP3 performance plans and monitoring reports are concerned with the period up to 2024, they provide information on the outlook for RP4 performance. The two most relevant aspects for the target ranges are the plans presented by the Member States in relation to the recruitment and training of air traffic controllers (ATCOs), and the ANSPs' capacity improvement measures.

140. The combination of all ATCO training plans included in performance plans shows that ANSPs are planning to have 8,402 ATCO FTEs working in operations by the end of 2024. This represents an annual average increase of +2% over RP3. If these plans are realised, this may serve as a solid basis for increasing capacity and reducing delays related to ATC capacity and staffing (i.e. SOG delays).

141. Further to recruiting and training ATCOs, ANSPs also plan to invest in new ATM functionalities and new ATM systems. Out of the 11 Member States that did not meet the 2022 local capacity targets, seven plan to upgrade/update their ATM systems in RP3. Moreover, in the NOP, almost all ACCs provided plans to further update their systems in RP4.

142. As shown by the recent system transition projects deployed at Reims ACC, Lisbon ACC, and Prague ACC, these measures can deliver a significant improvement in sector capacities, and thus enable a better capacity performance of the ANSPs. This indicates that ANSPs have a significant potential to improve their capacity performance and may be able to close the capacity gaps if the appropriate set of measures are defined and implemented in a timely manner.

143. With the implementation of new ATM systems and state-of-the-art data processing and data exchange functionalities, ANSPs should exploit the benefits of dynamic cross-border demand-capacity balancing solutions in order to alleviate the pressure on ATCO recruiting and training.

4.5 Combining the Evidence

144. The three pieces of Evidence in the capacity KPA are combined to obtain the proposed target ranges for the RP4 Union-wide target on average en route ATFM delay per flight. The overall priority for the target setting for RP4 in the capacity KPA is to ensure that capacity provision supports the delivery of the RP4 environmental targets, and that the European ATM Network can function efficiently without avoidable disruptions.

145. Evidence 1 demonstrates that the current capacity problems in the network can be associated with the local issues of a few ANSPs, and if these are resolved, network performance would improve significantly. Evidence 1 also shows that 45% of the delays experienced in 2022 were related to sector-opening gaps, and should be resolved without major, long-term measures. Finally, Evidence 1 also indicates that the current capacity targets are realistic and achievable despite the disappointing actual average Union-wide performance.

146. Evidence 2 defined the allowances to be included in the target ranges for the Union-wide capacity target with respect to delays which cannot be influenced by the ANSPs.

147. Evidence 3 defined the required and realistic levels of capacity improvement over the course of RP4.

148. Based on the above, the PRB proposes the target ranges for the Union-wide capacity target by combining the below three elements.

149. The proposed allowance for non-ATC disruption delays is 0.03 minutes per flight for the upper bound, and at 0.01 for the lower bound of the target ranges. The PRB proposes these allowances in each of year of RP4.

150. The proposed allowance for weather-related delays is at 0.27 minutes per flight for the upper bound of the targets, and at 0.20 minutes per

flight for the lower bound. The PRB proposes these allowances in each of year of RP4.

151. Based on Evidence 1 and 3, the PRB proposes to include a system resilience buffer defined as the amount of delay that may occur despite the best efforts of ANSPs due to unforeseen sudden local traffic growth or minor issues in the operations of ANSPs. The PRB expects ANSPs to resolve SOG delays by the end of RP3, and to address their remaining capacity issues by 2027 (i.e. within the timeframe of the current NOP). The proposal of the system resilience buffer is based on the assumption that these two expectations are met.

152. For the upper bounds of the target ranges, the PRB proposes a system resilience buffer constant and equal to 0.20 minutes per flight in for the first three years of RP4 (2025, 2026, 2027). The PRB proposes to reduce the system resilience buffer to 0.10 minutes per flight in 2028 and 2029, since ANSPs are expected to resolve their remaining capacity issues by 2027 and to deliver the benefits of the improvement measures in 2028 and 2029.

153. For the lower bound of the target ranges, the PRB proposes a gradual improvement in capacity performance. The PRB expects that the major capacity improvement measures planned by ANSPs will deliver more significant results in 2026 and 2027, and this will be followed by a more organic improvement. Therefore, the system resilience buffer starting at 0.20 minutes per flight in 2025 is proposed to decrease by -0.03 minutes per flight in 2026 and 2027 (i.e. 0.17 in 2026, 0.14 in 2027), and by -0.02 minutes per flight in 2028 and 2029 (i.e. 0.12 in 2028, 0.10 in 2029).

154. The PRB proposes not to include a delay allowance due to the impact of Russia's war of aggression on Ukraine. As presented in Evidence 1, the impact of the war subsided significantly after the first few months following the outbreak of the war, and Member States and ANSPs managed to adapt. While it is not possible to predict the evolution of the conflict, the PRB assumes that ANSPs will had sufficient time to implement any further measures that might be required to mitigate the impacts.

155. The resulting proposed target ranges for the Union-wide target on average en route ATFM delay per flight in RP4 is shown in Table 21.

En route ATFM delay minutes per flight	2025	2026	2027	2028	2029
Allowance for non-ATC disruption delay	*0.03*	*0.03*	*0.03*	*0.03*	*0.03*
Allowance for weather-related delay	*0.27*	*0.27*	*0.27*	*0.27*	*0.27*
System resilience buffer	*0.20*	*0.20*	*0.20*	*0.10*	*0.10*
Targets upper bound	0.50	0.50	0.50	0.40	0.40

En route ATFM delay minutes per flight	2025	2026	2027	2028	2029
Allowance for non-ATC disruption delay	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*
Allowance for weather-related delay	*0.20*	*0.20*	*0.20*	*0.20*	*0.20*
System resilience buffer	*0.20*	*0.17*	*0.14*	*0.12*	*0.10*
Targets lower bound	0.41	0.38	0.35	0.33	0.31

Table 21 - Union-wide capacity target ranges.

5 COST-EFFICIENCY

5.1 *Introduction to the target setting*

156. To define the cost-efficiency target ranges, the PRB has relied on three pieces of Evidence:

- Member States costs forecast;
- PRB costs forecast; and
- Academic study on cost inefficiency (Annex II).

157. The pieces of Evidence are combined, and, after considering the PRB level of ambitions, are the basis for the definition of the baseline values, the Union-wide determined unit costs for RP4, and the related year-on-year targets range.

