Performance review body of the single european sky

EU-wide target ranges for RP 3

Annex 1. D412 - EUROCONTROL evidence for establishing the EU-wide RP3 targets

13 June 2018

Performance Review Body of the Single European Sky | Rond-Point Schuman 6, 4th Floor, Office 411, B-1040 Brussels
Office Telephone: +32 (0)2 234 7824 | prb-office@prb.eusinglesky.eu | webgate.ec.europa.eu/eusinglesky

D412 - EUROCONTROL evidence for establishing the EU-wide RP3 targets

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1 Introduction

This document presents a set of evidences provided by EUROCONTROL to the European Commission, and through it to the Performance Review Body (PRB), in the preparation of EU-wide target setting for the RP3 reference period.

The work has been performed under Task 4.1.1 of the Service Contract with the EC, and is delivered as deliverable D412. This version (V.2) complements the evidences provided in Version 1 (27/04/18) with additional sets of evidence based on historic and forward-looking data.

1.1 Geographical scope

According to Article 1(1) of the performance Regulation (EU) No 390/2013 [1], the scheme applies to airspace in the EUR and AFI ICAO regions of EU Member States where they are responsible for the provision of air navigation services.

Member States may decide to include airspace under their responsibility within other ICAO regions.

This document is based on the assumption that the scope of the performance scheme for RP3 remains EU28 plus Norway and Switzerland, as illustrated in Figure 1.

Figure 1: Geographical scope for RP2

2 CONTEXT

2.1 Air traffic demand

2.1.1 Air traffic indicators

Several air traffic indicators can be used when analysing ANS performance, mainly flights/movements[1], flight hours and service units (SU[2]). They are most relevant for terminal/airport traffic, en-route traffic and route charges respectively.

Their evolution over time in Europe [2] is markedly different[3], as can be seen in Figure 2.

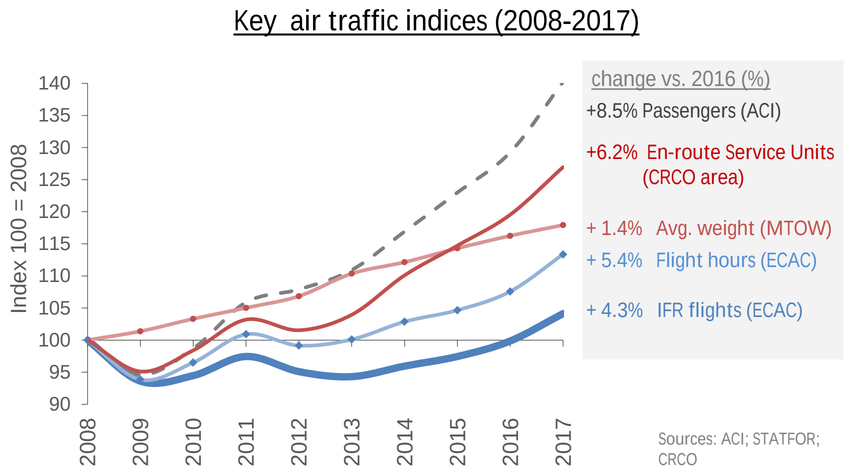

Figure 2: European air traffic indices

Figure 3 shows the evolution of IFR flights in the SES RP2 area in terms of average daily flights. The trend already observed over the past years continued and IFR flights in the SES RP2 area increased for the fourth year in a row in 2017 (+3.9% vs. 2016).

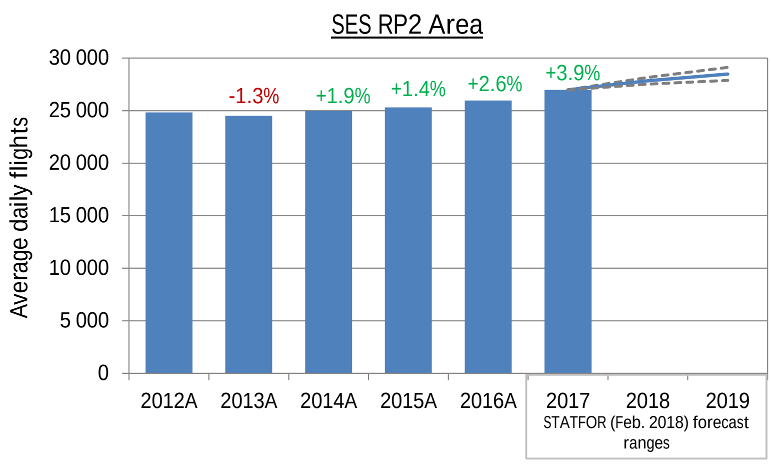

Figure 3: Evolution of flights in the SES RP2 area (2012-2017)

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[1] In general 2 airport movements per flight

[2] En route service units, computed as product of distance and square root of take-off mass, serve as a basis for en-route charges.

[3] Note that the individual indices refer to slightly different geographical areas.

2.1.2 Air traffic forecasts

The latest EUROCONTROL STATFOR air traffic forecast 2018-2024 [3] covers the remaining part of RP2 and the full RP3 period.

This essential piece of information in view of target setting for RP3 has been subject to extensive consultation. It anticipates that the substantial growth experienced in 2017 will progressively slowdown in the nominal scenario.

The forecast cumulated traffic growth over 2018-2024 is summarised in Figure 4.

Scenario	IFR movements	Service units
High	+25%	+34%
Base	+15%	+21%
Low	+7%	+10%

Figure 4: Forecast Traffic growth 2018-2024 for RP2 area (source STATFOR)

There is a relatively high spread between the low and high scenarios at the end of the period. The difference of forecast service units between the high and base scenarios is 13%, which is higher than the current alert threshold (10%). There would therefore be a significant likelihood that the alert threshold is exceeded before 2024 if the same alert threshold applied in RP3.

Figure 5 illustrates the forecast evolution of service units in the RP2 area.

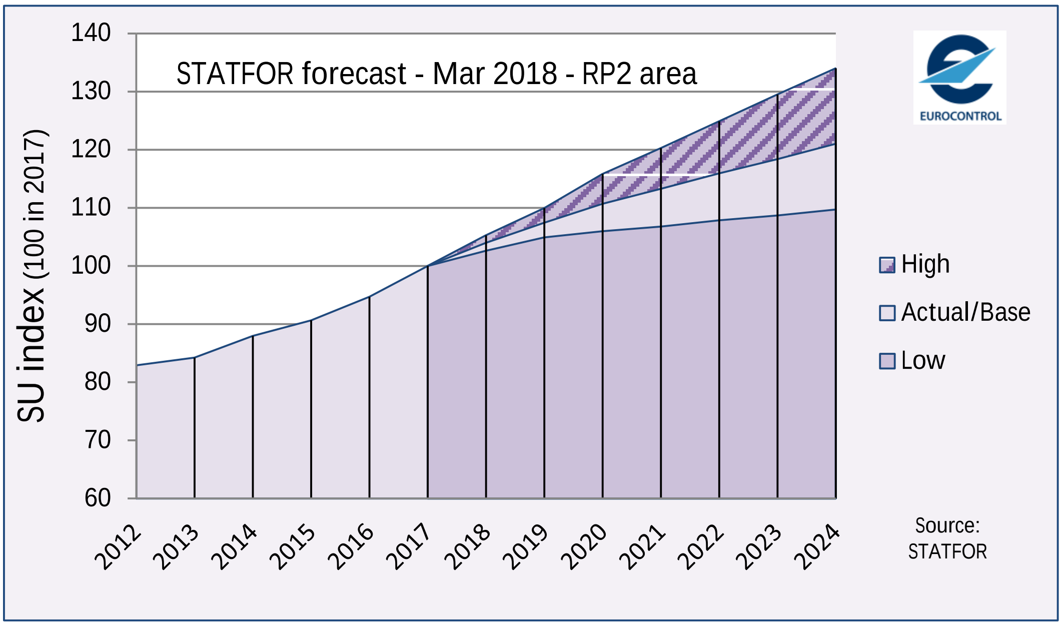


Figure 5: Service units forecast 2018-2024 (source STATFOR)

3 EVIDENCES FOR ESTABLISHING THE EU-WIDE RP3 ENVIRONMENT TARGET

3.1 INTRODUCTION

This section describes the evidences available at the time of publication of this report (i.e. May 2018) for establishing the EU-wide target for environment.

Since this document is only concerned with the EU-wide targets for environment, local environment targets at Functional Airspace Block (FAB) / national levels are considered to be outside the scope.

Upon adoption of an EU-wide target for environment, local reference values can be calculated and disseminated as necessary, as it was for RP1 and RP2 – taking local factors affecting environment performance into consideration.

3.1.1 Environment performance indicators

Environment performance indicators considered in this section are (1) the average horizontal en route flight efficiency of the last filed flight plan trajectory (KEP) and (2) the average horizontal en route flight efficiency of actual trajectory (KEA) as specified in Implementing Regulation (EU) No 390/2013 [1].

Horizontal en-route flight efficiency compares the length of the en-route portion of the flight plan or actual trajectories to the "achieved[4]" distance. The indicators are calculated as the ratio of the two sums (length of trajectories and achieved distances), over all flights considered in the reference area. The indicators are expressed in percent. For instance, an "inefficiency" of 5% means that the extra distance over 1000NM was 50NM.

If the origin/ destination airport is located outside of the reference airspace, the entry/exit point into the airspace is used for the calculation.

KEP and KEA are computed on an annual basis (moving window). In order to smooth out the influence of unusual events, the ten best days and the ten worst days for each measured area are excluded from the computation.

KEP and KEA are a measure of environmental performance as they relate to the amount of fuel which has to be uploaded in accordance with the filed flight plan (KEP) and the amount of fuel actually burnt (KEA).

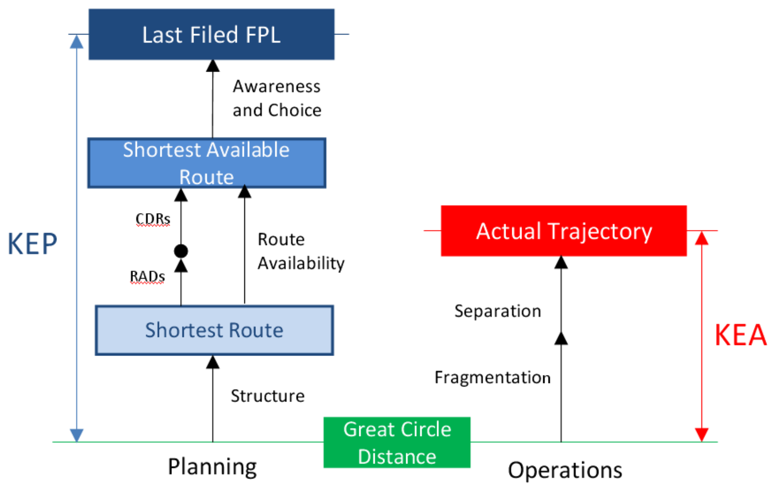


Figure 6: Flight efficiency drivers

[4] The achieved distance apportions the Great Circle Distance between two points within the European airspace (reference area). For the vast majority of flights, the origin and destination coincide with the airports in the reference area. If the origin/destination airport is located outside of the reference area, the entry/exit point into the area is used for the calculation. More information on the methodology is available at: prudata.webfactional.com/wiki/images/6/61/HFE_Methodology_2014_05_23.pdf

Although they both relate to fuel burn, Figure 6 shows how they refer to two separate domains: planning and operations.

It is acknowledged that the distance-based KEP and KEA indicators serve as proxies for fuel efficiency, as the most fuel-efficient route depends on wind. However, the wind-optimal route might not necessarily correspond to the choice of the airspace users because they might use different measures, such as total cost (the measurement of which would be dependent on the airspace user).

Moreover, the information needed to calculate these alternatives (wind optimal, total costs, etc.) is not currently available. The airspace users would have to either provide detailed information or agree on a standard method for the calculation of the route "values".

KEP and KEA, on the other hand, have the advantage of relying on a well-defined and standard measure (distance).

It should also be noted that the logic described in Figure 6 does not depend on the use of a particular measure. The key message is that each step corresponds to the addition of constraints restricting the number of alternative routes available.

3.2 OBSERVED HISTORIC PERFORMANCE

3.2.1 Evolution of KEP and KEA (EU wide level)

Figure 7 shows the evolution of KEP and KEA between 2014 and 2017 and the indicative reference line to reach the 2019 targets. Both indicators were to some extent affected by the crisis in Ukraine.

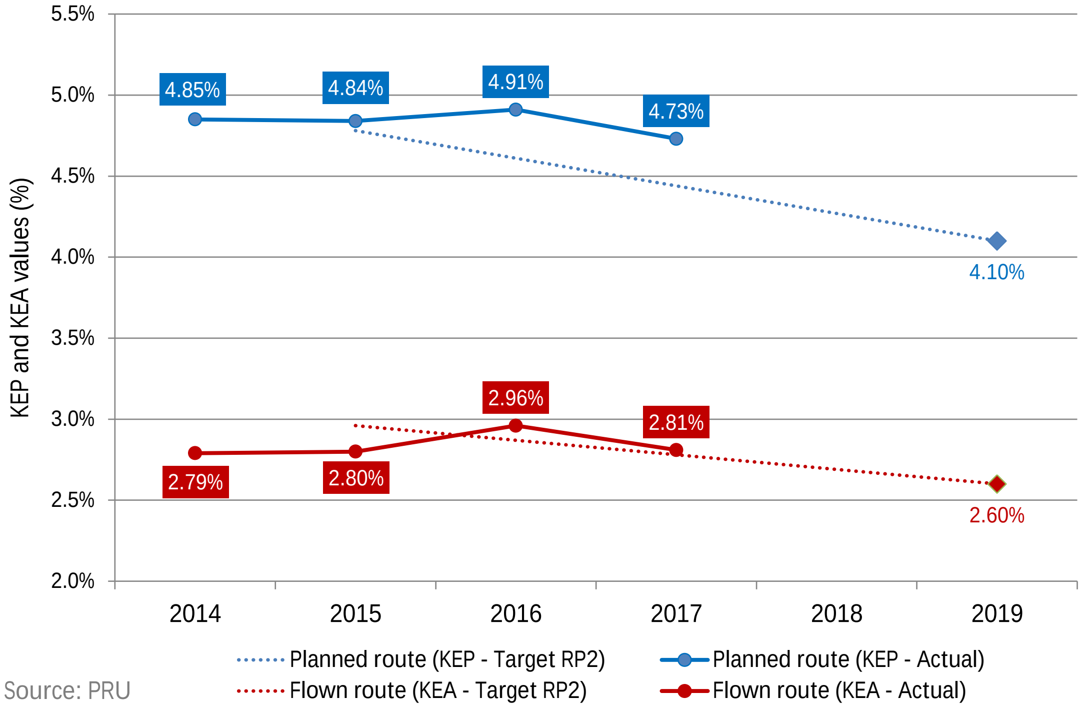


Figure 7: Horizontal en route flight efficiency (EU wide level)

As can be seen in Figure 7, for both indicators a deterioration in 2016 has been followed by an improvement in 2017. The value of KEA (actual trajectory) is close to the indicative reference line and appears to be on track to meet the RP2 targets set for 2019.

Surveillance reports are still not always provided at a uniform rate (and in some cases are not provided at all) but accuracy improved and it will continue improving during RP2.

Despite a notable improvement from 4.91% 2016 to 4.73% in 2017, the value of KEP (last filed flight plan) remains above the indicative reference line for the 2019 target.

3.2.2 KEP and KEA by Functional Airspace Block FAB

Although this document is only concerned with the EU-wide target for environment (i.e. local environment targets are outside the scope), on request by the PRB, this section provides a breakdown of the historic KEP and KEA performance by FAB between 2014 and 2017.

Figure 8 provides an overview of actual KEA for each FAB compared to the targeted performance in 2017. With the exception of DK-SE FAB and SW FAB, all FABs performed worse than the KEA performance target included in their performance plans for RP2.

Flown route (KEA) 2017			
Entity	Ind. ref. (annual)	Flown route (KEA)	Delta
Baltic FAB	1.44%	1.63%	0.19%
BLUE MED FAB	2.62%	2.82%	0.20%
DANUBE FAB	1.46%	1.62%	0.16%
DK-SE FAB	1.20%	1.18%	-0.02%
FAB CE (SES RP2	1.90%	1.91%	0.01%
FABEC	3.14%	3.23%	0.09%
NEFAB	1.29%	1.58%	0.29%
SW FAB	3.57%	3.25%	-0.32%
UK-Ireland FAB	3.18%	3.70%	0.52%
SES Area (RP2)	2.78%	2.81%	0.03%

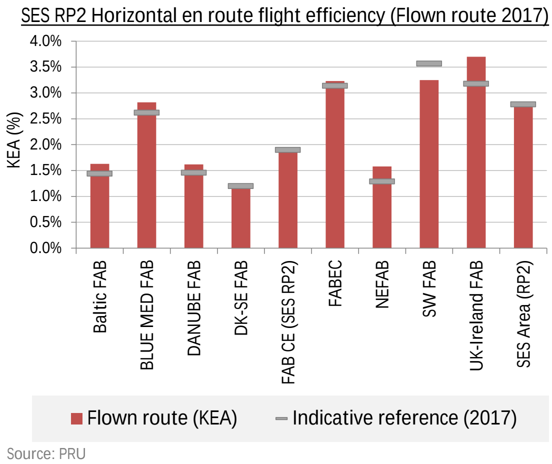
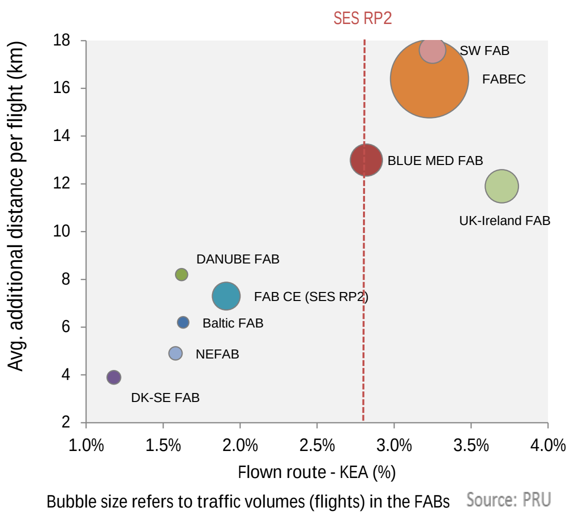


Figure 8: KEA vs target by FAB (2017)

Figure 9 shows the horizontal en route flight efficiency (actual trajectories) by FAB in 2017. KEA is expressed as a ratio of total distances and is therefore not influenced by traffic volume or individual flight length. The absolute values of the additional distance per flight and per FAB provide a more complete picture and an understanding of how FABs influence overall performance in Europe.



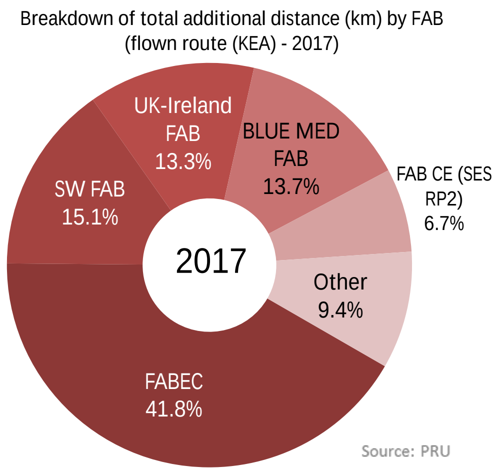


Figure 9: Horizontal en route flight efficiency (actual trajectory) by FAB in 2017

The scatter plot on the left side of Figure 9 provides a link between the three quantities. It shows the flight efficiency (KEA) (X-axis), the average additional distance per flight (Y-axis), and an indication of the traffic volume (flights) within the FABs (the size of the bubble).

FABEC (orange bubble) for instance combines a comparatively high KEA with long average flight segments and a high traffic volume. As a result, FABEC accounted for 41.8% of total additional distance flown in 2017, followed by SW FAB, UK-Ireland FAB and BLUE MED FAB.

Figure 10 shows the historic evolution of environmental KPIs in the nine FABs between 2014 and 2017. It should be noted that a meaningful time series analysis is limited to this period due to changes in methodology and scope between RP1 and RP2.

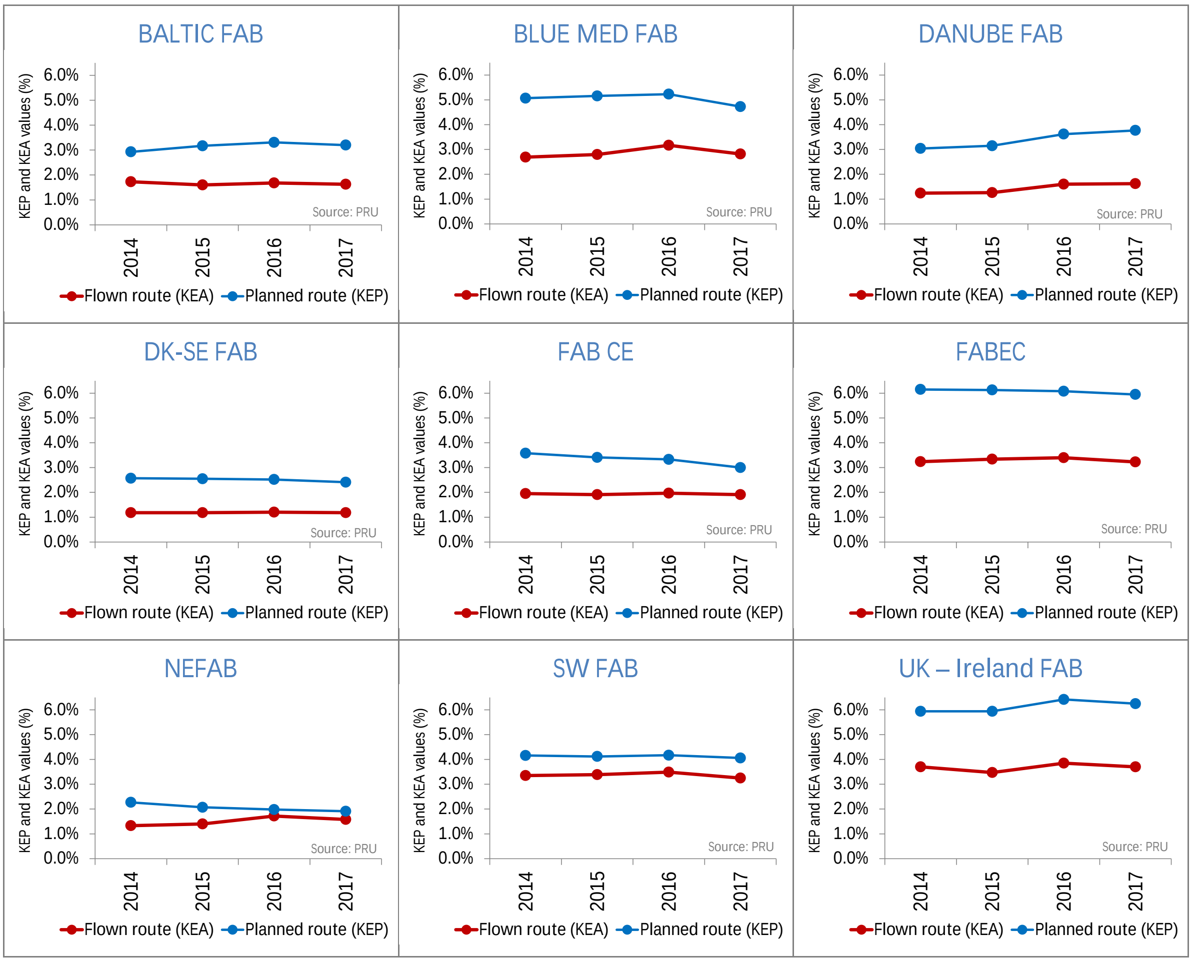


Figure 10: En route horizontal flight efficiency by FAB

3.2.3 Free Route Airspace (FRA) Implementation

The Performance Review Report (PRR) 2016 [4] underlined possible benefits of the implementation of Free Route Airspace (FRA) which offers a more flexible environment compared to a rigid route network and therefore more choices to airspace users whilst contributing to reduced fuel consumption and emissions and higher flight efficiency.

Figure 11 shows EU-wide FRA implementation status by the end of 2017.

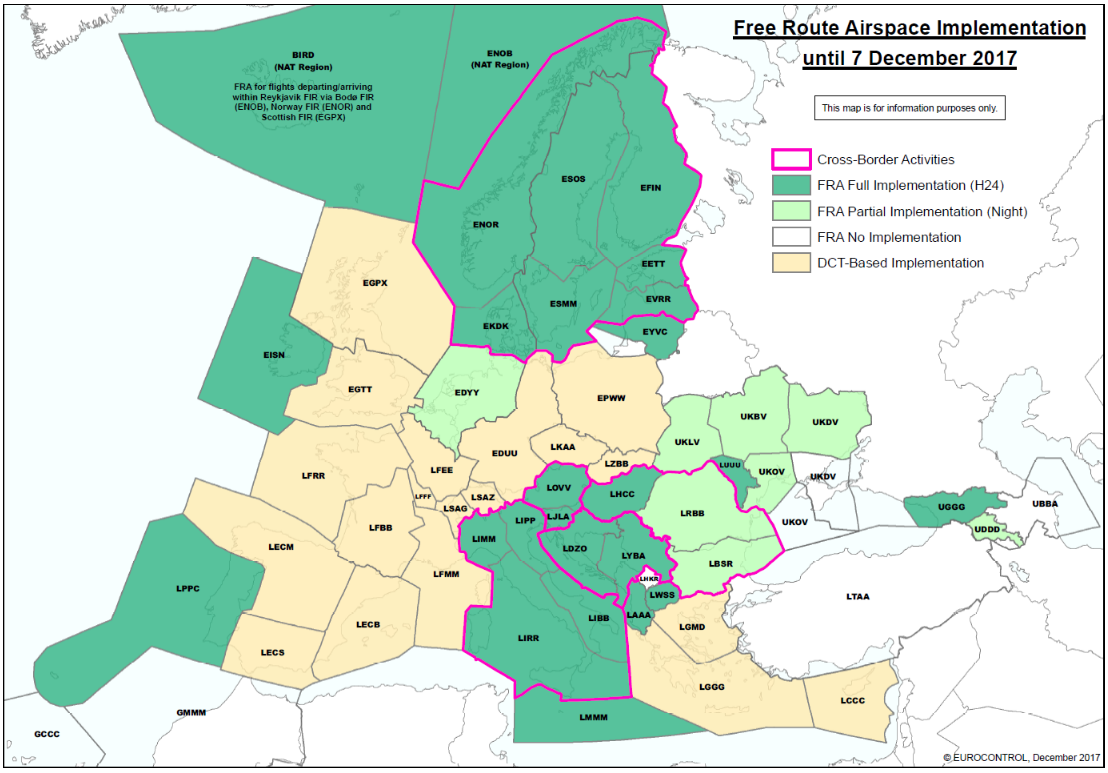


Figure 11: Free route airspace implementation (EUROCONTROL area – December 2017)

As can be seen, FRA is now in place in a large part of the European airspace but especially in the dense European core area even small improvements are expected to bring notable environmental effects.

3.2.4 Europe-US comparison

The latest report "Comparison of Air Traffic Management-Related 2015 Operational Performance: U.S./Europe" was published in 2016 [5] and compares operational performance up to year 2015.

In order to ensure comparability in view of available data, the analysis scope of this report is limited to flights to or from the main 34 airports for IFR traffic in both the US and in Europe, which represents a large share of traffic in both areas.

Figure 12 shows the evolution of horizontal en route flight efficiency (actual and flight plan) compared to achieved distance between 2008 and 2015. Due to data availability, indicators for Europe are only available as of 2011.

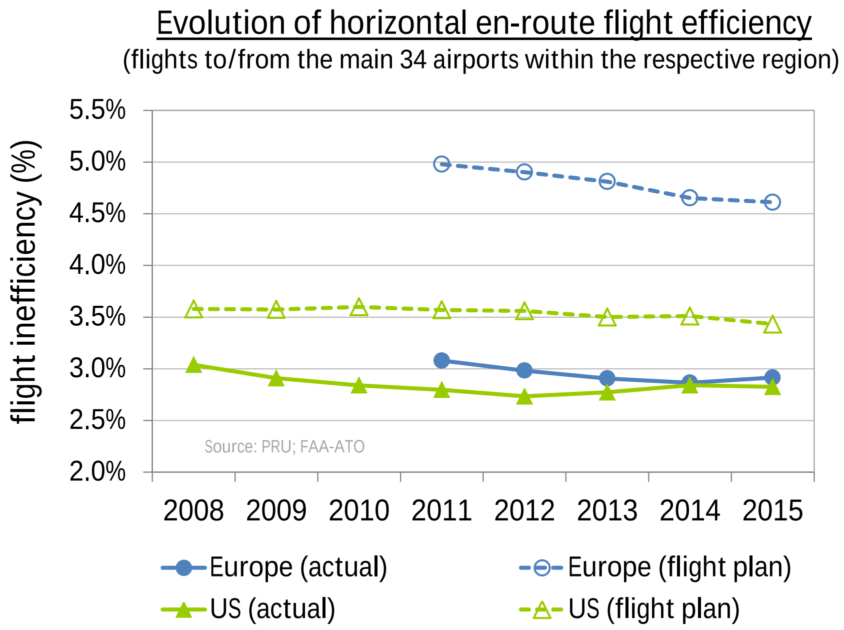


Figure 12: Horizontal en route flight efficiency (US – Europe comparison)

Over the past years, there has been a significant improvement of flight efficiency in Europe, and the gap between the Europe and the US is now very small when considering actual distance flown.

However, there is a large gap between planned and actual distances in Europe, less so in the US. Such difference is generally due to direct routings provided by ATC on a tactical basis when traffic and airspace availability permit. It has a negative impact on the predictability of routing and sector loads, and on fuel to be carried on board.

Note: The two systems differ notably in the way traffic is being managed. The results shown in Figure 12 are not directly comparable to the KEP and KEA figures due to differences in scope (SES area vs. flights to/from the main 34 airports within the respective region) and methodology (10 best and worst days are not removed in US-Europe comparisons).

3.3 FORWARD LOOKING PERFORMANCE

The latest STATFOR 7-year forecast published in February 2018 [3] predicts flights in the SES RP2 area to grow in the baseline scenario with an average annual growth rate (AAGR) of 2.0% between 2018 and 2024 (High: 3.4%; Low: 0.7%).

By 2024, the number of annual flights in the SES RP2 area is expected to increase by 15% compared to 2017, reaching a total of 11.4 million flights, according to the base forecast scenario.

With the airspace being finite, there is a need to make the ATM system more efficient to keep up with demand and to reduce operational inefficiencies as much as possible. However, as pointed out on a number of occasions, 100% flight efficiency cannot be achieved for a number of reasons including, inter alia, safety, weather and capacity issues.

3.3.1 Initial 2018 trend (KEP, KEA)

Figure 7 shows the evolution of KEP (last filed flight plan) and KEA (actual trajectory) from 2014 and the possible evolution of KEP and KEA for the year 2018.

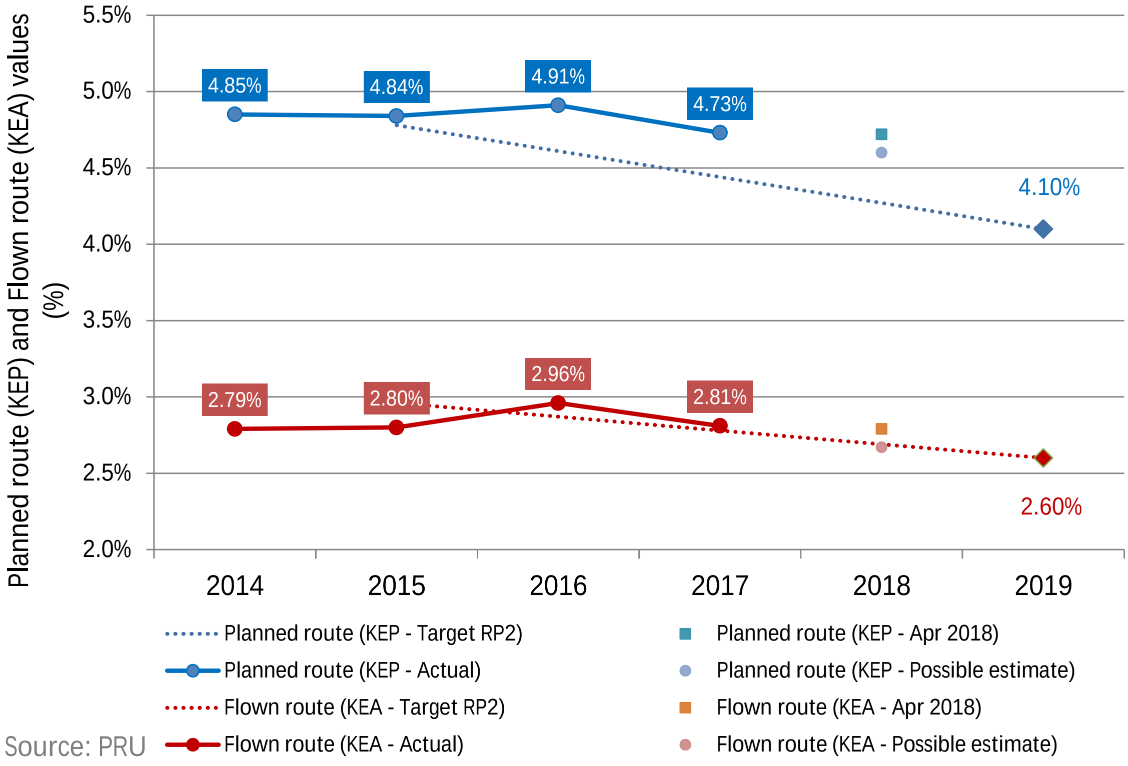


Figure 13: Horizontal en route flight efficiency (KEP and KEA)

The KEP value for the end of April 2018 was 4.72%, which is an improvement of 0.13 percentage points with respect to the previous year (giving an estimate of 4.60 for the whole year under similar improvements). Whilst KEP appears to continue on a positive trend, additional effort is required to meet the EU wide target for 2019 (4.10%). The indicator is dependent on airspace user's route choices and crisis impacts.

The KEA value for the end of April 2018 was 2.79%, which corresponds to an improvement of 0.14 percentage points with respect to the previous year (giving an estimate of 2.67 for the whole year under similar improvements). Hence, KEA appears to be on track to meet the 2019 EU wide target.

3.3.2 Free Route Airspace (FRA) implementation (Outlook)

Horizontal en route flight efficiency is affected by a number of factors including, inter alia, route network design, flight planning, awareness of route availability, civil-military coordination, and other factors.

It is acknowledged that the distance-based flight efficiency indicators in this section only serve as proxies for fuel efficiency as the most fuel-efficient route depends on wind. Airspace user-preferred trajectories additionally can include cost considerations based on route charges, crew costs and other factors. Despite their limitations, KEP and KEA enable a consistent and stable Europe-wide measure to identify areas for improvement and to monitor progress over time.

The European Route Network Improvement Plan (ERNIP) - Part 2 - ARN Version 2018 - 2019/22 [6] provides a consolidated picture of planned improvements aimed at delivering a safe and efficient operation of air traffic. It is based on ANSP and FAB airspace plans until 2022 and contains, at this stage, approximately 300 packages of airspace proposals scheduled for implementation for the summer seasons 2018 - 2019/22.

These proposals include more than 200 route changes, around 30 re-sectorisation plans, more than

30 TMA projects, more than 40 Free Route Airspace (FRA) projects, 1 civil/military airspace development as well as around 20 improvement measures eliminating unnecessary Route Availability Document (RAD) restrictions or improving flight efficiency. They were or will be implemented as follows:

- approximately 130 proposals for the Summer season 2018;
- approximately 110 proposals for the Summer season 2019;
- approximately 40 proposals for the Summer season 2020;
- approximately 30 proposals between Summer season 2021-end of 2022.

The implementation of FRA gives the aircraft operators more freedom in the choice of the flight plan and the possibility to avoid some of the restrictions imposed by a rigid route network. The expected benefits are, inter alia, reduced fuel burn (costs) and gaseous emissions.

Figure 11 on page 8 shows that FRA is not yet implemented in the dense European core area but will, according to the current plans, rapidly expand into this area by the end of 2019. Due to the high traffic volumes, the benefits of even small flight efficiency improvements in the core area will be substantial however, in view of the numerous factors and complexities involved and with traffic levels growing again, improvements may become more and more challenging. Expected benefits vary by airspace and depend, inter alia, on traffic volume, complexity and other factors.