5.2 *Actual data analysis*

158. Between 2012 (the first year of RP1) and 2022 (the latest available data), total actual costs at Union-wide level remained relatively stable (i.e. -0.1% compound annual growth rate (CAGR)). In contrast, over the same ten-year period, total service units increased at an average of +1.3% CAGR. The combination of these two trends resulted, excluding 2020 and 2021, in a steady reduction in the actual unit cost at Union-wide level, which moved from an average of 70.12$€_{2022}$ in 2012, to an average of 61.38$€_{2022}$ in 2022 (-1.3% CAGR) (Table 22).

	2012	2022	CAGR
Actual costs ($M€_{2022}$)	6,699	6,652	-0.1%
Actual service units (M)	96	108	+1.3%
Actual unit cost ($€_{2022}$)	70.12	61.38	-1.3%

Table 22 - 2012-2022 actual costs, service units, and actual unit cost evolution (source: PRB elaboration).

159. In 2020 and 2021, as a result of the COVID-19 pandemic, the average actual unit costs increased well above the historical values. The unprecedented drop in traffic brought about by the pandemic resulted in a sharp increase in the average unit cost at Union-wide level in both 2020 (+127.26$€_{2022}$, or +128% compared to 2019) and in 2021 (+95.62$€_{2022}$, or +72% compared to 2019).

160. Across the 29 en route charging zones, actual costs evolved rather homogenously, ranging from a minimum of -2.5% CAGR reduction, recorded by Latvia, to a maximum of +3.2% CAGR increase for Bulgaria. All the largest charging zones, with the exceptions of France (+0.4% CAGR), experienced a moderate reduction in costs between 2012 and 2022.

161. The ten-year evolution in the number of service units presents a more varied picture, especially considering the impact brought by Russia's war of aggression against Ukraine, which hampered the post pandemic traffic recovery in certain areas. Specifically, while Member States such as Bulgaria (+6.7% CAGR), Hungary (+4.6% CAGR), and Greece (+3.9%) experienced, on average, a steady increase in service units over the last ten years, other Member States such as Estonia (-5.1% CAGR), Latvia (-4.1% CAGR), and Finland (-2.8% CAGR), recorded actual 2022 service units well below the 2012 levels.

162. ANSPs, which account for about 90% of the total cost-base, are the entities explaining the evolution of costs at Union-wide level. Over the 2012-2022 period, total ANSP costs remained stable (-0.01% CAGR). This is the result of two different trends: First a progressive increase in ANSPs' costs over the RP2 period, and then followed by a reduction in 2020 and in 2021. The reduction reflected the fact that many ANSPs implemented cost-cutting measures in response to the COVID-19 pandemic. In summary, the total 2022 ANSP costs fell to their initial 2012 level.

163. While both MET service providers and Eurocontrol reduced their costs consistently during the entire period (-1.9% CAGR, and -0.8% CAGR respectively), NSAs exhibited an increasing trend in costs continuing throughout RP2 and RP3 (+3.3% CAGR). However, the increase in NSA costs has had a negligible impact on the Union-wide trend, as they represent 1% of the total cost-base (Figure 10, next page).

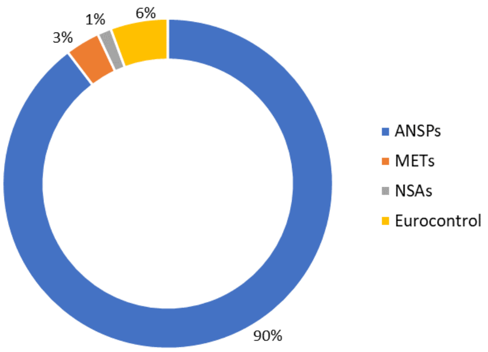

Figure 10 - 2012-2022 average proportion of costs across ANSPs, MET service providers, NSAs, and Eurocontrol (source: PRB elaboration).

164. In terms of cost categories, the analysis of actual 2012-2022 data shows the following (Figure 11):[21]

- Staff costs, which account on average for 64% of the total cost-base at Union-wide level, remained constant over the 2012-2022 period. The steady increase observed during RP2 (+4.2% between 2015 and 2019), was fully compensated by a strong reduction in both 2020 and 2021 (actual 2021 costs -8.4% below the 2019 actual costs).
- Other operating costs (on average, 22% of the total Union-wide costs) is the single cost category that consistently reduced over the last ten-year period. Actual 2022 other operating costs were -3.2% lower than in 2012 (-0.3% CAGR).
- Depreciation costs, which account for about 10% of the total costs, present a relatively stable trend over the 2012-2022 period (-0.1% CAGR). Towards the end of RP2 (2018-2019), depreciation costs recorded an increase over the 2012 value, which was subsequently compensated by a reduction in 2020 and 2021.
- Cost of capital is the category which presents the highest degree of variability (although the 2022 actual value remains close to the 2012 cost). The PRB notes that this is strongly influenced by the inconsistent reporting of cost of capital values by several ANSPs. This variability has a relatively minor impact on the overall trend, as the cost of capital represents some 4% of the total costs at Union-wide level.

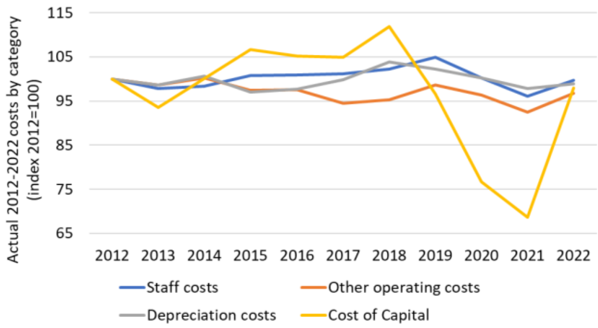

Figure 11 - 2012-2022 evolution of costs by category (index 100=2012) (source: PRB elaboration).

165. In addition to the cost evolution mentioned above, the PRB notes that, during both RP1 and RP2, actual costs were below their respective determined values, with ANSPs making the greatest contribution to this result. While during RP1 savings were mostly the result of lower staff costs, in RP2 the difference between actual and determined costs was largely due to lower other operating costs and depreciation costs.