Nonetheless, the implementation of the latest ERNIP Part 2 has the potential to enable further substantial flight efficiency improvements, if all projects are fully implemented. The map in Figure 14 shows FRA initiatives that are already in place or planned for implementation by 2022, according to the latest European Route Network Improvement Plan.

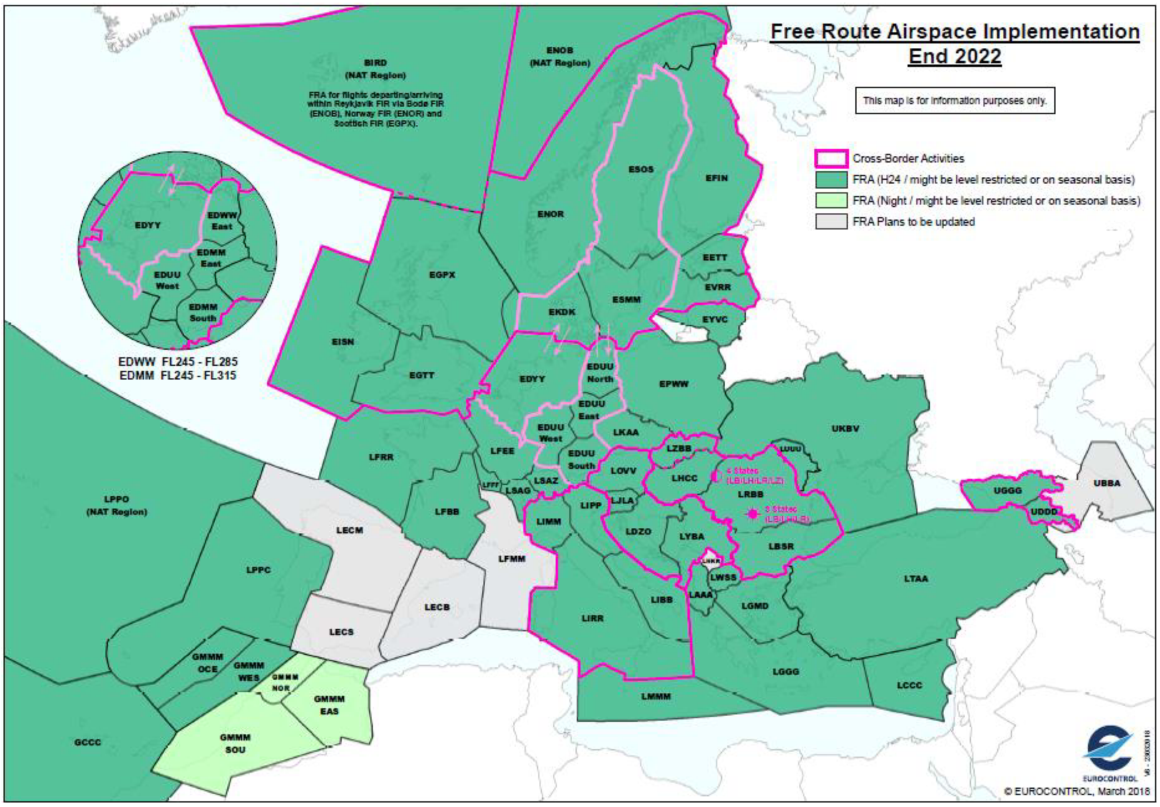


Figure 14: Free Route Airspace implementation plans proposed until end of 2022

With the exception of Madrid, Barcelona, Seville and Marseille, all ACCs within the SES RP2 area have plans to implement FRA by 2022.

KEA

If all currently planned airspace packages were fully implemented by 2022, the current estimate is that horizontal en route flight efficiency (KEA) could be improved by another 0.4 percentage points between 2018 and 2022 in an unconstrained scenario, i.e. no route restrictions (e.g. RAD), no capacity shortfall, no constraints due to military activity and all conditional routes (CDRs) are permanently available.

In more realistic scenarios, based on Network Manager (NM) expert judgement, KEA at EU wide level could be reduced by 0.2-0.3 percentage points between 2018 and 2022. The latter date would be postponed if some airspace improvement measures were not implemented on time.

Once FRA is fully implemented, horizontal en-route efficiency will reach limits, such as interfaces with TMAs and temporarily reserved areas. Achievable performance as measured by KEA will then reach a plateau. Further improvements in environmental performance could be achieved in vertical efficiency, Terminal areas (ASMA), taxiing, sequencing into airports, etc.

<u>KEP</u>

KEP is currently significantly higher than KEA, as shown in Figure 13. The following observations suggest that there is scope to reduce KEP faster than KEA.

1) As shown in PRR 2017 [2], the gap is clearly higher in States where FRA has not been fully implemented. FRA initiatives planned between 2018 and 2022 can therefore be expected to bring a notable improvement in KEP at EU wide level.
2) Airspace users and their flight planning systems might not always make the best us of route design improvements including free route airspace.
3) The difference between planned and actual routes is significantly smaller in the USA as shown in Figure 12.
4) Trajectory Based Operations (TBO) are central to the SESAR and ICAO ATM concepts. With TBO, planned and actual flight paths are closely related and the difference between KEP and KEA should become much smaller. The Flight and Flow Information for a Collaborative Environment (FF-ICE), a key enabler for TBO, will be gradually implemented worldwide as outlined in the GANP. One would expect TBOs to have a positive influence on KEP before the end of RP3.

4 EVIDENCES FOR ESTABLISHING THE EU-WIDE RP3 CAPACITY TARGET

4.1 INTRODUCTION

This section presents the evidences, available at the time of publication of this report (i.e. May 2018), for the formulation of the EU-wide capacity target for RP3 using the KPI specified in the performance regulation (EU) No 390/2013 [1].

Since this document is only concerned with the EU-wide target for capacity, local capacity targets at Functional Airspace Block (FAB) or national level are not addressed here.

Upon adoption of an EU-wide target for capacity, local reference values can be calculated and disseminated as necessary, as it was for RP1 and RP2 – taking local factors affecting capacity performance into considerations.

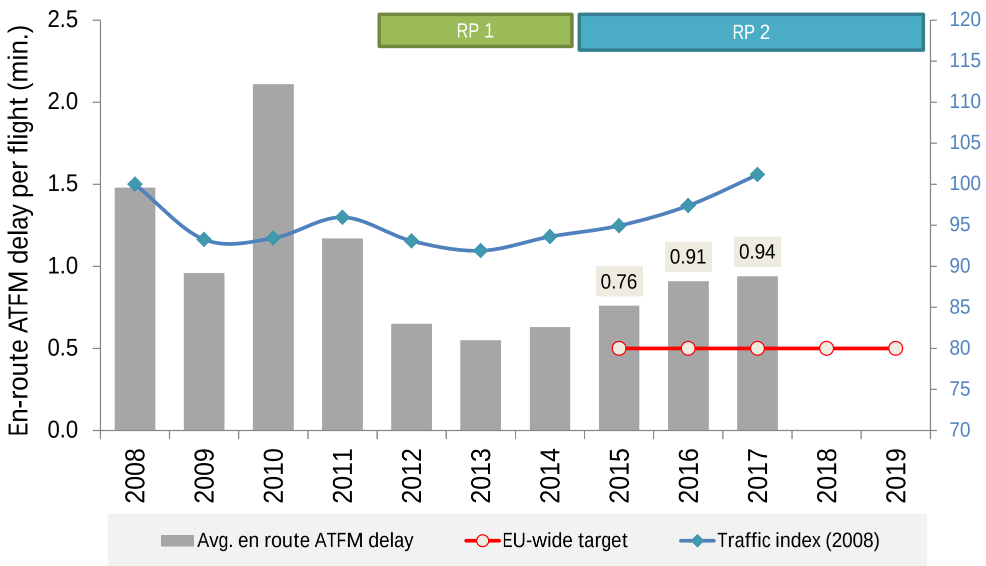
4.1.1 Capacity performance indicators

The capacity KPI is defined as minutes of en route Air Traffic Flow Management (ATFM) delay per flight. The en route ATFM delay is the delay calculated by the central unit of ATFM as defined in Regulation (EU) No 255/2010 [7] and expressed as the difference between the estimated take-off time requested by the aircraft operator in the last submitted flight plan and the calculated take-off time allocated by the central unit of ATFM.

The indicator includes all IFR flights within European airspace and all ATFM delay causes, excluding exceptional events[5]; it is calculated for the whole calendar year, and for each year of the reference period.

4.2 OBSERVED HISTORIC PERFORMANCE

Figure 15 shows the average en-route ATFM delay for the SES RP2 area between 2008 and 2017, as well as the evolution of IFR flights and the EU wide RP2 target.



Source: EUROCONTROL/ PRU

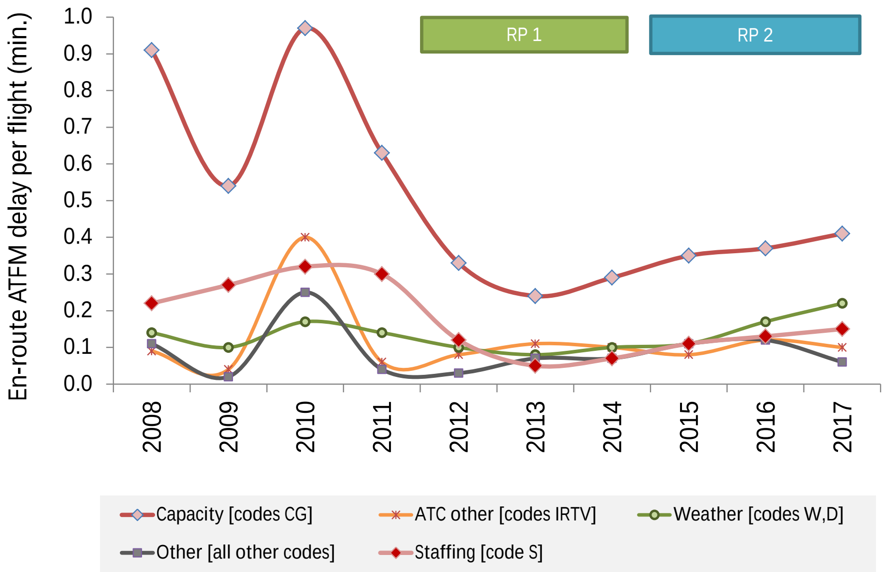
Figure 15: Average ATFM en route delay (RP2 area)

5 According to Regulation (EU) No 390/2013 [1], 'exceptional event' means circumstances under which ATM capacity is abnormally reduced so that the level of ATFM delays is abnormally high as a result of: a planned limitation induced through operational or technical change, major adverse weather circumstances, the unavailability of large airspace parts either through natural or political reasons, or industrial action and the activation of the European Aviation Crisis Coordination Cell (EACCC) by the Network Manager as a result of one or more of these causes.

Changes due to the post operations adjustment process as published by the Network Manager have been taken into account for the analysis of historic performance in this section.

Figure 15 shows that the EU-wide target of an average delay of 0.5 minutes per flight has never been met in the first three years of RP2. The delay KPI reached its lowest value in 2013 (0.55 min/flight), which is close to the EU-wide target applicable since 2014. Since 2013, IFR flights increased by +10% and total en-route ATFM delays by + 89%.

Figure 16 shows the EU-wide average ATFM en route delay by attributed delay category.



Source: EUROCONTROL/ PRU

Figure 16: Average ATFM en route delay by attributed delay category (RP2 area)

The Flow Management Position (FMP) requesting the ATFM regulation is responsible for determining the reason for the delay, not the Network Manager that activates the regulation. The reason for the regulation can be evaluated in the post-operations process at ANSP or NSA initiative.

The observed increase in average en route ATFM delay in RP2 is mainly driven by delays attributed to (insufficient) ATC capacity, ATC staffing and adverse weather, each of which shows an upward trend.

ATC staffing attributed delays are an indication that insufficient staff is available to open enough sectors to provide the required capacity. A reduced number of available staff leads to collapsed sectors, which limits offered capacity. A significant amount of ATC staffing delays occurred in the core area during periods of peak traffic demand - with a high cost impact on airspace users.

Delays are normally attributed to ATC capacity when traffic demand is higher than the declared sector capacity. However, analysis in PRR 2017 [2] shows a high proportion of delays attributed to ATC capacity when sectors were in fact collapsed due to internal constraints such as insufficient availability of qualified ATC staff. Therefore, attribution of delays to staffing or ATC capacity causes is often blurred.

ANSPs' capacity plans are updated at least on a yearly basis and compiled in successive editions of the Network Operations Plan (NOP). The latest NOP [8] indicates that the current capacity plans are insufficient to meet the capacity target set for RP2 for many years to come. This results in high additional costs to airspace users as indicated in section 4.2.1. Section 4.2.2 shows that capacity issues are in fact concentrated in two FABs and a small numbers of ACCs.

As it takes some time and resources to increase capacity (optimised rostering, new airspace design, ATCO recruitment and training, new investment) actions and possibly investments are required to address the issues in several cases.

Previous analysis for PRB Annual Monitoring Reports showed that some ANSPs had a tendency to implement cost-savings by postponing or reducing investments in capacity enhancements. ANSPs get the benefits of such savings under cost risk sharing rules while airspace users incur additional costs.

In terms of weather attributed delays, the RP2 EU-wide target included an allowance to account for weather delays and other events. During the consultation on target ranges, historical evidence was provided to show the 'typical' impact of adverse weather, between 0.1 and 0.16 minutes per flight.

In adopting their performance plans for RP2, several FABs/States established performance targets and incentive schemes for their ANSPs which excluded weather attributed delay from the local target and incentive scheme. This approach was permitted in the Charging Regulation EU No.391/2013 (Article 15).

As shown in Figure 16 and Table 1, the proportion of weather attributed delays increased year on year during RP2.

	Reference Period 1			Reference Period 2		
	2012	2013	2014	2015	2016	2017
Total en route ATFM delay	0.63	0.54	0.61	0.76	0.91	0.94
En-route ATFM delay attributed to weather	0.09	0.08	0.09	0.11	0.17	0.22
% of weather attributed en route delay	14%	15%	15%	15%	18%	23%

Table 1: Weather attributed delays (SES area)

However, on closer examination, a very significant proportion of weather attributed delays (up to 90% in certain sector groups) in fact occurred when sectors were collapsed, possibly due to staffing issues [2]. This raised the question why such delay was attributed to weather rather than staffing.

Whilst it is accepted that there should be an allowance for adverse weather, it is important to ensure that this is not used as an excuse to hide internal capacity constraints such as staffing issues.

4.2.1 Cost of delay

Insufficient capacity results in additional expenses for the airspace users: the cost of delay (including lower aircraft and crew productivity, missed connections, passenger compensation).

A comprehensive report on the unit cost of delay was published by the University of Westminster in 2004 and complemented subsequently. This study was completely updated in 2015 (using 2014 data). The latest version 4.1 [9] estimates the average cost of one minute of ATFM delay at €100. These costs to airlines mainly arise from crew costs, passenger compensation and the value of passenger loyalty[6].

	Reference Period 2		
	2015	2016	2017
Total en route ATFM delay above target (million minutes)	2.4	3.9	4.3
Estimated en route ATFM delay costs due to delays above target (€)	€240M	€390M	€430M

Table 2: Estimated en-route ATFM delay costs to airspace users (SES area)

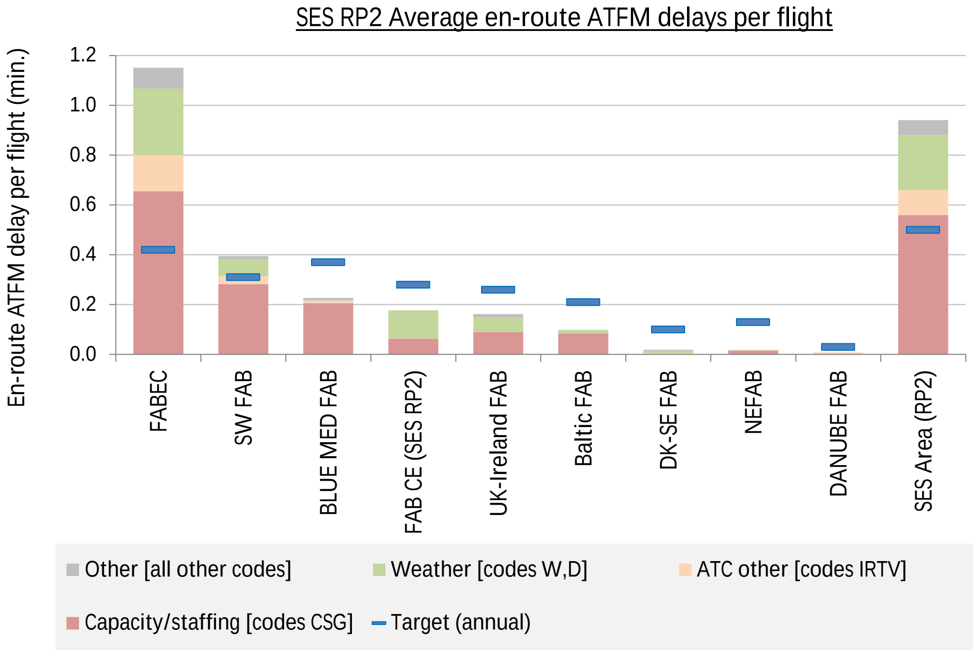
Based on latest estimated cost of delays, Table 2 shows estimates of additional costs incurred by airspace users due to the Capacity target being missed in the first three years of RP2.

[6] This estimate includes direct costs, the network effect (i.e. the costs of reactionary delays that are generated by primary delays) and the cost of lost passengers to an airline. (These costs represent an estimate of the value an airline places on passenger loyalty in order to avoid the loss of future earnings). The cost of time lost by passengers is partly reflected here."

Note: Estimating the cost of delay is a complex task requiring expert judgement and assumptions based on published statistics and the most accurate data available. There are inevitably margins of uncertainty which need to be taken into account for the interpretation of the results.

4.2.2 Average en route ATFM delay by Functional Airspace Block FAB

Although this document is only concerned with the EU wide target for capacity (i.e. local targets are outside the scope) - on request by the PRB - this section provides a breakdown of the historic capacity performance by FAB in RP1 and RP2.



Source: EUROCONTROL; PRU

Figure 17: Average ATFM en route delay by FAB vs target in 2017

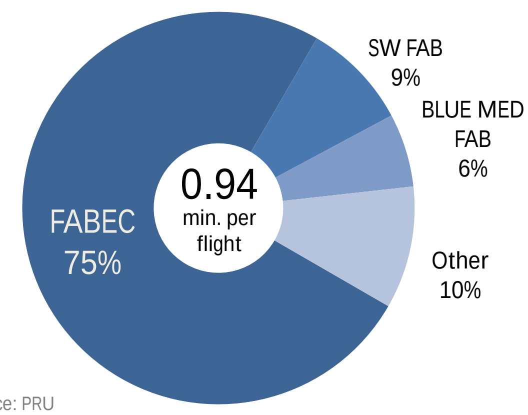
Figure 17 provides an overview of the FAB performance compared to the capacity target in 2017.

With the exception of FABEC and SW FAB, all FABs performed better than the target for 2017 set in their performance plan.

With the exception of FABEC and SW FAB, all FABs performed better than their target for 2017.

Figure 18 shows the share of the total en route ATFM delay in 2017. The share of FABEC (75%) significantly exceeds its share of flight-hours (36%).

As detailed in the latest PRR 2017 [2] and the Network operations report [10], the capacity performance of the network in 2017 was negatively influenced by the performance in a limited number of Area Control Centres (ACCs).



Source: PRU

Figure 18: Share of total en route ATFM delay 2017

The most constraining ACCs in 2017 were Karlsruhe, Maastricht, Marseille, Brest, Bordeaux, Nicosia and Barcelona, which together accounted for almost 70% of en route delays in the SES RP2 area in 2017.

Figure 19 shows the historic evolution of capacity performance in the nine FABs in RP1 and RP2, as well as targets for RP2.

Figure 19: Average ATFM en route delay by FAB (RP1 & RP2)

Time series for RP1 and RP2 shown in Figure 19 are not fully comparable. In RP1, the average ATFM en route delay computation for each FAB was based on the aggregation of the ANSPs whereas for RP2 the computation was changed to the aggregation of the Flight Information Regions (FIRs), which in some cases had an impact on traffic counts.

4.2.3 Europe-US comparison

The latest report “Comparison of Air Traffic Management-Related 2015 Operational Performance: U.S./Europe” was published in 2016 [11] and compares operational performance up to the year 2015.

In order to ensure comparability in view of available data, the analysis scope of this report is limited to flights to or from the main 34 airports for IFR traffic in both the US and in Europe, which represents a large share of traffic in both areas.

Both the US and Europe report delay imposed on flights[7] in order to achieve the required levels of safety as well as to most effectively balance demand and capacity.

[7] In the US, ATM delay by Causal Factor is recorded in the FAA OPSNET database. FAA requires facilities to report all delay equal or greater than 15 minutes.

ATFM departure delays can have various ATM-related (ATC capacity, staffing, etc.) and non-ATM related (weather, accident, etc.) reasons. The categories of delay cause codes differ in the US and Europe; however, five general categories were developed to encompass the varying causal factors (see grey box). Both systems track the constraining facility, which allows delay to be reported as either due to terminal/airport or en-route constraints.

Figure 20 shows average total ATFM ground delay (en-route and terminal) per flight between 2008 and 2015 (T34 airports only). For comparability reasons, only flights with ATFM ground delays equal or greater 15 minutes were included in the analyses.

Although the trend over time was different, average total ATFM delay per flight in Europe was slightly below the observed level in the US in 2015.

In Europe, average ATFM delay continuously decreased until 2013, following the historically bad performance due to weather and strikes in 2010.

Between 2013 and 2015, total ATFM ground delays equal to or greater than 15 minutes increased in Europe by 43.4% whereas traffic only increased by 4.1% during the same time.

Figure 21 shows this change from 2013 to 2015 by causal factor. In the US, the decrease between 2013 and 2015 was largely due to weather.

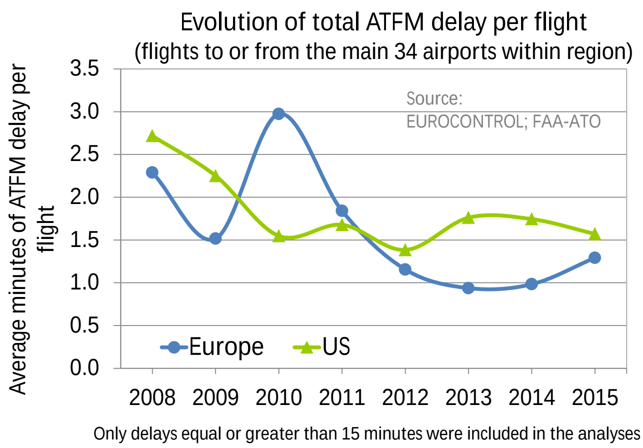


Figure 20: Evolution of total ATFM delay per flight (US vs Europe)

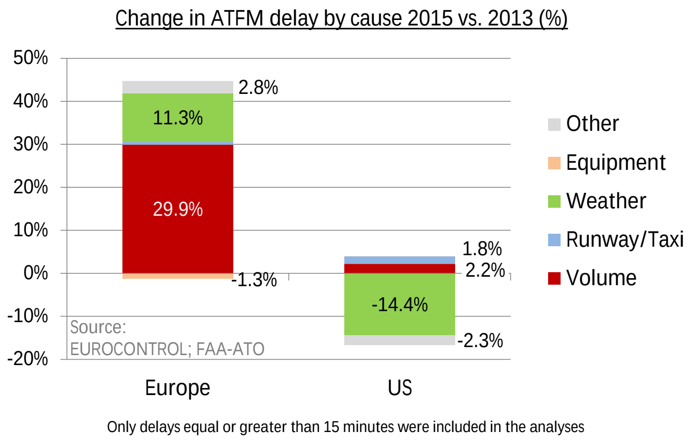


Figure 21: Percent change in ATFM delay by cause (2015 vs. 2013)

In Europe, the notable performance deterioration was due to a significant increase in capacity related delays and to a lesser extent due to weather.

Table 3 compares ATM-related departure restrictions imposed in the two ATM systems due to en-route and airport constraints. As can be expected, the share of flights affected by departure ground restrictions at origin airports differs considerably between the US and Europe.

Only delays > = 15 min. are included.		EUROPE			US (CONUS)		
		2008	2013	2015	2008	2013	2015
	IFR flights (M)	5,5	4,8	4,8	9,3	8,4	8,2
En route related delays >=15min. (EDCT/ATFM)	% of flights delayed >=15 min.	5,0%	1,3%	2,0%	1,1%	0,8%	0,8%
	delay per flight (min.)	1,4	0,4	0,6	0,4	0,3	0,3
	delay per delayed flight (min.)	28	31	28	38	36	35
Airport related delays >=15min. (EDCT/ATFM)	% of flights delayed >=15 min.	2,8%	1,6%	2,3%	4,1%	2,6%	2,5%
	delay per flight (min.)	0,9	0,5	0,7	2,3	1,5	1,3
	delay per delayed flight (min.)	32	33	33	56	57	51

Table 3: ATFM/EDCT departure delays (flights to or from main 34 airports within region)

Despite a reduction from 5.0% in 2008 to 2.0% in 2015, flights in Europe are still over twice more likely to be held at the gate or on the ground for en-route constraints than in the US where the share of flights was 0.8% in 2015.

Whereas in the US, en-route delays in 2015 were mostly driven by convective weather, in Europe they were mainly the result of capacity and staffing constraints (including ATC industrial actions).

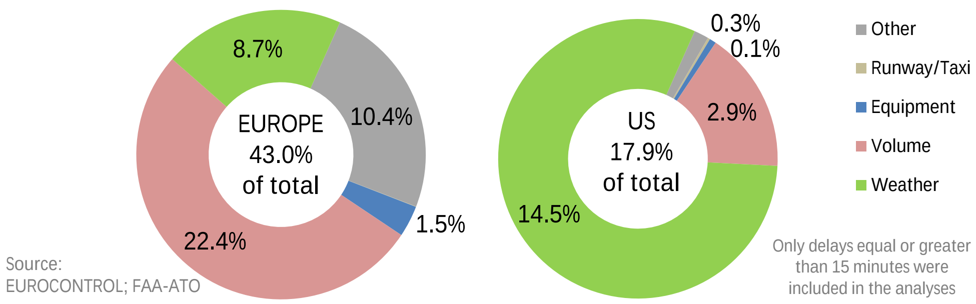


Figure 22: Breakdown of en-route ATFM delay by cause (2015)

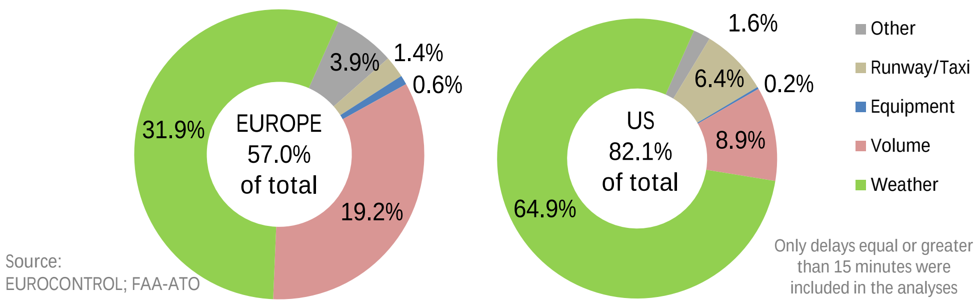


Figure 23: Breakdown of airport ATFM delay by cause (2015)

Note: The two systems differ notably in the way traffic is being managed. The systemic differences need to be considered for the interpretation of the results.

4.3 FORWARD LOOKING PERFORMANCE

4.3.1 Modelling system wide cost optimum capacity

This section provides a high-level estimate of the system wide economic optimum, performed by the NM, based on the trade-off between the cost of providing additional en route capacity and the cost of en route ATFM delay.

Data and methodology used

The NM simulations to estimate the system-wide economic optimum were based on EUROCONTROL tools which were developed within the European Network Capacity Planning Process.

Those tools were developed and refined in cooperation with their users over the past 15 years. The tools are well established, transparent, and - although there is scope for further improvement - commonly accepted at European level. The capacity assessment and planning process is described in more detail in a dedicated publication [12].

The data used as input to the EUROCONTROL tools were derived from different sources:

- Operational data collected by EUROCONTROL/Network Manager;
- cost information from the EUROCONTROL Central Route Charges Office (CRCO); and,
- Information on configuration opening schemes and sector capacities provided by ANSPs.

Rationale and assumptions

In Europe, airspace users bear both the cost of route charges associated with the provision of en route capacity and the cost of ATFM delays due to insufficient en route capacity. A capacity shortfall has a strongly non-linear impact on delays.

The underlying rationale for the calculation of a system wide economic optimum is the minimisation of total costs to airspace users. The “optimum capacity level” corresponds to the level of capacity at which airspace users incur the lowest total costs.

The model used for the NM simulation applies a simplified approach and assumes a positive elasticity[8] between capacity and cost.

However, the marginal costs of capacity can vary significantly at different times and places due to differences in investments cycles and the efficiency of capacity provision.

Moreover, if there is spare capacity or if additional effective capacity can be generated by better matching rosters with demand, the marginal costs are relatively low. However, if new major investments are required (new system, etc.) the marginal cost of capacity will increase significantly.

The following parameters influence the level of the system-wide modelled cost optimum capacity:

- Available level of capacity: The current capacity baseline computed by NM is determined for each ACC. For the simulation, the capacity baseline of 2016 or 2017 (whichever one was higher) has been used.

- Traffic evolution: The predicted traffic demand is based on the latest STATFOR traffic forecast which is distributed over the route network. For the simulation, the high growth scenario of the latest STATFOR traffic forecast published in February 2018 [3] and the shortest route scenario has been used.

- Cost of en route capacity[9]: The system-wide modelled cost optimum depends on the unit cost of capacity. The higher the cost of capacity, the higher the system-wide modelled cost optimum delays, as it would cost more to invest in capacity. The underlying capacity costs in the model are based on 2017 data from the CRCO.

  The cost of capacity increases as a function of capacity, which can be characterised at the margin by a given cost elasticity factor[9]. In order to account for differences in marginal costs of capacity and to evaluate the sensitivity of the economic optimum to the aggregate cost elasticity, the following three cost elasticity factors were used for the simulations:
  - Cost elasticity factor of 0.5
  - Cost elasticity factor of 0.3
  - Cost elasticity factor of 0.1

- Cost of en route ATFM delay: The system-wide modelled cost optimum depends on the cost of delays. The relationship between capacity provision and delays is of a non-linear nature. For the simulation, en route ATFM (ground) delays need to be expressed in monetary terms in order to be able to balance them with the costs for providing additional capacity. The higher the cost of delays, the lower the system-wide modelled cost optimum delays, as it would cost more to have higher levels of delays.

[8] The cost elasticity is the ratio of the relative increase in cost and the relative increase in capacity. A cost elasticity of 0.3 means that 3% additional cost is incurred to provide 10% additional capacity.

[9] The costs of providing en route capacity are regional parameters which vary according to the cost of living, equipment, working arrangements, etc.

The cost of delay is frequently used in cost benefit analysis of air traffic management projects which are expected to increase capacity and, as a consequence, reduce the level of delay in the system.

A comprehensive report on the unit cost of delay was published by the University of Westminster in 2004 and completely updated in 2015. The latest version 4.1 [9] estimates the average cost of one minute of ATFM delay at €100. These costs to airlines mainly arise from crew costs, passenger compensation and the value of passenger loyalty[10]. Inevitably, there are margins of uncertainty in delay costs estimates, which should therefore be handled with a degree of caution. In order to evaluate the sensitivity of the economic optimum towards delay costs, the following assumptions were used in the simulations:

- €40 per minute
- €85 per minute
- €120 per minute

Based on the established capacity baseline, the predicted demand level and the respective cost of capacity and delay, the economic analysis balances the cost of capacity provision and the cost of delay to determine the optimum capacity and optimum delay level (from a total cost point of view) for each ACC. For the estimation of the system-wide optimum, the economic optimisation process continues until a theoretical system-wide economic optimum is achieved.

Simulation results

Table 4 shows the results from NM's simplified model for the nine (9) simulated scenarios. The simulations only consider capacity related delay and the optimum delay levels shown in the table therefore do not include, for instance, weather related ATFM delays.

		Cost elasticity of en route capacity		
		50% variable	30% variable	10% variable
Cost of ATFM delay	40 € / min.	0.16 min./flight	0.12 min./flight	0.08 min./flight
	85 € / min.	0.11 min./flight	0.09 min./flight	0.08 min./flight
	120 € / min.	0.10 min./flight	0.08 min./flight	0.08 min./flight

Table 4: System-wide en route delay optimum for 9 scenarios

Depending on the different scenarios, the simulation suggests a system-wide optimum en route delay level between 0.08 to 0.16 minute per flight for capacity related ATFM delays.

4.3.2 Capacity Planning and Delay forecast

This section provides an outlook of the expected performance of the European en-route ATM network for the period 2018-2024. It is the result of simulations performed with the tools used in the capacity planning process, combined with operational analysis made by the Network Manager Operations Planning Unit.

10 This estimate includes direct costs, the network effect (i.e. the costs of reactionary delays that are generated by primary delays) and the cost of lost passengers to an airline. (These costs represent an estimate of the value an airline places on passenger loyalty in order to avoid the loss of future earnings). The cost of time lost by passengers is partly reflected here.

The en route delay forecast produced on the basis of this information provides a useful indication of the adequacy of the current capacity plans to meet the required level of performance.

Data and methodology used

As part of the EUROCONTROL capacity planning process which is described in a dedicated publication [12], ANSPs provide information on the capacity improvement planned over the next years.

The outlook is based on the latest capacity plans agreed with all ANSPs during the period November 2017 – January 2018 and published in the latest NOP 2018-2019/22 [8].

The traffic evolution is based on the STATFOR February 2018 traffic forecast [3].

Different routing scenarios have been taken into account.

Rationale and assumptions

The following assumptions were used to compute the system wide delay forecast:

- Traffic growth:
  - Base scenario - STATFOR Medium-Term Forecast, February 2018 [3];
- Capacity plans:
  - up to 2022 as published in the NOP 2018-19/22 [8];
- ATFM en route delay:
  - Weather delay added based on statistics from 2015 to 2017 included at the level of 0.15 minutes per flight
  - Disruptions (industrial actions and technical failures) added at a statistical level of 0.10 min per flight

Outlook results (Network level)

Table 5 shows the en route ATFM delay forecast between 2018 and 2022 based on ANSP's current capacity improvement plans and the assumptions listed above (weather delay and disruption delay included based on past statistical data).

Year	En route ATFM delay target full year (min/flt)	En route ATFM delay forecast full year (min/flt)
2018	0.5 min/flt	1.05
2019	0.5 min/flt	1.01
2020		0.97
2021		0.82
2022		0.74

Table 5: EU wide en route delay forecast based on NOP 2018

Although SES performance targets for Capacity have applied since 2014[11], as in previous years, the ANSP's capacity plans published in the latest edition of the NOP are inconsistent with the capacity profiles that would be required to meet the FAB reference values and EU-wide target for en route capacity during RP2.

As shown in Table 5, this target will likely be missed by a large margin until the end of RP2 .This generates additional costs to users shown in Table 2.

[11] The EU-wide capacity target for RP1 was set for year 2014.

Capacity issues are not systemic, but concentrated in the 11 ACCs listed below.

- Cyprus - Nicosia ACC
- Czech Republic – Prague ACC
- Eurocontrol – Maastricht UAC
- France - Bordeaux ACC
- France - Brest ACC
- France - Reims ACC
- France – Marseille ACC
- Germany – Karlsruhe ACC
- Portugal – Lisbon ACC
- Spain - Barcelona ACC
- Spain - Palma ACC

The EU-wide capacity target for RP2 could be met if these ACCs performed in line with the capacity profiles. Capacity profiles and reasons for delays are given in the NOP. With possible exceptions in very few sectors, there is no physical limit to meeting these profiles. Subject to detailed verification, additional revenue that corresponding ANSPs will get from traffic risk sharing covers the additional costs that would be incurred to provide the required capacity.

In case of under-delivery of capacity, additional costs of delays are borne by users while savings remain with ANSPs under cost risk sharing. Penalties incurred for missing FAB capacity targets (maximum 1% of revenue) do not appear to be sufficient to deter such behaviours.