166. Over RP2, ANSPs and METs achieved, at an aggregated level, a regulatory result (i.e. RR) of 2.9B€$_{2022}$ (on average, 0.6B€$_{2022}$ per year), which represents about 8.8% (ranging between a minimum of 7.4% in 2019 and a maximum of 10.1% in 2017) of the actual revenues generated over the same period.[22] In addition to the 1.5B€$_{2022}$ embedded in the actual return on equity (RoE), ANSPs and METs achieved a net gain from the en route activity of 1.4B€$_{2022}$ (0.7B€$_{2022}$ from the application of the cost sharing mechanism and 0.7B€$_{2022}$ related to the traffic risk sharing (TRS)). The impact of the financial incentives related to capacity is negligible (a total of 18M€$_{2022}$ of bonuses gained over the five years) (Figure 12, next page).

[21] The exceptional costs and the deduction of costs incurred for services provided to exempted VFR flights are excluded from the figure due to their negligible impact on the trend (less than 1%).

[22] The regulatory result corresponds to the revenues (or losses) generated by the activities of a specific year that exceed (or are lower than) the direct and indirect operating costs of an ANSP, and so provide for a reasonable return on assets to contribute towards necessary capital improvements. The regulatory results should be associated to a "margin" generated by the ANSPs with respect to the activity of the year but should not be considered or be compared to the financial profit/loss margin from financial statements as its calculation does not take account items such as taxes, capital expenditure, or dividend payments.

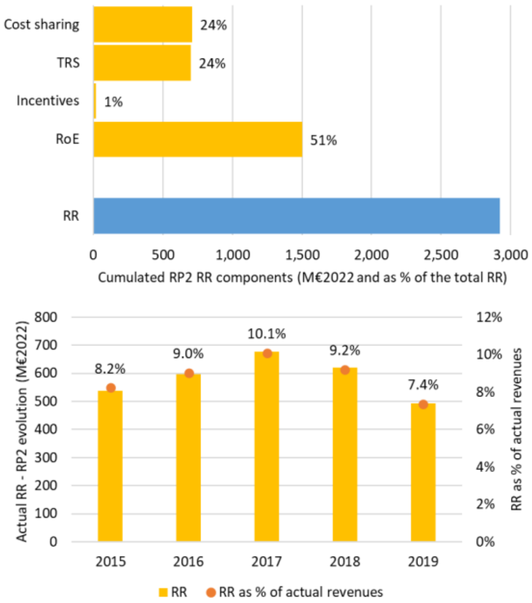

Figure 12 - Evolution of RP2 regulatory result and its components (M€$_{2022}$ and as % of actual revenues) (source: PRB elaboration).

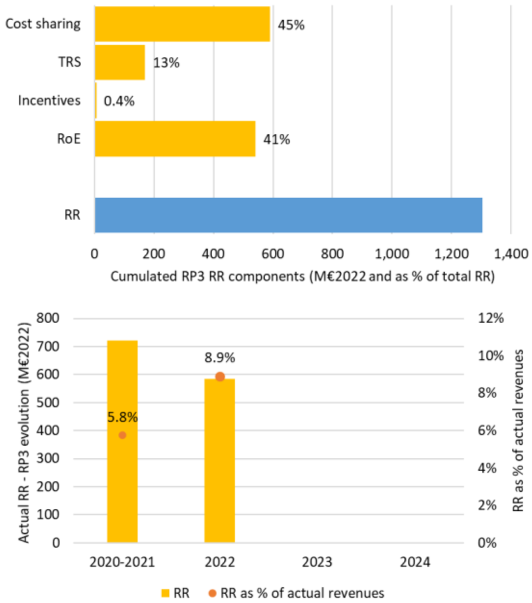

Figure 13 - Evolution of RP3 regulatory result and its components (M€$_{2022}$ and as % of actual revenues) (source: PRB elaboration).

167. The RP3 actual RR to date amounts to 1.3B€$_{2022}$ (i.e. 0.7B€$_{2022}$ for the combined year 2020-2021 and 0.6B€$_{2022}$ for 2022), which represent about 6.8% (5.8% for the combined year 2020-2021 and 8.9% in 2022) of the actual revenues collected over the three years. The most significant element contributing to the achieved RR is the net gains from the application of the cost sharing mechanism (0.6B€$_{2022}$), particularly influenced by the significant inflation adjustment recorded in 2022, followed by the embedded RoE in value (0.5B€$_{2022}$) (Figure 13).

5.3 Evidence 1 – Member States costs forecast

168. As defined by the Regulation, the NSAs are requested to provide the Commission, no later than 19 months before the start of a reference period, initial cost data and information about traffic related to the upcoming reference period, as inputs for the setting of Union-wide performance targets. This section presents the aggregation of the data submitted in June 2023 by the NSAs.

169. In some instances, data sets provided by the NSAs were missing key elements needed for proper aggregation at system level and the PRB had to make some assumptions to complete the data set. The summary of the PRB assumptions is provided in Table 23 (next page).

Charging zones	Missing data	PRB adjustment
Norway	Complementary information on the cost of capital for the ANSP	Assumptions: 10.8% RoE, 2.95% interest on debt, 40% share of financing through equity.
Ireland	Complementary information on the cost of capital for the ANSP	Assumptions: 100% share of financing through equity.
Netherlands	Complementary information on the cost of capital for the ANSP	Assumptions: 50% share of financing through equity.
Malta	Missing Eurocontrol costs	Eurocontrol costs forecast 2024-2029 dated May 2023.
	Inflation rates and index	IMF forecast dated April 2023.
	Complementary information on the cost of capital for the ANSP	Assumptions: 8% RoE, 2% interest on debt, 98% share of financing through equity.
Czech Republic	MET provider inflation index	IMF forecast dated April 2023.
Denmark	MET provider inflation index	IMF forecast dated April 2023.
Slovakia	Missing Eurocontrol costs	Eurocontrol costs forecast 2024-2029 dated May 2023.

Table 23 – Adjustments/corrections made to the revised initial data for RP4 received by the NSAs (source: PRB elaboration).

170. The unit costs derived from the initial data submitted (i.e. costs, inflation rates, traffic forecast) by the NSAs increase from 54.08€$_{2022}$ in 2024 (the last year of RP3) to 55.96€$_{2022}$ in 2029, the last year of RP4 (Table 24).[23]

171. Compared to the 2022 actuals, the unit costs as submitted by the Member States are lower for each year of RP4 (Figure 14).