Going forward, capacity plans for those ACCs would need to be revised significantly if the same Capacity target was to apply in RP3 as in RP2.

4.3.3 Additional considerations

4.3.3.1 Cost of delay for airspace users

In view of the fact that airspace users bear the cost of ANS provision and the cost of delay, it is appropriate that any additional costs to them, due to delays through the ATFM process, are considered in the target setting.

4.3.3.2 Allowance for severe weather phenomena

Whilst it is accepted that there should be an allowance for adverse weather, it is important to ensure that this is not used as an excuse to hide internal capacity constraints such as staffing issues.

The historic range between 0.11 and 0.22 for adverse weather is shown in Table 1 on page 15.

4.3.3.3 Allowance for exceptional events

Since the definition of the indicator (see section 4.1.1) specifically excludes exceptional events, such events are also excluded from the target setting process.

4.3.3.4 Allowance for network disruption

Occasionally, the planned implementation of network-critical capacity enhancements could result in a transitional reduction in local performance, below the required standard, e.g. short term local pain being required for long term network gain. An allowance should be made for such network disruptions in the interests of the network.

Such an allowance could be allocated at the beginning of the reference period and managed by the Network Manager. It could be used in cases where, in the opinion of the Network Manager, a positive contribution to network performance has been provided by an ANSP and where the post-operations adjustment process cannot be applied, for example if the off-loaded ANSP is not within a SES Member State.

It could also be used in cases where, according to the Network Manager, an ANSP has actively coordinated the implementation of network-critical capacity enhancements, with the network manager and other ANSPs, to ensure that the airspace users experience the minimum disruption possible.

The value for the network disruption allowance should be sufficient that the network manager can promote network-centric behaviours and encourage close cooperation with the Network Manager and individual ANSPs, for the overall benefit of airspace users.

Simultaneously improving performance in safety, flight efficiency and cost efficiency, as well as capacity, represents a significant challenge ahead for the ANSPs. The deployment of SESAR related operational and technical improvements will require significant coordination between the Network Manager and individual ANSPs to minimise the disruption experienced by airspace users.

5 EVIDENCES FOR ESTABLISHING THE EU-WIDE RP3 COST-EFFICIENCY TARGET

5.1 INTRODUCTION

The following sections present the pieces of evidences available for establishing the RP3 EU-wide targets for cost-efficiency at time of publication of this report (i.e. April 2018), and cover the analysis of the past and current performance, namely:

- The monitoring of the en-route cost-efficiency targets at Union-wide level over RP1 and RP2 up to and including 2016;
- The evolution of EU-wide actual en route costs, service units and unit costs over 2009-2016;
- A high level analysis of the cost structure for the provision of en-route services over 2009-2016, including the differences between planned and actual costs in RP1 and RP2;
- The latest update of the US-Europe benchmarking of ANS economics (2006-2014); and
- An analysis of the ANSP “overall estimated surplus” over RP1 and RP2 up to and including 2016.

The data is presented at Union-wide level and therefore reflects the average trends for the system. It should be noted that Union-wide averages may mask considerable variations between situations in the individual Member States.

The data is taken from the RP1 and RP2 performance plans en-route reporting tables and takes account of the revised cost-efficiency targets of Malta, Bulgaria and Poland covering years 2017-2019.

These evidences on historical analysis will be complemented in May 2018 by an additional piece of evidence covering forward looking performance, namely:

- The forward-looking analysis of EU-wide en-route unit costs from States submissions due by 30 April 2018.

5.2 OBSERVED HISTORIC PERFORMANCE

5.2.1 Monitoring of RP1 and RP2 en-route cost-efficiency targets at Union-wide level

This section describes the cost-efficiency targets at Union-wide level in the two first reference periods of the SES Performance Scheme (RP1 covering 3 years 2012-2014 and RP2 covering 5 years 2015-2019), as well as the actual performance observed to date against these targets.

In the SES Performance Scheme, cost-efficiency targets are met (by design) and performance is incentivised through the features built in the Common Charging Scheme for Air Navigation services. It is nevertheless important to monitor actual performance against the cost-efficiency targets set prior to the reference period.

5.2.1.1 RP1 en-route cost-efficiency target - DUR

Table 6 presents a summary of the key data for RP1 (2012-2014): the data related to the Union-wide targets for RP1 as set in Commission Decision 2011/121/EU of 21 February 2011, the aggregated data from adopted national performance plans, and the actual data taken from the annual NSA Monitoring Reports and the June 2015 reporting tables. This information covers the 29 States that were part of the SES Performance Scheme in RP1 (i.e. it excludes Croatia which is now included in RP2).

Using the KPI defined in the Performance Regulation 691/2010, the Determined Unit Rates (DUR)[12], Table 6 shows that in RP1 overall,

(i) The DUR derived from the aggregated data from the adopted performance plans provide for a slightly lower figure for 2012 and higher figures for 2013 and 2014 in comparison to the Union-wide targets. This situation was accepted by the European Commission in the light of RP1 being a transitional period and that the States which did not contribute adequately to the Union-wide targets in RP1 would be expected to make additional efforts in their cost-efficiency performance in RP2.[13]

(ii) Compared to the adopted performance plans, actual performance at Union-wide level was slightly better than the aggregated DUR target overall in RP1 (-0.1%), although above the Union-wide targets.

(iii) Actual en-route costs in €$_{2009}$ were lower by -5.0% compared to the determined costs of the adopted performance plans, while traffic was lower by -4.9% in terms of total service units. These results confirm that the Performance Scheme for the cost-efficiency KPA is working as expected, with States/ANSPs taking actions to reduce their costs in response to lower than planned traffic demand (TSUs) so as to preserve (or even increase) their economic surplus (see point 5.2.5 below).

Data as per EC Decision on Union-wide targets for RP1		2012P	2013P	2014P	RP1 overall
Real en-route costs (EUR2009)		6 296 297 788	6 234 893 556	6 179 610 754	18 710 802 098
Total en-route service units		108 776 000	111 605 000	114 610 000	334 991 000
DUR - Real en-route unit costs per service units (EUR2009)		57.88	55.87	53.92	55.85

Data from RP1 national performance plans		2012P	2013P	2014P	RP1 overall
Real en-route costs (EUR2009)		6 258 122 341	6 318 609 442	6 304 761 101	18 881 492 884
Total en-route service units		108 359 738	111 461 030	114 964 695	334 785 463
DUR - Real en-route unit costs per service units (EUR2009)		57.75	56.69	54.84	56.40

Actual data from June 2015 reporting tables		2012A	2013A	2014A	RP1 overall
Real en-route costs (EUR2009)		6 047 812 097	5 947 919 729	5 947 263 158	17 942 994 984
Total en-route service units		103 501 763	105 171 670	109 836 771	318 510 204
AUC - Real en-route unit costs per service units (EUR2009)		58.43	56.55	54.15	56.33

Difference between actuals and EC Decision on Union-wide targets		2012	2013	2014	RP1 overall
Difference in real en-route costs	(in EUR2009)	- 248 485 691	- 286 973 827	- 232 347 596	- 767 807 114
	(in %)	-3.9%	-4.6%	-3.8%	-4.1%
Total en-route service units	(in value)	- 5 274 237	- 6 433 330	- 4 773 229	- 16 480 796
	(in %)	-4.8%	-5.8%	-4.2%	-4.9%
Real en-route unit costs per service units	(in EUR2009)	0.55	0.69	0.23	0.48
	(in %)	0.9%	1.2%	0.4%	0.9%

Difference between actuals and RP1 national performance plans		2012	2013	2014	RP1 overall
Difference in real en-route costs	(in EUR2009)	- 210 310 244	- 370 689 713	- 357 497 943	- 938 497 900
	(in %)	-3.4%	-5.9%	-5.7%	-5.0%
Total en-route service units	(in value)	- 4 857 975	- 6 289 360	- 5 127 924	- 16 275 259
	(in %)	-4.5%	-5.6%	-4.5%	-4.9%
Real en-route unit costs per service units	(in EUR2009)	0.68	- 0.13	- 0.69	- 0.06
	(in %)	1.2%	-0.2%	-1.3%	-0.1%

Table 6: Summary of RP1 en-route cost-efficiency targets (2012-2014)

[12] The Determined Unit Rate (DUR) of RP1 was replaced by the Determined Unit Cost (DUC) in RP2. The difference between the two lies in the fact that the Determined Costs used to calculate the DUR included costs for services to exempted VFR flights, while the DUC is net of costs for these services. The new terminology also better reflects what is measured and targeted and avoids the confusion with the chargeable unit rate (price paid by airspace users).

[13] See EC Recommendation 2012/C228/01 of 26.07.2012.

5.2.1.2 RP2 en-route cost-efficiency target - DUC

The key data available to date for RP2 (2015-2019) are shown in Table 7. This table summarizes the data related to the Union-wide targets for RP2 as set in Commission Decision 2014/131/EU of 11 March 2014, the aggregated data from adopted FAB performance plans, and the actual data taken from the November 2017 reporting tables. This information covers the 30 States that were part of the SES Performance Scheme in RP2 (i.e. including Croatia).

Using the KPI defined in the Performance Regulation 390/2013, the Determined Unit Costs (DUC), Table 7 shows that in the two first years of RP2,

(i) Compared to the adopted performance plans, actual performance at Union-wide level was significantly better than the aggregated DUC target in both 2015 and 2016 (by -4.5% and -6.4%, respectively). The Union-wide targets have been outperformed in both years (i.e. -6.7% lower in 2015 and -8.2% lower in 2016).

(ii) This evolution is mainly due to actual traffic being higher than planned (opposite situation than in RP1). Actual total service units were higher by +2.0% in 2015 and by +4.4% in 2016, compared to the forecasts in the adopted performance plans. This difference is further widening in 2017, where actual TSUs are higher by +8.0% than planned in the adopted performance plans. The gap between actual TSUs and the underlying assumptions for the EU-wide target is even wider due to the use of the STATFOR low forecast from September 2013 for the EU-wide targets (see also item 5.2.2 below).

(iii) Actual en-route costs in $€_{2009}$ were lower by -2.5% in 2015 and -2.2% in 2016 compared to the determined costs of the adopted performance plans. This has implications on the States/ANSPs economic surpluses in respect to cost sharing (see also item 5.2.5 below).

Data as per EC Decision on Union-wide targets for RP2		2015P	2016P	2017P	2018P	2019P
Real en-route costs (EUR2009)		6 147 905 000	6 055 686 000	5 904 294 000	5 756 687 000	5 612 769 000
Total en-route service units		108 541 000	110 196 000	111 436 000	112 884 000	114 305 000
DUC - Real en-route unit costs per service units (EUR2009)		56.64	54.95	52.98	51.00	49.10
Data from RP2 FAB performance plans		**2015P**	**2016P**	**2017P**	**2018P**	**2019P**
Real en-route costs (EUR2009)		6 235 113 277	6 195 878 072	6 164 525 008	6 110 343 143	6 018 185 578
Total en-route service units		112 687 532	115 027 116	117 494 197	120 642 948	122 962 099
DUC - Real en-route unit costs per service units (EUR2009)		55.33	53.86	52.47	50.65	48.94
Actual data from November 2017 reporting tables		**2015A**	**2016A**	**2017A**	**2018A**	**2019A**
Real en-route costs (EUR2009)		6 079 182 146	6 060 071 682			
Total en-route service units		114 994 014	120 135 471			
AUC - Real en-route unit costs per service units (EUR2009)		52.87	50.44			
Difference between actuals and EC Decision on Union-wide targets		**2015**	**2016**	**2017**	**2018**	**2019**
Difference in real en-route costs	(in EUR2009)	- 68 722 854	4 385 682			
	(in %)	-1.1%	0.1%			
Total en-route service units	(in value)	6 453 014	9 939 471			
	(in %)	5.9%	9.0%			
Real en-route unit costs per service units	(in EUR2009)	- 3.8	- 4.5			
	(in %)	-6.7%	-8.2%			
Difference between actuals and RP1 national performance plans		**2015**	**2016**	**2017**	**2018**	**2019**
Difference in real en-route costs	(in EUR2009)	- 155 931 130	- 135 806 390			
	(in %)	-2.5%	-2.2%			
Total en-route service units	(in value)	2 306 482	5 108 355			
	(in %)	2.0%	4.4%			
Real en-route unit costs per service units	(in EUR2009)	- 2.5	- 3.4			
	(in %)	-4.5%	-6.4%			

Table 7: Summary of RP2 en-route cost-efficiency targets (2015-2019)

5.2.1.3 Key points for RP3 target setting

- So far the cost-efficiency targets set in the performance plans adopted by the States have been outperformed at EU-wide level for RP1 as a whole and for the two first years of RP2;
- In RP1, States/ANSPs were able to adjust their costs downwards compared to plans (-5.0% for the period) in reaction to lower traffic than planned (-4.9% for the period). This has resulted in an average real en-route actual unit cost of 56.33 $€_{2009}$ at Union-wide level for the period, i.e. better than the average DUR aggregated from the performance plans of 56.40 $€_{2009}$ by -0.1%;
- In RP2, the DUC at Union-wide level has been outperformed in the two first years of the period (for which actual data is available at the time of writing this report), by -4.5% and -6.4% respectively, mainly as a result of significantly higher actual traffic than planned (by +2.0% and +4.4% respectively) but also as a result of lower actual costs than planned (-2.5%; -2.2%) in spite of the higher traffic.

5.2.2 Evolution of EU-wide actual en-route costs, service units and unit costs over 2009-2016

This section describes historical and current trends in the actual en-route unit costs since 2009, when the SES II package was developed. 2009 was also the last year of available actual cost data at the time of setting the first Union-wide targets in RP1.

The data is presented in Table 8. In order to have consistent series, it has been computed for the 30 States participating to the Performance Scheme in RP2 and on the basis of the RP2 definition of total costs in real terms, i.e. after deduction of costs for services to exempted flights. The data is taken from the November 2017 reporting tables.

Actual data	2009	2010	2011	2012	2013	2014	2015	2016
Real en-route costs (EUR2009)	6 302 059 643	6 117 433 826	6 023 434 500	6 121 684 913	6 020 379 322	6 017 964 074	6 079 182 146	6 060 071 682
% YoY		-2.9%	-1.5%	1.6%	-1.7%	0.0%	1.0%	-0.3%
Total en-route service units	99 364 769	101 937 437	106 678 327	105 180 397	106 866 247	111 594 616	114 994 014	120 135 471
% YoY		2.6%	4.7%	-1.4%	1.6%	4.4%	3.0%	4.5%
AUC (EUR2009)	63.42	60.01	56.46	58.20	56.34	53.93	52.87	50.44
% YoY		-5.4%	-5.9%	3.1%	-3.2%	-4.3%	-2.0%	-4.6%

Table 8: Actual real en-route unit costs RP2 States

Figure 24 shows the evolution of the actual real en-route costs, actual total service units and actual en-route unit cost (AUC) based on an index 100 in 2009. It highlights that:

(i) Traffic growth in TSUs was strong in 2010 and 2011, leading to the expectation that traffic growth would continue in RP1, as reflected in the RP1 targets. Instead, the economic downturn caused traffic to decrease in 2012 (-1.4% in TSUs) followed by a slow return growth until 2014. As a result, actual traffic was below planned traffic at EU-wide level in RP1 (see 5.2.1.1 above).

(ii) The traffic in the 2015 and 2016 showed robust growths of +3% and +4.5% respectively. According to the latest baseline STATFOR forecast (February 2018 issue), the number of TSUs is expected to continue to increase by +4.3% on average p.a. until the end of RP2. As a result, the actual number of TSUs is significantly above the forecasts in the adopted performance plans. This will generate significant additional revenues for the States/ANSPs in respect to the traffic risk sharing adjustments and have implications on the ANSPs economic surpluses (see item 0 below), as well as on the share of these additional revenues that States/ANSPs have to reimburse to airspace users two years later. Table 9 below shows that higher traffic than planned in 2015-2017 generated already 641.1 M€ additional revenues to be reimbursed to users in 2017-2019. It also indicates an estimate of the additional revenues that would have to be returned to users due to higher traffic than planned in 2018 and 2019 if the latest STATFOR February 2018 baseline scenario would materialise. These amounts to be returned to users in the first two years of RP3 would amount to 1034.4 M€. Table 9 also shows the amounts to be charged to airspace users in respect of lower traffic than planned. These amounts can be charged two year later or beyond, at the States' choice.

(iii) Actual costs have remained relatively stable since 2009. Decreases are noted in 2010 and 2011, which resulted from cost-containment measures in response to the economic and financial pressures that had arisen from the 2009 economic crisis. The decrease in 2011 also reflects the one-off reduction in EUROCONTROL costs (-55M€). Increases are noted in 2012 and 2015, which correspond to the first years of the reference periods. These increases are linked to staff costs, inter alia pension costs, in a few Member States (see also 5.2.3 below).

(iv) Overall, over the 7-year period from 2009 to 2016, the actual real en-route unit cost has decreased by -20.5%, as costs decreased by -3.8% over the period, while the number of TSUs has increased by +20.9%. Details on the trend at EU-wide level per entity and per nature of costs are presented in item 5.2.3 below.

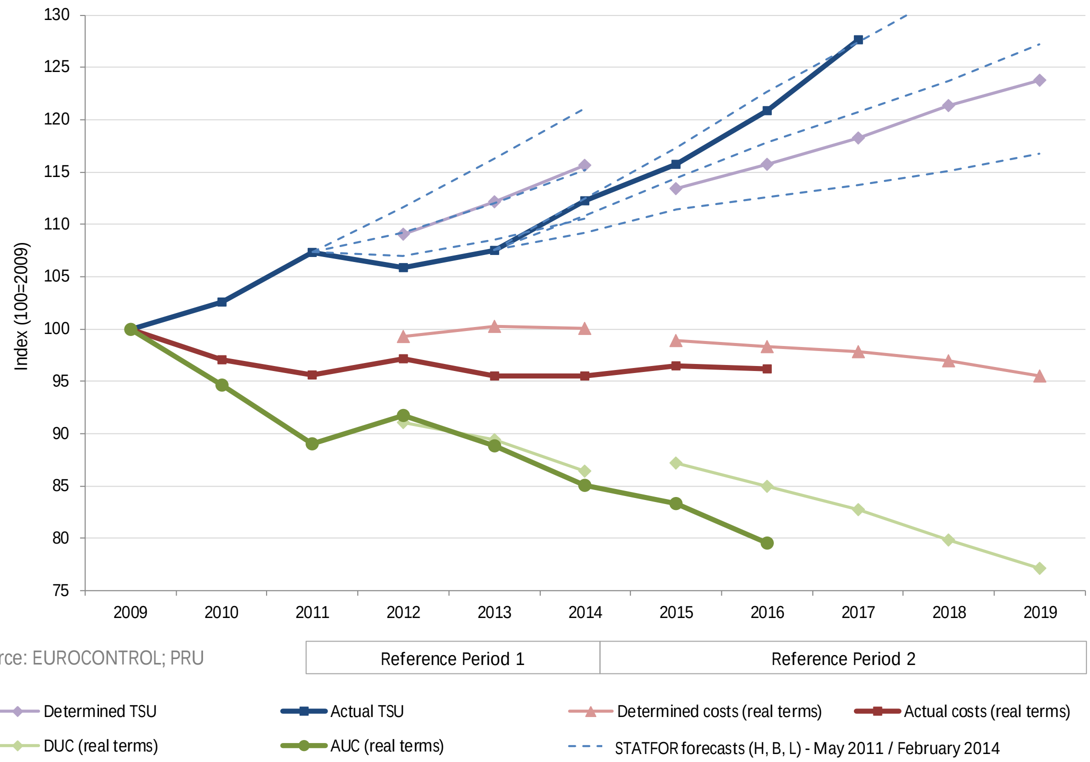


Figure 24: En-route cost-efficiency trends 2009-2016 (index 2009=100)

In MEUR (at 2017 average exchange rate)	2015 A	2016 A	2017 A	2015-2017A	2018 F	2019 F	2018-2019F
Number of charging zones with higher traffic than planned in the PP	21	22	27		28	27	
Additional revenues due to higher traffic than planned in the PP	145.1	321.8	581.9	1 048.8	672.5	790.5	1 463.0
Amounts kept by the ANSPs	68.4	140.2	199.1	407.7	208.7	219.9	428.6
Amounts to be returned to users in N+2	76.7	181.6	382.8	641.1	463.8	570.6	1 034.4
In % of the determined costs	1.1%	2.6%	5.4%	3.0%	6.5%	8.0%	7.3%
Number of charging zones with lower traffic than planned in the PP	9	8	3		2	3	
Loss of revenues due to lower traffic than planned in the PP	- 66.7	- 66.6	- 45.4	- 178.7	- 47.2	- 52.8	- 100.0
Amounts borne by the ANSPs	- 33.0	- 30.0	- 19.7	- 82.8	- 19.5	- 20.8	- 40.3
Amounts to be charged to users in N+2 or beyond	- 33.7	- 36.5	- 25.6	- 95.9	- 27.7	- 32.0	- 59.6
In % of the determined costs	-0.5%	-0.5%	-0.4%	-0.5%	-0.4%	-0.4%	-0.4%

Table 9: Amounts to be charged/returned to users due to the difference between planned and actual traffic in RP2

5.2.2.1 Key points for RP3 target setting

- En-route costs remained nearly unchanged in real terms since 2009 (reference year for RP1 targets) while service units have grown significantly albeit with some downturns.
- In RP2, determined traffic in the adopted performance plans was set on the low forecast scenario for a number of States (as was the case for the EU-wide targets), while traffic has been and is forecast to remain above the STATFOR baseline forecast 2014 issued at the time of preparing the performance plans. As a result, the actual number of TSUs is significantly above the forecasts in the adopted performance plans.
- This difference between actual and planned traffic in RP2 will generate significant additional revenues for the States/ANSPs in respect to the traffic risk sharing adjustments and have implications on the ANSPs economic surpluses (see item 5.2.5 below).
- This difference also generates significant additional revenues to be reimbursed to airspace users two years later. Hence the higher actual traffic than planned in 2015-2017 generated already 641.1 M€ additional revenues to be reimbursed to users in 2017-2019. If the latest STATFOR February 2018 baseline scenario would materialise in 2018-2019, the amounts to be returned to users in the first two years of RP3 would amount to 1034.4 M€.
- This situation underlines the importance of the choice of the traffic forecast for establishing the EU-wide target on cost-efficiency in RP3.

5.2.3 High level analysis of the cost structure for the provision of en-route services

This section presents the structure of the actual real en-route costs at Union-wide level, per entity type and per cost nature, as well as their evolutions over the period 2009-2016. The data is aggregated for the 30 States participating to the Performance Scheme in RP2.

It also presents the differences between the planned and actual data for the each of the cost items by entity and by nature in RP1 and in the first two years of RP2.

5.2.3.1 Evolution of the total actual real en-route costs by entity 2009-2016

Figure 25 below presents the evolution of the actual real en-route costs based on an index 100 in 2009, as well as the share of the costs per entity for 2016. It should be noted that the share between entities has remained stable overall over the period.

Figure 25 shows that:

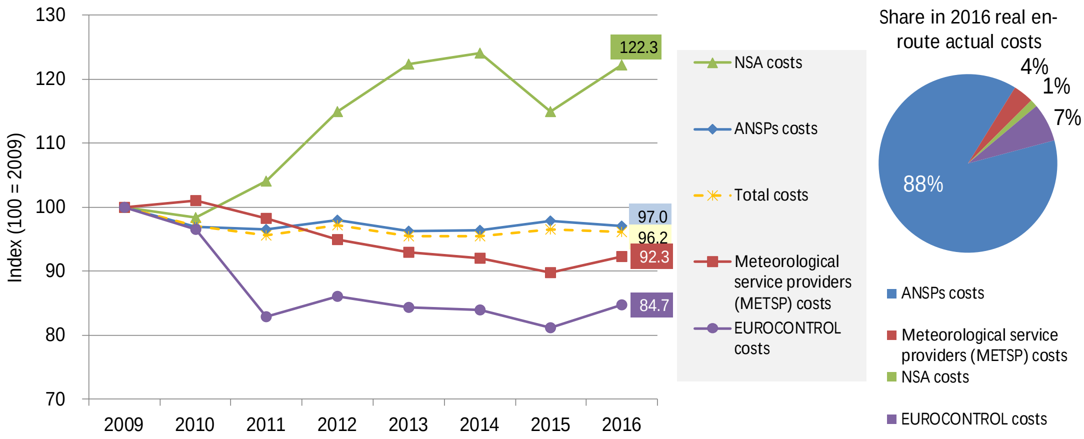
(i) As presented in 5.2.2 above, real en-route actual costs have remained nearly unchanged in real terms since 2009 (-3.8% over the 7-year period between 2009 and 2016).

(ii) The large majority of real en-route costs are incurred by the ANSPs (88% in 2016) and have remained relatively stable since 2009 (a decrease of -3.0% over the 7-year period). The ANSPs are subject to traffic risk-sharing and financial incentives on capacity (and environment) in addition to the cost-sharing incentive (which applies to all entities).

(iii) The EUROCONTROL costs as recorded in the actual costs of the States (accounting for 7% of the total costs in 2016) have remained stable overall between 2012 and 2016, after a significant decrease in 2011 due to a one-off effect related to IFRS.

(iv) The METSPs costs (accounting for 4%) have decreased overall over the period 2009-2016 (by -7.7% over the 7-year period). It should be noted that the MET costs provided by separate entities from the ANSPs and recorded here as METSPs account for around 80% of the total MET costs for the en-route activity, the remaining 20% of MET costs are provided by the ANSPs and recorded in the ANSPs costs.

(v) The NSA costs account for around 1% of the total en-route costs. They have increased significantly over the period (+22.3% over the 7-year period). The dip observed in 2015 is due to the recording as negative exceptional costs of the reimbursement of the German NSA cost-sharing surplus 2012 and 2013 to users.



Source: EUROCONTROL; PRU

Figure 25: Real en-route costs trends (index 2009=100) and shares per entity

5.2.3.2 Evolution of the total actual real en-route costs by nature 2009-2016

Figure 26 below presents the evolution of the actual real en-route costs by nature for the main items based on an index 100 in 2009, as well as the share of the costs per entity for 2016. The exceptional costs (representing -0.2% of the actual costs) and the deduction of costs incurred for services provided to exempted VFR flights (representing -0.3% of the actual costs) are excluded from the figure due to their negligible impact on the trend.

Figure 26 indicates that:

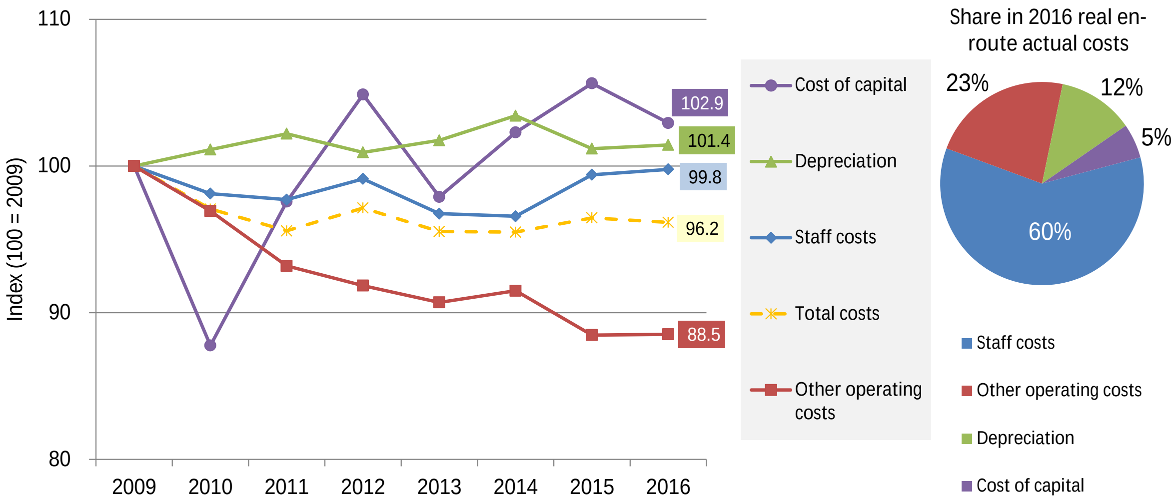
(i) The staff costs account for the largest part of real en-route costs (around 60%). Staff costs in 2016 are at a similar level as in 2009 (-0.2% lower). Year on year variations reflect the sensitivity of the staff costs to variations in pension costs and their treatment. Increases are noted in 2012 and 2015, which correspond to the first years of the reference periods and reflect inter alia increases in pension costs in a few Member States which may be imputable to a change in the hypotheses set for the reference period. The issue of pension costs could potentially become more important in the future and should be carefully considered when setting the RP3 targets. The upcoming PRC pension study that will become available in the autumn could be useful during the discussions that will take place in view of the adoption of the RP3 EU-wide targets.

(ii) The other operating costs are the second largest component and accounted for around 23% in 2016. They have decrease by -11.5% over the period 2009-2016, i.e. -1.7% per year on average and constitute the area where cost-reduction and cost-containment measures are the most visible.

(iii) The investment costs represent around 18% of the real en-route actual total costs (12% for depreciation and 6% for the cost of capital).

(iv) Depreciation costs have remained stable over the 7-year period (+1.4% or +0.2% per year on average).

(v) The actual cost of capital has slightly increase between 2009 and 2016 (+2.9% or +0.4% per year on average). Year on year changes reflect mainly the variations in the net book value of the asset base occurring in the amounts recorded as adjustments and as net current assets, whereas the net book value of fixed assets has continued to decrease year on year. This steady decrease in the net book value of fixed assets could be a sign of underinvestment in equipment, which could be detrimental to current and future quality of service.



Source: EUROCONTROL; PRU

Figure 26: Real en-route costs trends (index 2009=100) and shares per cost nature

5.2.3.3 Differences between determined and actual real en-route costs at Union-wide level in RP1

Figure 27 below shows the difference between planned and actual real en-route costs at Union-wide level for the States participating to the Performance Scheme in RP1. The planned and actual costs have been computed with the RP2 rules, i.e. after deduction of costs for exempted VFR flights and therefore give slightly different results than in item 5.2.1 above. It shows that, for RP1 as a whole at Union-wide level:

(i) Actual real en-route costs were lower than planned by -5.1% or -954.4 M€$_{2009}$. This could reflect the effect of the adopted cost control measures in response to traffic volumes lower than planned (see item 5.2.1).

(ii) Actual real en-route costs were lower for each entity type, the ANSPs being the main contributors to this difference (-837.2 M€$_{2009}$).

(iii) As far as costs by nature are concerned, all cost items were also lower than planned. The exceptions to this situation relate to exceptional costs (due to exceptional and often unforeseeable nature of exceptional costs) and to the deduction of costs for exempted VFR flights, which were lower in real terms than the amounts presented in the adopted performance plans, thereby generating a positive difference.

(iv) Variations suggest that around 74% of the cost savings achieved in RP1 relate to structural measures in the staff costs (-415.8 M€$_{2009}$ or -3.8% compared to plan) and other operating costs (-291.1 M€$_{2009}$ or -6.5% lower than planned) categories.

(v) Actual real en-route depreciation costs were -10.2% lower than planned or -249.3 M€$_{2009}$ for the RP1 period. The fact that depreciation costs are significantly lower than planned in the adopted performance plans can be explained by four main drivers: 1) the postponement of capital expenditures to future years given lower than expected traffic volumes, 2) temporary delays which are due to technical issues, 3) in some cases likely overestimation of capex during the planning phase, and 4) the fact that the depreciation costs are converted in real terms in the same manner as the operating costs, whereas these are only slightly affected by inflation (hence, as actual inflation was higher than planned, the actual depreciation costs would seem to be lower than planned if they were the same as planned in nominal terms).

(vi) The difference between planned and actual cost of capital is proportionally smaller than for depreciation, which seems to contradict the fact that actual capex was lower than planned. This is mainly due to much higher adjustments to total assets and net current assets than planned, whereas indeed the net book value of fixed assets is significantly lower than planned (-7.8%), which reflects the fact that the capex plans of the ANSPs for the period were not fully realised.

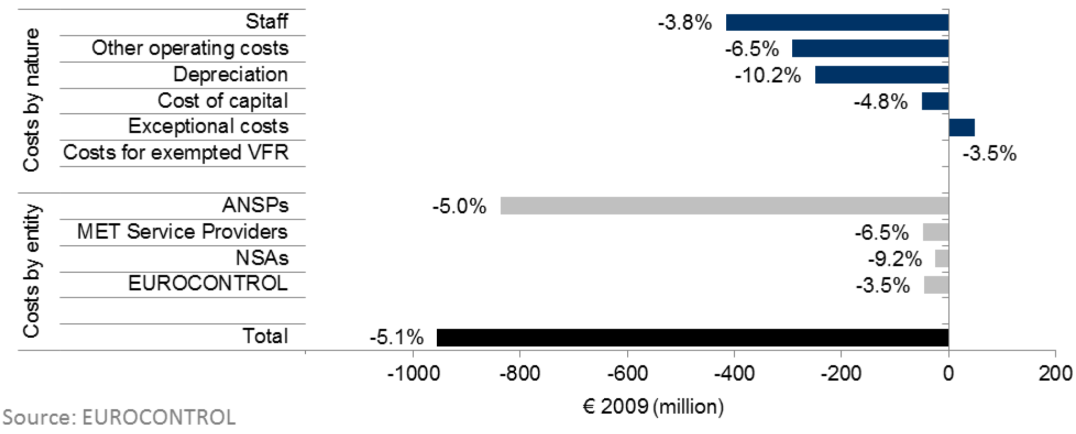


Figure 27: Actual real en-route costs compared to plan – RP1 (2012-2014)

5.2.3.4 Differences between determined and actual real en-route costs at Union-wide level in RP2 up to and including 2016

Figure 28 below shows the difference between planned and actual real en-route costs at Union-wide level for the two first years of RP2. It shows that, for at Union-wide level:

(i) Actual real en-route costs were lower than planned by -2.3% for the two first years of RP2 (-291.7 M€$_{2009}$). This gap has reduced from -155.9 M€$_{2009}$ in 2015 to -135.8 M€$_{2009}$ in 2016 (see also Table 7).

(ii) As for RP1, actual real en-route costs were lower for each entity type, the ANSPs being the main contributors to this difference (-283.0 M€$_{2009}$). This time, this situation occurs in the context of significantly higher actual traffic than the forecast presented in the performance plans (see also see item 5.2.1).

(iii) As far as costs by nature are concerned, all cost items were also lower than planned (except for the exceptional costs and the deduction of costs for exempted VFR flights, as explained above).

(iv) Actual real en-route staff costs are -1.0% (-71.1 M€$_{2009}$) lower than the aggregated figure from the performance plans. The difference observed in 2016 is small (-15.5 M€$_{2009}$ or -0.4%) and reduced compared to the difference observed for 2015 (-55.6 M€$_{2009}$ or -1.5%). This may suggest a reversed situation for the remaining of years RP2.

(v) The largest part of the total difference between planned and actual costs is imputable to the other operating costs (-155.5 M€$_{2009}$ or -5.3%), with similar situations in both first years of RP2 (-75.6 M€$_{2009}$ or -5.2% for 2015 and -79.9 M€$_{2009}$ or -5.5% for 2016).

(vi) Actual real en-route depreciation costs are -4.9% lower than planned or -75.2 M€$_{2009}$ for the two-year period. The net book value of fixed assets is also lower than planned at system level (-4.4%).

(vii) The actual real en-route cost of capital is only -0.5% lower than planned for the two first years of RP2, mainly due to the fact that the actual net current assets are significantly higher than planned.