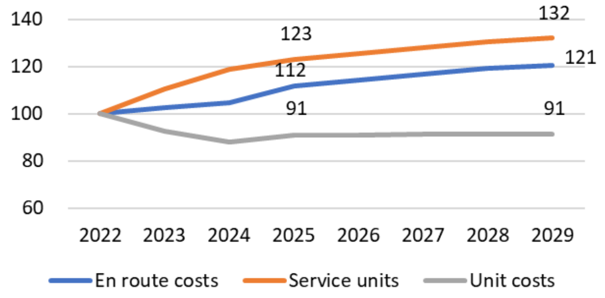

Figure 14 - Member States forecasts, index 100 in 2022. (source: PRB elaboration).

172. To evaluate the robustness of the initial RP4 data provided by the Member States, the PRB has analysed the difference between the initial RP3 data, as provided in December 2020 ahead of the draft revised performance plan process, and the determined data included in the RP3 draft revised performance plans:[24]

- In terms of costs, the initial data provided by the Member States present a trend consistently above the determined costs from the RP3 performance plans. This gap, which amounted to 250M€$_{2022}$ in 2020, widened to reach 565M€$_{2022}$ (+7.3%) in 2024 (Figure 15, next page).
- In terms of traffic forecast, the 2024 determined service units included in the adopted revised RP3 plans are expected to be +10.6% above the value originally forecast in the initial RP3 data submission for 2024.

	Union-wide en route costs – States submission (M€$_{2022}$)						CAGR 2024-2029
	2024	2025	2026	2027	2028	2029	
Costs (M€$_{2022}$)	6,959	7,433	7,603	7,774	7,932	8,023	+2.9%
Service units (M)	129	133	136	139	141	143	+2.2%
Unit costs (€$_{2022}$)	54.08	55.85	55.87	56.05	56.13	55.96	+0.7%

Table 24 – Aggregation of Member States forecasts (source: PRB elaboration).

[23] Values are including the PRB adjustments specified in Table 23.
[24] A similar analysis has been conducted also in respect of the initial data provided in the context of the original RP3 target setting process, which led to the submission of RP3 plans in autumn 2019. However, considering that the original RP3 assessment process was halted because of the COVID-19 outbreak at the beginning of 2020, this analysis is considered as not representative.

173. As a result of these two different trends in both costs and service units between the initial RP3 data and the RP3 performance plans, the initial forecast 2024 DUC at Union-wide level (65.82€$_{2022}$) was +16% higher than the RP3 performance plans (55.16€$_{2022}$). This indicates that the initial cost data was overestimated by Member States, while traffic expectations were still strongly affected by the uncertainty concerning the post-COVID recovery.

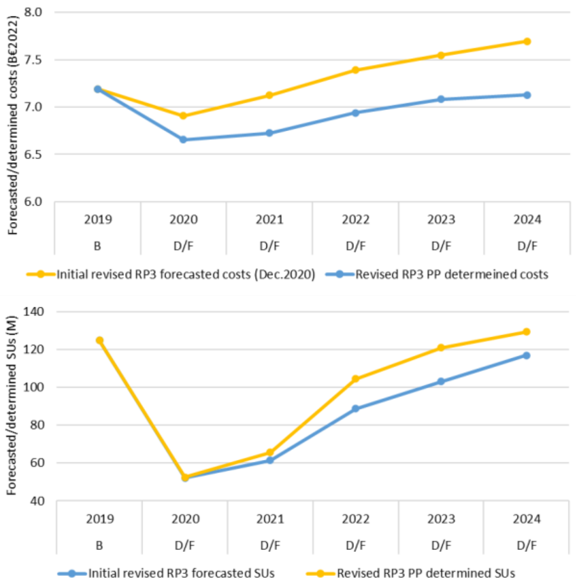

Figure 15 – Comparison between initial revised RP3 data and RP3 performance plans data for costs (figure above) and service units (figure below) (source: PRB elaboration).

Initial data for the remaining years of RP3 (2024 baseline)

174. The initial cost and traffic data reported for the two remaining years of RP3 (2023 and 2024) include a mix of determined and revised forecast data:

- In respect of the costs, Cyprus and Bulgaria have reported the determined costs from their RP3 performance plans at charging zone level in nominal terms but have associated them with a revised inflation forecast. It is also the case for the following entities: DFS (Germany), HASP (Greece) and LGS (Latvia) and some MET providers. This may have a impact on the level of the 2024 forecast costs, which could be artificially lower in real terms than they were in the performance plans. Belgium-Luxembourg have also reported the determined costs from their draft RP3 performance plans both in real and nominal terms, as reported with the inflation forecast associated with the determined costs.
- In respect of traffic, most Member States have reported service unit forecasts in line with the STATFOR March 2023 base forecast. In four charging zones, Member States have reported the determined service units from their RP3 performance plans (Belgium-Luxembourg, Cyprus, and Bulgaria for both 2023 and 2024, and Lithuania for 2023 only). For some, the initial data presents slightly higher services units than the STATFOR March 2023 base forecast, while in others it is the opposite. In three charging zones (Portugal, Finland, and Norway) the service units forecast has been revised for 2023 and 2024 compared to their performance plans but differs from the STATFOR March 2023 base forecast (while for the first two the initial data were slightly lower, for the latter the initial data was slightly higher). At Union-wide level, the difference between the Member States' initial data and the STATFOR March 2023 base forecast is negligible (-0.7% lower for each year).

175. Given the above, the PRB concludes that the 2024 aggregated unit cost as submitted by the Member States may be underestimated.

176. The 2024 forecast costs provided by the States are higher by +4.6% than the actual costs 2022 (+304M€$_{2022}$), while the forecast service units 2024 show an increase of +19% compared to 2022 actuals. This results in a forecast unit cost for 2024 which is significantly lower (-12%) than the actual unit cost 2022 (Table 25).

	2022	2024	Variation	CAGR
Costs (M€$_{2022}$)	6,652	6,959	+4.6%	+2.3%
Service units (M)	108	129	+19%	+9.0%
Unit costs (€$_{2022}$)	61.38	54.08	-12%	-6.1%

Table 25 – Aggregation of Member States cost forecasts 2024 vs 2022 actuals (source: PRB elaboration).

177. The main contributors to the increase in costs (+304M€$_{2022}$) are: Romania (+55M€$_{2022}$), the Netherlands (+33M€$_{2022}$), Italy (+31M€$_{2022}$), Greece

(+30M€$_{2022}$), and Portugal (+28M€$_{2022}$), all of which also have significant increases in forecast service units (more than +15%). The 2024 forecast costs are lower than the 2022 actuals in four charging zones: Germany (-34M€$_{2022}$), Spain Continental (-16M€$_{2022}$), Sweden (-11M€$_{2022}$), and Spain Canarias (-5M€$_{2022}$), all of which had higher actual 2020 costs than planned in their performance plans.