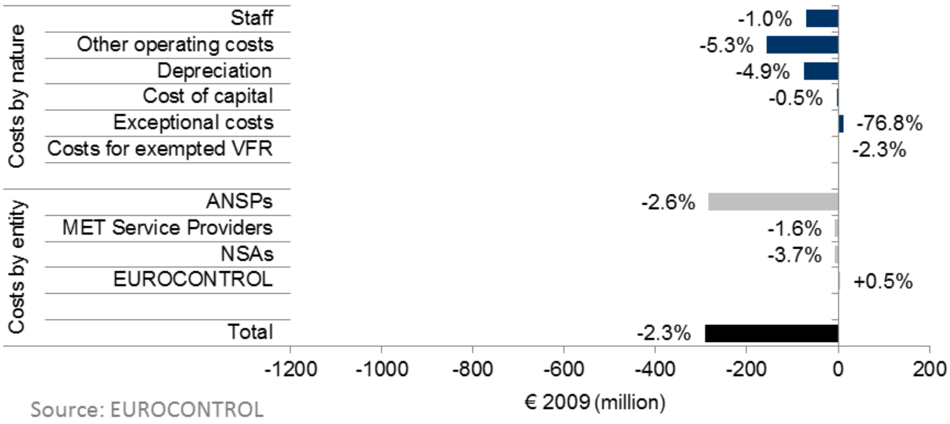


Figure 28: Actual real en-route costs compared to plan – first two year of RP2 (2015-2016)

5.2.3.5 Key points for RP3 target setting

- Staff costs accounting for around 60% of the total en-route costs have remained stable overall in real terms over the period 2009-2016 but are sensitive to variations in pension costs and their treatment. These variations potentially become larger in the future and should be carefully considered when setting the RP3 targets. The upcoming PRC pension study that will become available in autumn could be useful during the discussions that will take place in view of the adoption of the RP3 EU-wide targets.
- The net book value of fixed assets has been decreasing steadily since 2012 at system-wide level (by 11.1% over the 5-year period until 2016, or -2.3% on average per annum). This could be a sign of underinvestment in equipment, which could be detrimental to current and future quality of service.
- At EU-wide level, real actual en-route costs have been lower than the determined costs from the States adopted performance plans across the different entities and the different items by nature, both in the situation when actual traffic has been lower than planned and in the reverse situation when actual traffic has been higher than planned.
- The majority of the real en-route determined and actual costs are incurred by the ANSPs (88% of total actual in 2016), which are also the entities subject to traffic risk-sharing and financial incentives on capacity (and environment) in addition to the cost-sharing incentive. Their costs have remained stable overall at EU-wide level during the 7-year period between 2009 and 2016. They were -5.0% below plan in RP1 and -2.6% below plan for the two first years of RP2.

5.2.4 Latest update of the US-Europe benchmarking of ANS economics (2006-2014)

This section sets out a high-level comparison of the cost-efficiency performance of the ANSPs operating in the SES States and US Air Traffic Organisation within the Federal Aviation Administration (FAA-ATO). The comparative analysis is focused on the period from 2006-2014, for which latest cost data for the FAA-ATO is available. It draws from a more detailed study, including a high level comparison of cost-efficiency performance between the EU and US [5].

Due to its size and traffic density, the FAA-ATO is considered to be a realistic comparator for the European ANS system. It is however acknowledged that, even though many similarities exist between the FAA-ATO and the European ANS systems, there are different legal/regulatory, economic, social, cultural and operational environments which affect observed differences in performance. Whereas the US system is operated by one single ANSP, in Europe ANSPs are still largely organised by State boundaries with different working arrangements and cost structures and therefore many issues revolve around the level of fragmentation and its impact on ANS performance and costs.

The high-level figures highlighting differences in operational characteristics between the continental

U.S. and the SES States are summarised in the Table 10 below.

2014	SES RP2 Area (EU28+2 States)	US FAA-ATO	Difference US vs. SES
Geographic Area (million km²)	9.5	14.8[14]	57%
Number of Air Traffic Controllers (ATCOs in OPS)	15 025	12 959	-14%
Total staff	42 897	31 501	-27%
Flight-hours controlled (million)	12.9	22.9	78%
Controlled flights (IFR) (million)	9.1	15.2	67%
Relative density (flight-hours per km²)	1.4	1.5	13%
Number of en route facilities	51	23	-
Number of terminal facilities (stand alone and collocated)	221	161	-27%
Number of airports with ATC services	332	517	56%
ATM/CNS provision costs (in billion €2015 for Europe and billion US$2015 for the USA)	€ 7.12	$10.96	-
ATM/CNS provision costs (in billion €2015)	€ 7.12	€ 8.27	16%
Source:	Eurocontrol	FAA/ATO	

Table 10: European and US operational structures and traffic (2014)

5.2.4.1 Sources and methodology

The comparison presented in this section covers the period 2006-2014 and focuses on the costs of ATM/CNS provision. The analysis is undertaken on a gate-to-gate basis and draws heavily on the ACE analysis framework[15]. The information for the SES States also includes data for 2015, which is not available for the FAA-ATO. While this does not allow for a direct comparison, it nevertheless provides a good indication of the latest trends in cost-efficiency performance for the SES States.

The US data was provided by the FAA-ATO in 2016 and is consistent with the CANSO submission, which has underlying definitions of cost items and output metrics that are in line with those used in the context of ATM cost-effectiveness (ACE) benchmarking programme in Europe. The data for SES States is an aggregation of the data submitted by the ANSPs for the EU28+2 States (29 national ANSPs plus Maastricht UAC), which were subject to the Second Reference Period of the SES Performance Scheme. The data was submitted to the PRU in 2016 for the ACE benchmarking cycle, with some adjustments to make the US and European figures more comparable (e.g. ACE data excludes MET costs and cost of capital, but includes costs for the Central Flow Management Coordination).

The costs are presented in real terms (2015 prices) and in a common currency (Euros) using currency exchange and inflation rates published by Eurostat. This approach allows for consistent analysis of time-series data which can be distorted by transient fluctuations in spot exchange rates between 2006 and 2015. An average exchange rate of US$1.33: €1 was applied on the US costs consistently for the entire period. Important to note that US costs are particularly sensitive to the exchange rate used in the analysis e.g. if an annual average annual exchange rate of 2015 (US$1.11: €1) was used, the FAA costs in 2014 would be some 20% higher, when converted to Euros.

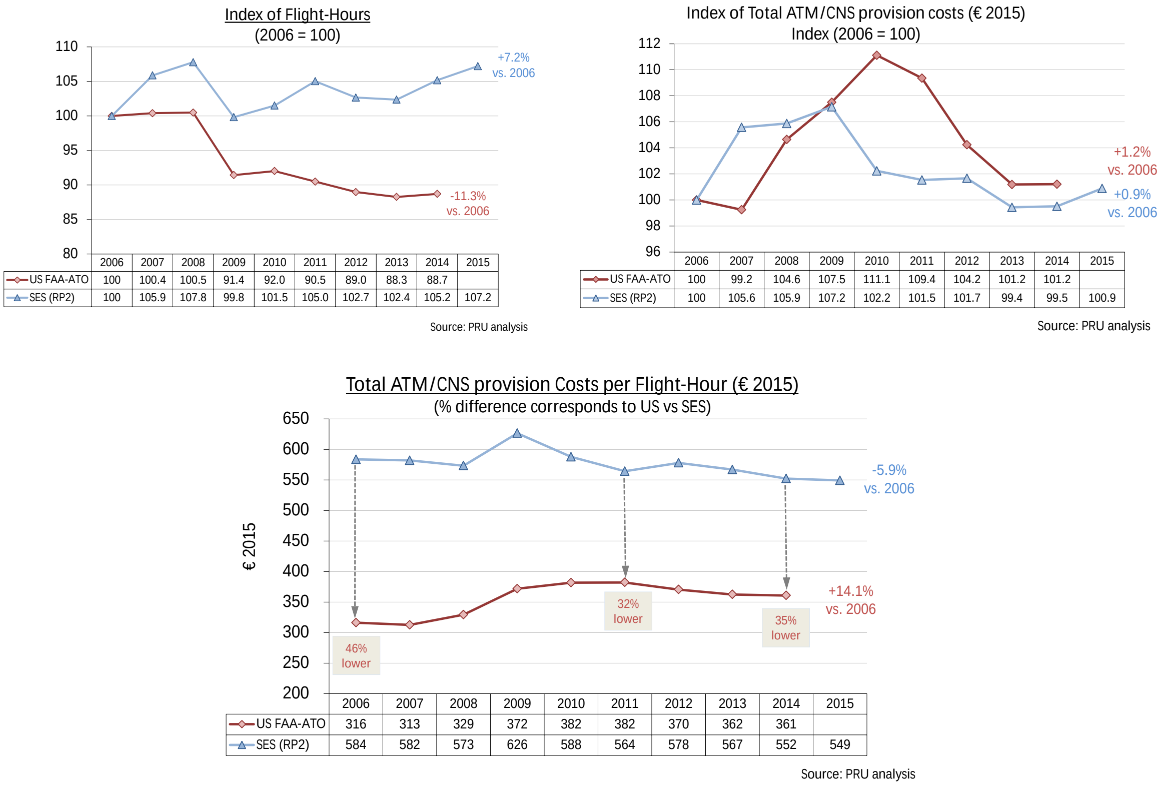
5.2.4.2 ATM/CNS unit costs per flight-hour

Over the period from 2006 to 2014, the ATM/CNS unit costs per flight hour for the US have been consistently lower than for the SES States (see Figure 29 below). While the total ATM/CNS costs in the SES States and the US in 2014 are broadly similar (8.3 B€2015 for the US and 7.1 B€2015 for the

[14] 10.4 million km² excluding Alaska and Hawaii

[15] See "ATM Cost-Effectiveness (ACE) 2015 Benchmarking Report with 2016-2020 outlook" for more information. Available online on: http://www.eurocontrol.int/publications/atm-cost-effectiveness-ace-2015-benchmarking-report-2016-2020-outlook

SES States), the FAA-ATO serviced nearly twice the level of traffic controlled in the SES States (22.9 M flight-hours, compared to 12.9 M in Europe).



Index of Flight-Hours (2006 = 100)

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
US FAA-ATO	100	100.4	100.5	91.4	92.0	90.5	89.0	88.3	88.7	
SES (RP2)	100	105.9	107.8	99.8	101.5	105.0	102.7	102.4	105.2	107.2

Index of Total ATM/CNS provision costs (€ 2015), Index (2006 = 100)

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
US FAA-ATO	100	99.2	104.6	107.5	111.1	109.4	104.2	101.2	101.2	
SES (RP2)	100	105.6	105.9	107.2	102.2	101.5	101.7	99.4	99.5	100.9

Total ATM/CNS provision Costs per Flight-Hour (€ 2015)

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
US FAA-ATO	316	313	329	372	382	382	370	362	361	
SES (RP2)	584	582	573	626	588	564	578	567	552	549

Figure 29: Unit ATM/CNS provision costs in the SES States compared to the US

Since 2006, there has been a considerable reduction of the gap in total ATM/CNS costs per flight-hour between the SES States and US ATO, from 46% in 2006 to 35% in 2014, which, for the SES States can be seen as a combination of:

(i) growth in traffic volumes (in terms of flight-hours) over this period (+0.6% p.a. on average), with notable downturns in 2009 and 2012; and,

(ii) slight reduction in ATM/CNS costs (-0.1% p.a.), in particular over the period from 2009 to 2014, during which costs decreased by-1.5% p.a. on average.

At the same time, the traffic in the US has declined significantly (-1.5% p.a. on average) over 2006-2014, while the costs were some +1.2% higher by the end of the period, which resulted in the unit ATM/CNS costs being some +14.1% higher in 2014 than at the beginning of the period.

The available data for the SES States show that the trend of decreasing unit ATM/CNS costs continued in 2015, with the unit costs being -5.9% lower than at the beginning of the analysis period, albeit the improvement in unit costs was solely driven by an increase in traffic volumes (+1.9%) since the costs also grew by +1.4% between 2014 and 2015.

Nevertheless, despite significant improvements in Europe, the FAA-ATO continues to provide services at a much lower unit cost. This indicates that further cost-efficiency improvements should be possible in the SES States in the long run.

5.2.4.3 ATCO productivity and employment costs

The average employment costs per ATCO in operations in 2014 are similar in both Europe and the US, however, due to the differences in average working hours, the employment costs per ATCO-hour in the US are notably lower than in the SES States (see Figure 30 below). This gap has continuously widened from -12% in 2006 to -32% in 2014, driven by divergent trends in hourly employment costs in Europe and the US.

For the US, the employment costs per ATCO-hour decreased at an average rate of -1.8% p.a., while for the SES States the hourly costs grew, on average, by +1.5% p.a. over the period, with a notable decrease in 2010 resulting from the implementation of structural changes in one Member State. Recent data for the SES States shows that this trend continued in 2015 with a further increase in costs per ATCO-hour of +2.4%.

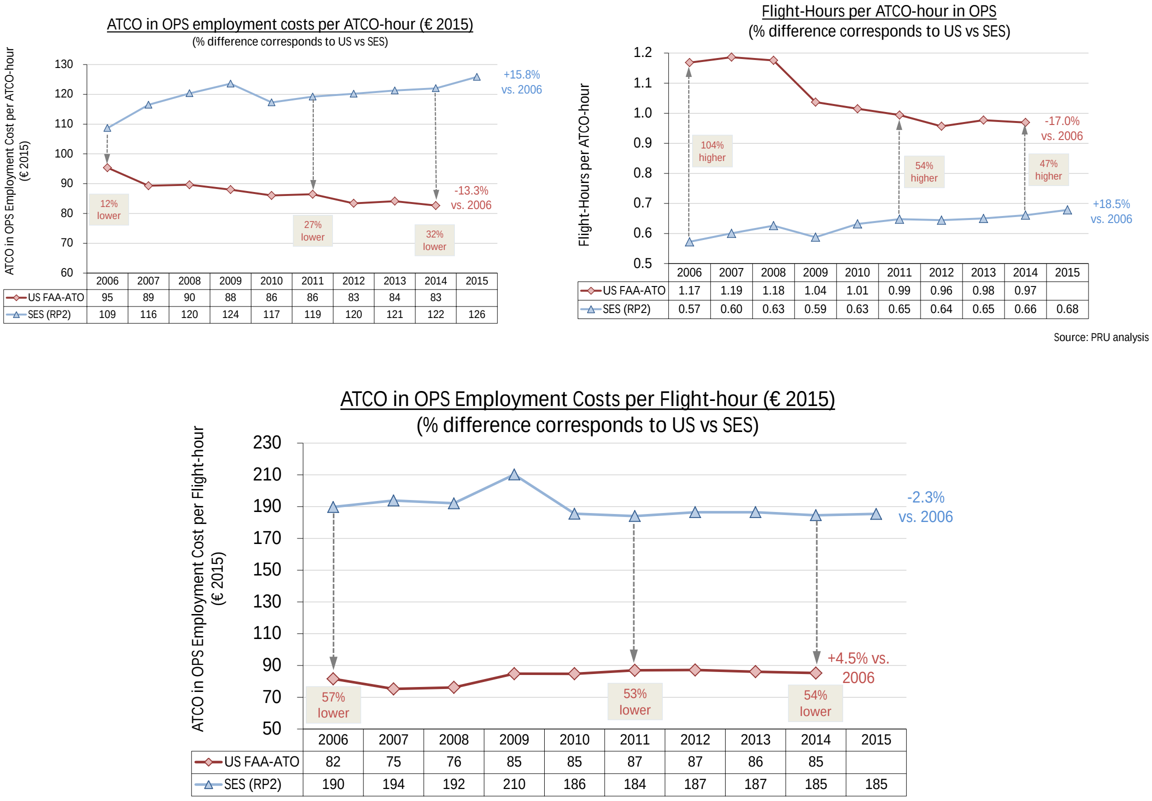


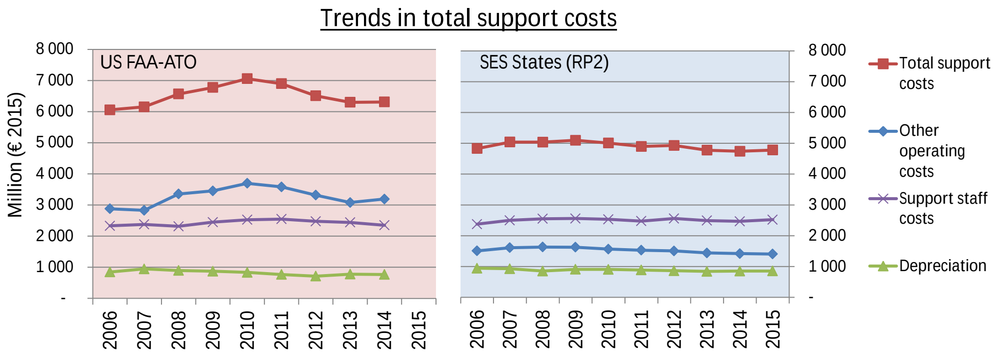
Figure 30: ATCO productivity and employment costs

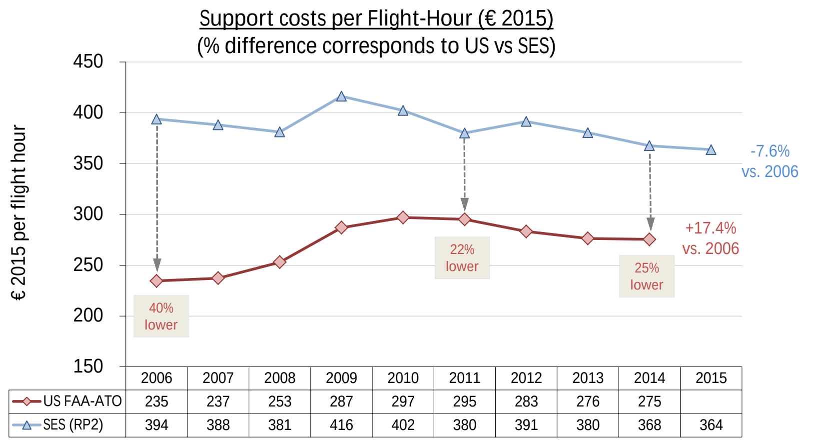
Since, as highlighted in Table 10, in 2014 the US handled some 80% more traffic than the SES States, this is also reflected in the measure of ATCO-hour productivity, which was consistently higher in the US over the whole period. It is noted that the gap in productivity, which measured 104% in 2006 indicating that US ATCOs handled twice as many flight-hours per hour as their European counterparts, continued to diminish over the whole period and was reduced by half (47%) by 2014. This improvement results from opposite trends in the average annual working hours per ATCO in the SES States and the US between 2006 and 2014 (-12.7% and +3.8% respectively over the period) as well as diverging traffic trends as indicated in the top left part of Figure 29.

While the ATCO costs per flight-hour remained mostly flat in the SES States and the US, in particular over the period from 2010 to 2014, this masks different drivers. For the US, this should be seen as a result of increasing ATCO-hours coupled with a reduction in costs, which compensated the declining traffic. On the other hand, for the SES States the stable ATCO employment costs per flight-hour suggests that the productivity gains were diminished by decreasing ATCO hours and increasing employment costs.