178. In terms of service units, strong increases are forecast in all charging zones, ranging from +7% to +32% for the two-year period.

Initial data for RP4

179. The Member States were required to use the latest inflation forecast from IMF (April 2023) to compute their cost forecasts. All bar three complied. Of the three, Bulgaria and Italy used a local forecast (higher than the IMF April forecast) and Croatia used different figures (lower than the IMF April forecast), although it reported to have used the IMF April 2023 forecast.[25]

180. In respect of the traffic forecast, the Member States were required to use the latest available base forecast from STATFOR (March 2023). All of them did, except for Bulgaria which used a local forecast (higher than the STATFOR March 2023 base forecast).[26] For Germany, the STATFOR figure includes service units for flight segments performed as Operational Air Traffic, which are then deducted for the setting of the cost-efficiency targets and unit rates.[27] At Union-wide level, the difference between the Member States initial traffic data and the STATFOR March 2023 base forecast is negligible (+0.4% in 2029).

181. Overall, over RP4, the forecast unit cost shows a slight increase by +3.5% (or by +0.7% per year on average), as costs are forecast to increase by +15% over the period (or +2.9% per year on average), while the number of service units is forecast to increase by +11% (or +2.2% per year on average) (Table 26).

	2024	2029	Variation	CAGR
Costs (M€$_{2022}$)	6,959	8,023	+15%	+2.9%
Service units (M)	129	143	+11%	+2.2%
Unit costs (€$_{2022}$)	54.08	55.96	+3.5%	+0.7%

Table 26 – Aggregation of Member States cost forecasts 2029 vs 2024 forecasts (source: PRB elaboration).

182. At local level, costs and service units are forecast to increase over RP4. In ten charging zones, the unit cost is forecast to decrease over RP4, as the estimated increase in service units outweighs the estimated increase in real en route costs. In the remaining 19 charging zones, the unit cost is forecast to increase over RP4, as the estimated increase in costs is greater than that for service units. The largest average annual increases in unit costs are observed in Romania (+8.3%), Latvia (+4.8%), Hungary (+4.1%), Germany (+3.5%), Estonia (+3.3%), and Poland (+2.5%).

183. The difference in costs between 2024 and 2029 forecasts amounts to +1,064M€$_{2022}$. The main contributors to this increase are: Germany (+267M€$_{2022}$), Romania (+175M€$_{2022}$), France (+84M€$_{2022}$), Poland (+54M€$_{2022}$), Bulgaria (+51M€$_{2022}$), the Netherlands (+39M€$_{2022}$), Italy (+39M€$_{2022}$), and Hungary (+37M€$_{2022}$). These eight charging zones account for 70% of the increase.

Analysis of the 2029 initial forecast data compared to the actual 2022 data (latest available actual data)

184. The aggregation of the initial cost data indicates an increase from 6,652M€$_{2022}$ in 2022 (the latest available actual data) to 8,023M€$_{2022}$ in the last year of RP4 (CAGR +2.7%), which is lower than the increase in service units forecast for the same period (CAGR +4.1%). This results in a decrease of -1.3% per year on average in the unit costs between 2022 and 2029 (Table 27, next page).

[25] For Bulgaria, higher by 5.1 pp by 2029. For Italy, higher by 1.4 pp by 2029. For Croatia, lower by -2.1 pp by 2029.
[26] For Bulgaria, higher by 12% by 2029.
[27] 152 thousand service units per year, representing around 1% of the total en route service units for Germany.

	2022	2029	Variation	CAGR
Costs (M€2022)	6,652	8,023	+21%	+2.7%
Service units (M)	108	143	+32%	+4.1%
Unit costs (€2022)	61.38	55.96	-9%	-1.3%

Table 27 – Aggregation of Member States cost forecasts 2029 vs 2022 actuals (source: PRB elaboration).

185. The increase in staff costs between 2022 actuals and 2029 forecasts (+733M€2022, or +17%) accounts for more than half of the total increase (Table 28). The increase in depreciation (+279M€2022, or +43%) and the cost of capital (+247M€2022, or +87%) account for nearly 40% of the total increase. Although some of the Member States' submissions provide some information on SESAR deployment costs and benefits expected for RP4, it is not clear to what extent these have been reflected in the overall Member States' forecasts at system level.

186. The aggregated RoE forecast for the main ANSPs in RP4, and included in the cost of capital, ranges from 5.1% in 2025 to 6.0% in 2029, a significant increase from the 3.0% applied for 2022 in the performance plans.

Costs (M€2022)	2022	2029	Variation	CAGR
Staff	4,271	5,005	+17%	+2.3%
Other operating	1,470	1,582	+8%	+1.1%
Depreciation	643	921	+43%	+5.3%
Cost of capital	283	530	+87%	+9.4%
Exceptional items	5	7	+44%	+5.3%
Exempted VFR	21	22	+7%	+1.0%
Total costs	**6,652**	**8,023**	**+21%**	**+2.7%**

Table 28– Aggregation of Member States cost forecasts by nature 2029 vs 2022 actuals (in M€2022) (source: PRB elaboration).

187. At local level, the unit costs show a decrease between 2022 actual and 2029 forecasts for 17 charging zones. The largest decrease is observed for Spain (Continental and Canarias), as costs are expected to be close to 2022 actual levels, despite an average annual increase in service units of +4-5%. (Figure 16, next page). For the other 12 charging zones, costs are forecast to increase more than the traffic in service units between 2022 and 2029. The most significant increase is reported by Romania, with a forecast average annual increase of +6%, due to an average increase in costs of +11% p.a., which exceeds the forecast traffic increase. This increase is principally due to a significant increase in staff costs by +121% over the 7-year period, or +12.0% p.a. on average, mainly due to the recruitment and training of ATCOs while the ageing ATCOs are only starting to retire. Romania indicates that "*there are no major operational or structural changes foreseen for RP4*".

188. At Union-wide level, the cost forecasts submitted by the Member States (+2.7% CAGR from 2022 actuals to 2029- forecasts) depart from the relatively stable costs observed between 2012 and 2022 despite significant traffic variations. The PRB analysis of the differences between the initial RP3 data and the current RP3 plans showed that the Member States overestimated the initial cost data by +7.3% by the end of RP3. The 2029 forecast costs from the Member States' submissions should be considered as the maximum cost envelope before considering any inefficiency gap reduction.

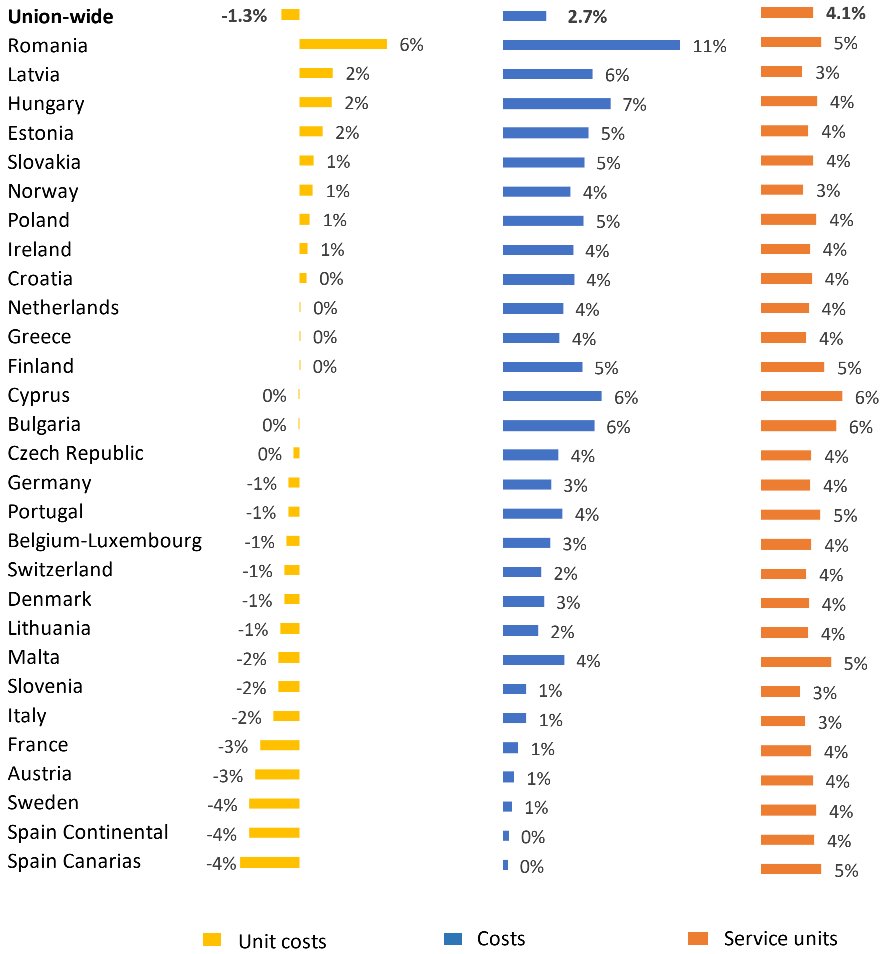

Figure 16- Member States forecasts, CAGR variations in unit costs, costs, and service units 2022-2029, per en route charging zone (source: PRB elaboration).

5.4 Evidence 2 – PRB costs forecast

Data and variables

189. The PRB cost forecasts are based on a statistical analysis of the historical actual costs. The level of observations are the charging zones considered for the period 2012 to 2019. The years from 2020 to 2022 have been excluded from the analysis; they are considered exceptional years, due to the impact of the pandemic. A total of 233 observations have been considered in the analysis.

190. The variables included and combined in different models are:

- Total real actual costs for each charging zone, excluding the exceptional items cost category, costs for exempted VFR flights, NSA and Eurocontrol costs;
- Real actual staff and other operating costs for each charging zone, excluding NSAs and Eurocontrol costs;
- Real actual depreciation and cost of capital for each charging zone, excluding NSAs and Eurocontrol costs;
- Actual IFR movements for each charging zone;
- Actual service units for each charging zone (in M3); and
- Actual sector opening hours for each charging zone.

191. All cost variables have been expressed in euros and converted in €$_{2022}$ real values following the Regulation rules. Inflation rate values are the annual average Consumer Price Index change (in percentage) published by the IMF in April 2023. The average 2022 exchange rates used for non-euro currencies are the average of the daily "Closing Rates" calculated by Reuters based on daily bid rates.

192. As the aim is to forecast Union-wide costs for the years 2024-2029, the models only include variables that can be forecast for this period. The PRB recognises that other variables (e.g. complexity, FTEs and flight hour controlled) may better explain the evolution of costs, however no reliable or complete forecasts for each year of RP4 are available.

Models

193. Two sets of models have been estimated:

- Set 1 includes as dependent variable the total costs in euros 2022 (without exceptional costs, cost for exempted VFR flights, NSA and Eurocontrol costs).
- Set 2 includes as dependent variable a decomposition of the actual costs, in euros 2022, in two sub-categories: Staff and other operating costs, and depreciation and cost of capital.

194. For each of the two sets, three models have been estimated considering as explanatory variables: (i) the service units, (ii) the IFR movements, (iii) the sector opening hours. The PRB has also estimated models including the squared value of the explanatory variables, a set of dummies to control for the size, time and locations. However, none of the approaches resulted in statistically significant results.

195. All the models have been estimated with fixed effects (i.e. the charging zone) applying a panel estimator (i.e. controlling for the time).[28] The fixed effect models explore the relationship between dependent and explanatory variables taking the individual characteristics of each entity into account (i.e. the charging zones). Characteristics not captured through specific variables are included in the estimation and quantified within the specific intercept value. All models consider the natural logarithm of the variables and have been tested for the standard statistical assumptions.

[28] Fixed effects vs Random effects have been tested with Hausman test.

196. The results of the models are shown in Table 29. The Set 1 models (based on service units and IFR movements) show a low but not negligible R^2 value. This means that despite the low predictive power of the variables, the models are retained for the forecast. Both service units and IFR movements show a positive and significant coefficient. An increase of 1% in service units is, on average, increasing the total costs by 0.33%, while an increase of 1% in IFR movements is, on average, increasing the total costs by 0.39%.[29] The Set 1 model (based on the sector opening hours) shows a negligible predictive power, and the coefficients estimated are not significant. Therefore, the model using sector opening hours as explanatory variable is discarded.

197. When analysing the Set 2 models, the results show that none of the variables are significant in the models with the dependent variable as depreciation and cost of capital (models with time lags have been estimated to consider the investment planning, but none of those show statistically significant results). Therefore, the Set 2 models have been discarded.

Forecast

198. The results obtained from the Set 1 models are applied to forecast the costs for the years 2024 to 2029. As the models considered data up to and including 2019, the underlying assumption is that the manner of operations for ANSPs during RP3 has not changed when compared to the previous years. Despite the significant decrease of traffic due to COVID-19 pandemic, it appears that ANSPs did not fully adapt and did not implement innovative or radical change within their operation. The results of the estimated models can be used for forecasting.

199. To forecast costs from 2024 to 2029, the forecasts for IFR movements and service units for each charging zone (STATFOR March 2023 base) have been applied to the coefficients resulting from the Set 1 models.[30] As the models are considering actual data up to and including 2019, any change in the costs resulting from a change of scope between RP2 and RP3 is not included in the results of the model. To correct for this, the adjustments of the cost base in the approved RP3 performance plans have been added to the costs for each year forecast.

		Set 1	Set 2	
	Variables	Total costs	Staff+other operating costs	Deprecia-tion+cost of capital
Service Units	Ln(SUs)	0.33***	0.38***	0.07
	R^2	*0.19*	*0.23*	*0.00*
IFR move-ments	Ln(IFR_mov)	0.39***	0.45***	0.00
	R^2	*0.19*	*0.25*	*0.00*
Sector opening hours	Ln(Soh)	0.18***	0.20	0.09
	R^2	*0.04*	*0.05*	*0.00*

*Table 29 – Estimation of the two set of models. The models that are retained for the analysis are underlined. Significant levels: 1% ***, 5% **, 10% *.*

[29] The intercept values are not shown for the sake of brevity. They can be provided upon request to prb-office@prb.eusinglesky.eu.

[30] The STATFOR base forecast for Germany has been modified by deducting the OAT flights, 152,000 service unit for each year.

200. The actual total cost data used to estimate the Set 1 models does not include exceptional costs and costs for exempted VFR flights, NSA, and Eurocontrol. To account for these costs, the values as provided by the Member States in the initial data submission have been added to the forecast costs for each year.

201. The forecast Union-wide costs, applying the Set 1 models for service units and IFR movements and all the adjustments, are shown in Table 30. The two series of forecast costs are quite similar in each year; differing on average by 0.5% (i.e. 36M€$_{2022}$). The forecast Union-wide costs for 2024 are between 7,173M€$_{2022}$, and 7,206M€$_{2022}$, increasing to 7,471M€$_{2022}$ and 7,513M€$_{2022}$ in 2029, respectively (CAGR +0.8% for both the forecast).

202. The two forecasts at Union-wide level are relatively similar to the aggregation of the submissions of the Member States (Evidence 1). Both forecasts are 3% above the submissions of the Member States in 2024, and 7% below in 2029. The main differences, especially for 2029 are stemming from a small number of Member States, notably Belgium-Luxembourg, Bulgaria, Cyprus. Hungary, and Romania. These countries submitted the highest increase against the actual costs 2022 (Evidence 1).

	2024	2025	2026	2027	2028	2029
	Set 1 – Forecast based on service units (M€$_{2022}$)					
Model forecast	6,620	6,681	6,728	6,767	6,807	6,835
	Set 1 – Forecast based on IFR movements (M€$_{2022}$)					
Model forecast	6,588	6,649	6,694	6,732	6,770	6,793
	Costs as provided by Member States (M€$_{2022}$)					
Exceptional cost	-16	2	4	5	7	7
Exempted VFR cost	-22	-22	-22	-22	-22	-22
NSA ECTL costs	514	548	565	575	578	581
	RP3 baseline values adjustments (M€$_{2022}$)					
Baseline RP3	110	110	110	110	110	110
	Union-wide total cost RP4 forecasts (M€$_{2022}$)					
Forecast (SU based)	7,206	7,319	7,385	7,436	7,481	7,513
Forecast (IFR based)	7,173	7,287	7,351	7,400	7,444	7,471

Table 30 – Union-wide cost forecast based on Set 1 models results (Service units and IFR movement models). The forecast costs are expressed in real term and include the baseline adjustments of each of the Member States as for RP3 performance plans, and considers exceptional costs, exempted VFR costs, and NSA and Eurocontrol costs as submitted by the Member States.

5.5 Evidence 3 – Academic study on cost inefficiency

203. To identify the cost base inefficiency, the PRB commissioned a benchmarking study from a group of Academics (Annex II). The study developed and combined two benchmarking models which are well recognised in the scientific domain and are applied to regulated industries. One model is based on data envelopment analysis (DEA) and the other is based on stochastic frontier analysis (SFA). The models define the percentage of costs that an entity (i.e. the ANSPs) can reduce compared to the best performers.

204. The results show that the weighted average of inefficiency of the cost base is between the range of 11% to 21%, depending on the model applied. The study recommends applying a middle point of intervals to balance advantages and disadvantages of two modeling approaches, defining a 16% average Union-wide inefficiency.

205. The results are based on historical data (up to and including 2019). Despite the significant decrease of traffic due to the COVID-19 pandemic, ANSPs did not fully adapt their cost base and did not implement innovative or radical changes within their operation. On this basis, the PRB assumes that the estimated inefficiency in the cost base remained unchanged during RP3 (as highlighted in the historical data analysis), and that the results can be applied to the RP4 cost base.

206. Given that the RP4 priority for cost-efficiency is to facilitate the delivery of the capacity targets to achieve the environmental targets, the PRB proposes to recover a proportionate share of the inefficiency in the ANSPs cost base by the end of RP4. The PRB proposes to consider the average of 16% of inefficiency, and to recover 1/3 (5%) of it for the upper bound of the targets, while 2/3 (10%) of it for the lower bound of the targets. The inefficiency not recovered in RP4 should be considered as extra means to improve operational performances.

5.6 Combining the Evidence

207. The three cost-efficiency pieces of Evidence are combined to calculate the ranges of the year-on-year change of the Union-wide average determined unit cost. The RP4 priority for cost-efficiency is to facilitate the delivery of the capacity targets to achieve the environmental targets. The PRB proposes that this should be implemented while gradually improving the efficiency of the cost base. Accordingly, the yearly target ranges for cost-efficiency should be constant over the period. This allows for a gradual improvement as defined most adequate by the PRB.

208. To calculate the year-on-year change of the Union-wide determined unit cost, the PRB applies the CAGR (i.e. the average change) between the baseline values for 2024 (i.e. the starting point) and the determined unit costs for 2029 (i.e. the end point).[31]

209. All the calculations have been carried out to include all the digits and decimals. Values displayed in the tables (e.g. costs, service units) are rounded for the sake of readability.

2024 baseline values

210. As defined by the Regulation, both a Union-wide baseline value for the determined costs and a Union-wide baseline value for the determined unit costs should be defined in respect to the year preceding the start of the reference period (i.e. 2024). The PRB considered four baseline values, calculated by dividing the 2024 costs estimated in the evidences by the 2024 STATFOR base forecast.[32] The Member States' submissions for 2024 may have been underestimated for some, while for others the forecast costs are more accurate and reflect the latest available data.[33] In order to eliminate the bias of the underestimated data and capture at the same time the latest available costs

[31] The compounded annual growth rate (CAGR) is calculated following this formula $CAGR = \left(\frac{end\ point}{start\ point}\right)^{\left(\frac{1}{end\ year - start\ year}\right)} - 1.$

[32] As defined by Article 9 of the Regulation, to calculate the cost-efficiency targets the latest available STATFOR base forecast should be used.

[33] In particular for those Member States not having updated the 2024 nominal costs from the RP3 plans, while having updated upwards both the service units forecast and the inflation index.

forecasts, the PRB calculated a baseline based on the sum of the maximum costs per Member State (i.e. the maximum costs between Evidence 1 and 2 for each Member State separately). The summary of the baseline considered is presented in Table 31.

	2024 Costs (M€$_{2022}$)	2024 Service units (M)	2024 Unit cost (€$_{2022}$)
Evidence 1 – Member States submission	6,959	129	53.77
Evidence 2 – SU based forecast	7,206	129	55.68
Evidence 2 – IFR based forecast	7,173	129	55.42
Max of evidence 1 and 2	7,452	129	57.58

Table 31 – 2024 baseline values as estimated from the cost-efficiency evidence.

211. Considering the potential bias of each evidence, the PRB recommends, as 2024 baseline, the average between the four values estimated. The resulting 2024 unit cost baseline equals **55.61€$_{2022}$**.[34]

212. In advising the Commission on the cost-efficiency targets for RP4, the PRB proposes to revise the baseline values in light of the new traffic forecast, the new inflation forecast, the latest available information, and the outcomes of the stakeholder consultation.

2029 determined unit cost

213. The determined costs for 2029 have been estimated in Evidence 1 and 2 as follows:

- Evidence 1 - 2029 Union-wide costs: 8,023M€$_{2022}$;
- Evidence 2 SU based forecast – 2029 Union-wide costs: 7,512M€$_{2022}$; and
- Evidence 2 IFR based forecast - 2029 Union-wide costs: 7,471M€$_{2022}$.

For the calculation of the upper bound of the target ranges, the highest of the estimated values has been selected (i.e. 8,023M€$_{2022}$ from Evidence 1 – Member States submission). Using the highest end point allows for the calculation of the lowest, less ambitious year-on-year change. Conversely, for the calculation of the lower bound of the target ranges, the lowest of the estimated values has been selected (i.e. 7,471M€$_{2022}$ from Evidence 2 – IFR based forecast). Using the lowest end point allows for the calculation of more ambitious year-on-year change.

214. Evidence 3 provides information on the level of inefficiency in the ANSPs' cost bases (16% of the Union-wide cost base). In line with the priorities defined in the main report, the PRB proposes a gradual improvement in the cost-efficiency KPA, which in the less ambitious scenario should recover 5% of the inefficiency in the cost base by the end of RP4 (i.e. 1/3 of the estimated inefficiency), and the more ambitious scenario should recover 10% by the end of RP4 (i.e. 2/3 of the estimated inefficiency). Given that the cost inefficiency from Evidence 3 is estimated on the ANSPs costs, the percentage is applied only to a part of the cost base (i.e. NSAs and ECTL costs are not reduced). Dividing the resulting cost bases by the 2029 Union-wide service units as forecast by STATFOR base scenario, the 2029 unit costs for the upper and lower bounds of the targets are as in Table 32 (next page).[35]

215. As described in the main report, for both the upper and the lower bounds, the PRB proposal allows for the retention of certain inefficiencies in the ANSPs' cost bases. These amount to 746M€$_{2022}$ for the upper bound of the target ranges, and 345M€$_{2022}$ for the lower bound of the target ranges, in 2029. The PRB fully expects that Member States transform these cost inefficiencies into measures to demonstrably improve the

[34] The 2024 costs corresponding the unit cost baseline equals 7,198M€$_{2022}$.

[35] As defined by Article 9 of the Regulation, the latest available STATFOR base forecast should be used in order to calculate cost-efficiency targets.

operational performances leading to improved capacity and environmental outcomes.

Upper bound 2029	
Evidence 1 – 2029 Member States submission costs	8,023M€$_{2022}$
5% efficiency gain	-373M€$_{2022}$
2029 Union-wide costs	7,650M€$_{2022}$
2029 Service units (M)	143
2029 upper bound unit cost	**53.58€$_{2022}$**

Lower bound 2029	
Evidence 2 – 2029 IFR based forecast costs	7,471M€$_{2022}$
10% efficiency gain	-691M€$_{2022}$
2029 Union-wide costs	6,780M€$_{2022}$
2029 Service units (M)	143
2029 lower bound unit cost	**47.49€$_{2022}$**

Table 32 - Upper and lower bound 2029 unit cost.

Target ranges

216. To determine the target ranges, the 2024 baseline for the unit costs and the unit costs for 2029, for both the upper and lower bounds were included in the CAGR formula.

217. The target proposed as upper bound is a year-on-year decrease of the unit cost by -0.7%, while the target proposed as lower bound is a -3.1% year-on-year decrease (Table 33). The targets should be applied equally for each year of RP4.

Union-wide cost-efficiency target ranges					
2024 baseline	55.61€$_{2022}$ / 7,198M€$_{2022}$				
y-o-y change of Union-wide determined unit costs	2025	2026	2027	2028	2029
Targets upper bound	-0.7%	-0.7%	-0.7%	-0.7%	-0.7%
Targets lower bound	-3.1%	-3.1%	-3.1%	-3.1%	-3.1%

Table 33 - Union-wide cost-efficiency target ranges.