5.2.4.4 Support costs per unit of output

The total support costs have increased +4.2% in the US over the period from 2006 to 2014, while they have slightly decreased in the SES States (-1.8% over the period). At the end of the period, the total support in the US were some 33% higher than in Europe, which is primarily due to much higher other operating costs, while the depreciation and support staff costs were at a comparable level. The gap also reflects differences in accounting practices, since the growth in other operating costs in the US between 2006 and 2010 is driven mostly by changes in procurement practices associated with NextGen[16].





	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
US FAA-ATO	235	237	253	287	297	295	283	276	275	
SES (RP2)	394	388	381	416	402	380	391	380	368	364

Source: PRU analysis

Figure 31: Unit support costs in the SES States compared to the US

Over the period 2006 to 2014, the unit support costs have reduced continuously in the SES States (-0.9% p.a. on average) with notable interruptions in 2009, when a dip in traffic volumes raised the unit support costs by +9.2%, and in 2012, when unit costs grew by +3.0% due to traffic downturn. The trend of decreasing unit support costs for the SES States is achieved mostly by decreasing costs in the context of traffic increase (-1.8% and +5.2% respectively over the period). This is particularly the case for the period from 2009 to 2014, when the traffic volumes increased by +1.0% p.a. on average, while the support costs decreased, on average, by -1.4% p.a.

During the same period, unit support costs for FAA-ATO increased at an average rate of +2.0 p.a. between 2006 and 2014, with a significant growth between 2006 and 2010 (+6.1% p.a.) driven by increasing other operating costs (mostly due to changes in procurement practices) as well as significant traffic downturn in 2009. However, the unit support costs reduced by -1.9% p.a. between 2010 and 2014 as a result of cost reductions (-2.8% p.a.) in the context of decreasing traffic (-0.9% p.a.).

[16] U.S. Next Generation Air Transportation System.

As a result, the gap in the unit support costs between the SES States and the US has almost halved from 40% in 2006 to 25% in 2014. The presence of this gap can, in part, be attributable to the fact that the US benefits from economies of scale due to fewer operational units compared to the highly fragmented ATM landscape in Europe. At the same time, the analysis shows improvements in the SES States, which have managed to slightly reduce support costs while handling increasing traffic volumes, resulting in notable reduction of the gap. Indeed, the latest available data for the SES States shows that the trend of decreasing unit support costs continued in 2015, primarily driven by mostly stable costs in the context of traffic growth over 2014-2015 period.

5.2.4.5 Key points for RP3 target setting

- Since 2006, there has been a considerable reduction of gap in the total ATM/CNS unit cost per flight hour across the European SES States as compared to the US ATO. This mostly reflects the reduction in costs for the SES States (-0.1% p.a. on average), in particular from 2009, as well as traffic growth in Europe (+0.6 p.a. on average), while at the same time the traffic has declined consistently in the US over the period following the economic crisis (-1.5% p.a. on average).
- While the trends in unit costs for US and Europe are converging, a gap of 35% in 2014 still remains (see Figure 29). The FAA-ATO continues to provide services at a significantly lower unit cost, which indicates that some level of cost-efficiency improvements should be possible in the SES States in the long run.
- The ATCO employment costs per flight-hour remained mostly flat for in the SES States and the US over the period. As a result, the gap remained mostly unchanged over 2006-2014 with the unit ATCO employment costs in the US being some 54% lower at the end of the period. This suggests that the significant productivity gains recorded for the SES States (+18.5% over the period) were absorbed by growth in ATCO costs per ATCO-hour (see Figure 30).
- The support costs per flight-hour in 2014 were some 25% lower in the US despite significant improvements in the SES States, which managed to handle growing traffic volumes while maintaining the support costs mostly flat. While this gap is likely to result from the fragmentation in the European ANS industry and economies of scale in the US, the results suggest that there is still room for further improvement in Europe.

5.2.5 Historic analysis of ANSP surplus over RP1 and RP2 up to and including 2016

This section presents the evolution of the "overall estimated economic surplus" for the en-route activity for the main ANSPs covered by the SES performance scheme over RP1 and RP2 up to and including 2016. The main en-route ANSPs are the most significant contributors to the en-route costs (around 85% of the total cost base) and are the main entities subject to the financial incentive schemes.

5.2.5.1 The concept of "economic surplus"

The concept of "estimated economic surplus" is different from the net accounting profit disclosed by the ANSPs in their financial statements. The "estimated economic surplus" looks at the surplus generated by the en-route activities performed in a particular year and in respect of the charging zones concerned. The net accounting profit includes revenues and costs relating to other activities which are not financed through route charges, as well as revenues and costs pertaining to other years of activity, and is therefore not comparable with the notion of economic surplus. As a consequence, the "overall economic surplus" expressed as a percentage of the en-route revenues is not directly comparable to the profit margin that would be calculated from ANSPs' financial statements.

Ex-ante, the cost of capital from the adopted performance plans includes an element of "economic surplus" consisting of a "reasonable return on assets"[17], the return on equity (RoE) embedded in the determined cost of capital.

The financial incentives supporting the implementation of binding performance targets in the SES Performance Scheme and implemented through the SES Charging Scheme have an impact on the charges billed to users and the actual revenues perceived by the States/ANSPs and hence on their actual "economic surplus". Ex-post, the "overall estimated surplus" is calculated from two elements:

- the surplus embedded in the cost of capital; and
- the net gain/loss arising from the en-route activity. This comprises the net gain/loss from the costs-sharing mechanism (i.e. the difference between the actual and determined costs to which are added the inflation adjustment and the cost exempt from cost-sharing); the loss/gain arising from the traffic risk-sharing mechanism; and any gain/loss for capacity and environment incentive mechanisms.

The "estimated economic surplus" is a useful tool to monitor the financial strength of the ANSPs, so as to identify when corrective measures are needed to maintain the financial strength. It is also important to take account of the economic surplus generated in previous reference periods when setting the targets for the next reference period.

5.2.5.2 "Overall economic surplus" for the main ANSPs in the SES area in the en-route activity over RP1

Table 11 presents a summary of the en-route RP1 estimated overall economic surplus for the 28 main ANSPs that were part of the SES Performance Scheme in RP1 (i.e. it excludes the main ANSP from Croatia which is now included in RP2). Table 11 shows that in RP1 overall,

(i) The financial incentives generated a net gain in each year of RP1 for the main ANSPs as a whole. For RP1 overall, it amounts to 436.5 M€$_{2009}$. This is an important result since it indicates that in RP1, at Union-wide level, ANSPs were able to adjust their actual costs to the lower traffic than planned (see also 5.2.1) and the difference in costs that they can retain (amounting to 814.9 M€$_{2009}$) exceeds the loss of revenue they incur as a result of the traffic-risk sharing mechanism due to the lower traffic than planned (amounting to -

[17] Service Provision Regulation Article 15.3 (d).

406.6 M€2009). In addition, the ANSPs generated a net gain in respect of the incentive schemes for capacity and environment (28.1 M€2009).

(ii) This net gain generated by the financial incentives applied in RP1 enabled the main ANSPs, at Union-wide level, to increase their aggregated surplus from the en-route activity to 1179.7 M€2009 for RP1 as a whole (representing 7.6% of the revenues for the period) compared to an estimated planned surplus of 673.6 M€2009 (or 4.2% of the planned revenue for the period).

Estimated planned economic surplus (RP1 performance plans)	2012P	2013P	2014P	RP1 overall
Estimated surplus embedded in the cost of capital ('000EUR2009)	223 650	227 419	222 517	673 586
Estimated surplus in percent of en-route revenue/costs	4.3%	4.3%	4.2%	4.2%

Estimated actual economic surplus (RP1 reporting tables)	2012A	2013A	2014A	RP1 overall
Estimated surplus embedded in the cost of capital ('000EUR2009)	245 580	246 369	251 273	743 222
Estimated net gain/loss on en-route activity ('000EUR2009)	87 832	165 039	183 593	436 464
Overall estimated surplus ('000 EUR2009)	333 412	411 408	434 866	1 179 686
Estimated surplus in percent of en-route revenue/costs	6.4%	7.9%	8.4%	7.6%

Components of estimated net gain/loss on en-route activity	2012A	2013A	2014A	RP1 overall
Gain(+)/loss(-) in respect of cost-sharing ('000EUR2009)	201 938	304 900	308 092	814 930
Gain(+)/loss(-) in respect of traffic risk-sharing ('000EUR2009)	- 127 377	- 144 017	- 135 171	- 406 564
Gain(+)/loss(-) in respect of incentive scheme ('000EUR2009)	13 271	4 156	10 672	28 099
Estimated net gain(+)/loss(-) on en-route activity ('000EUR2009)	87 832	165 039	183 593	436 464

Table 11: RP1 estimated overall economic surplus for the 28 main ANSPs (2012-2014)

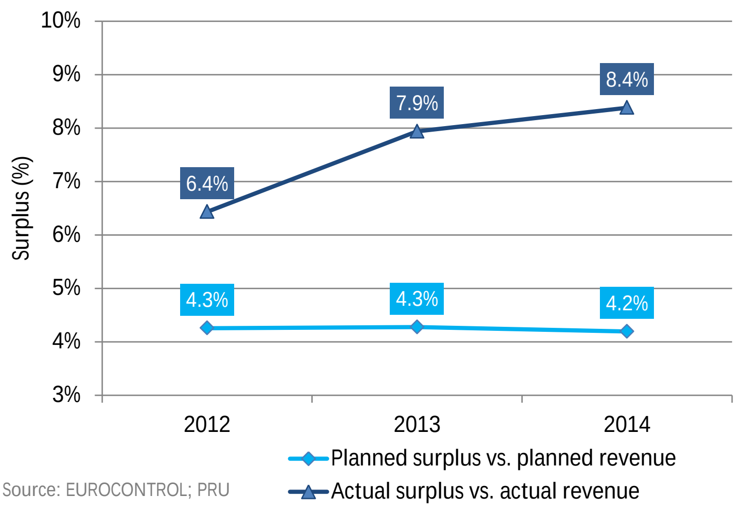


Figure 32: RP1 estimated overall economic surplus vs. revenues for en-route

5.2.5.3 "Overall economic surplus" for the main ANSPs in the SES area in the en-route activity over RP2, up to and including 2016

Table 12 presents a summary of the en-route RP2 estimated overall economic surplus for the 29 main ANSPs that are part of the SES Performance Scheme in RP2 (including Croatia main ANSP). Table 12 shows that in the two first years of RP2,

(i) At Union-wide level, the financial incentives generated a net gain in the two first years of RP2 for the main ANSPs amounting to 445.0 M€2009. This result indicates that, at Union-wide level, ANSPs were to reduce their actual costs compared to their plans, in spite of significantly higher traffic than planned (see item 5.2.1). The difference in costs that they can retain (amounting to 302.9 M€2009) is therefore cumulated with the additional revenue generated by the traffic-risk sharing mechanism due to higher traffic than planned (amounting to 129.2 M€2009). In addition, the ANSPs reported an aggregated net gain in respect of the incentive schemes for capacity and environment (12.9 M€2009).

(ii) This net gain generated by the financial incentives applied in the two first years of RP2 enabled the main ANSPs, at Union-wide level, to increase their aggregated surplus from the en-route activity to 964.4 M€2009 (representing 9.0% of the revenues for the 2-year period) compared to an estimated planned surplus of 491.3 M€2009 (or 4.7% of the planned revenue for the period).

(iii) It should be noted that the final amounts that will be allowed for carry-over in respect of RP2 cost-exempt from cost-sharing and in respect of the incentive schemes for capacity and environment have not yet been approved by the European Commission. The amounts considered in Table 12 are those reported by the States/ANSPs and amount to a total of 29.7 M€2009 for the cost-exempt from cost-sharing and 12.9 M€2009 for the incentives on capacity and environment. If these amounts were excluded from the calculations, the net aggregated gain for the 29 ANSPs would amount to 402.5 M€2009 and the aggregated cumulated surplus from the en-route activity for the two first years of RP2 would amount to 921.8 (representing 8.6% of the revenues for the 2-year period).

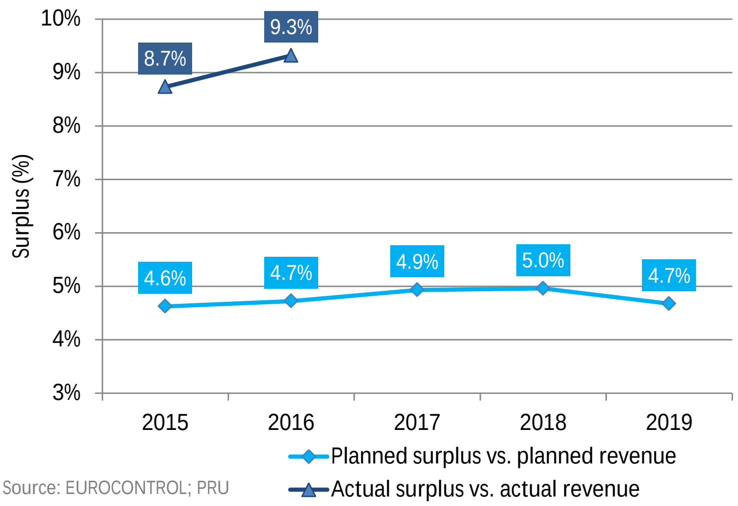
(iv) Planned surplus embedded in the cost of capital for the remaining 3 years of RP2 amounts to 754.4 M€2009, representing 4.9% of the planned revenue for the 3-year period. In view of the actual 2017 traffic and the latest traffic forecast for 2018 and 2019, it is expected that net gains will continue to be observed until the end of the RP and lead to significantly higher overall surpluses than planned.

Estimated planned economic surplus (RP2 performance plans)	2015P	2016P	2017P	2018P	2019P	2 years of RP2
Estimated surplus embedded in the cost of capital ('000EUR2009)	244 534	246 767	258 799	257 453	238 131	491 300
Estimated surplus in percent of en-route revenue/costs	4.6%	4.7%	4.9%	5.0%	4.7%	4.7%

Estimated actual economic surplus (RP2 reporting tables)	2015A	2016A	2017A	2018A	2019A	2 years of RP2
Estimated surplus embedded in the cost of capital ('000EUR2009)	260 890	258 494				519 384
Estimated net gain/loss on en-route activity ('000EUR2009)	206 561	238 470				445 031
Overall estimated surplus ('000 EUR2009)	467 451	496 963				964 415
Estimated surplus in percent of en-route revenue/costs	8.7%	9.3%				9.0%

Components of estimated net gain/loss on en-route activity	2015A	2016A	2017A	2018A	2019A	2 years of RP2
Gain(+)/loss(-) in respect of cost-sharing ('000EUR2009)	165 186	137 698				302 884
Gain(+)/loss(-) in respect of traffic risk-sharing ('000EUR2009)	31 689	97 558				129 247
Gain(+)/loss(-) in respect of incentive scheme ('000EUR2009)	9 686	3 215				12 901
Estimated net gain(+)/loss(-) on en-route activity ('000EUR2009)	206 561	238 470				445 031

Table 12: RP2 estimated overall economic surplus for the 29 main ANSPs (2015-2019)



Source: EUROCONTROL; PRU

Figure 33: RP2 estimated overall economic surplus vs. revenues for en-route

5.2.5.4 Key points for RP3 target setting

- At Union-wide level, ANSPs succeeded in retaining their planned surplus and even increasing it substantially, in a context of significantly lower traffic levels than planned in RP1 and significantly higher traffic than planned in RP2.
- As a result, the aggregated "overall estimated surplus" of the main ANSPs for the en-route activity amounts to 1 179.7 M€$_{2009}$ in RP1 (7.6% of the revenues) and 964.4 M€$_{2009}$ in the two first years of RP2 (some 9.0% of the revenues).
- This shows that the Performance Scheme has given positive results in respect of cost savings while allowing the ANSPs to increase their "overall estimated surplus". It is important that the determined costs of RP3 take account of the actual costs incurred in RP2.
- The increase in the "overall economic surplus" of the main ANSPs is a clear indication that further cost-efficiency improvements can be achieved in RP3.

5.3 FORWARD LOOKING PERFORMANCE

According to the current Charging Regulation 391/2013, States shall submit their forecast costs and traffic figures 19 months before RP3 (i.e. 1 June 2018) in order to facilitate the establishment by the Commission of Union-wide performance targets. Based on the experience in RP2 and following requests by the States, the European Commission proposed to move the deadline forward (finally to 30 April 2018).

The following analysis is based on the States' forecasts that were submitted by 17 May 2018, i.e. 25 out of the 30 charging zones in the RP2 SES area, accounting for 90.4% of the actual real en-route costs and 88.1% of the actual TSUs in 2016.

It should be noted that the States strongly caveat their preliminary forecasts and indicate that the final forecasts for RP3 may vary significantly. In some instances, the data sets provided were missing key elements to enable a proper consolidation at system level. The following assumptions were taken in case of incomplete data set:

(i) France reported on forecast costs but not on forecast service units. For the purpose of this analysis, the STATFOR February 2018 baseline forecast is used.

(ii) Slovakia reported on ANSP costs but not on NSA, EUROCONTROL and METSP costs. For the purpose of this analysis, estimates are made as follows: EUROCONTROL forecast cost-base as provided by EUROCONTROL in April 2018; NSA supervision costs forecast year on year increase of +2.819% as observed between 2015 and 2016; for the METSP: real en-route costs forecast to remain at 2016 level in real terms. The NSA supervision costs and the METSP costs accounted for 0.04% of the actual real en-route costs at EU-wide level in 2016, the lack of accuracy of the estimates should therefore have a limited impact on the analysis et EU-wide level.

(iii) The United Kingdom did not report EUROCONTROL costs. For the purpose of this analysis, EUROCONTROL forecast cost-base as provided by EUROCONTROL in April 2018 and the average April 2018 exchange rate (Reuters) were considered.

No data had been provided by that date for the following 5 en-route charging zones: Belgium/Luxembourg; Croatia; Hungary; Austria and Ireland. These 5 charging zones accounted for 9.6% of the actual real en-route costs and 11.9% of the actual TSUs in 2016.

Item 5.3.1 below focuses on the results of the aggregation of the en-route data provided for the 25 charging zones. Item 5.3.2 provides an extrapolation of these data at EU-wide level for the 30 charging zones forming the RP2 SES area and item 5.3.3 summarises the key points to be considered for RP3 target setting.

5.3.1 En-route preliminary RP3 forecasts provided for the 25 en-route charging zones

5.3.1.1 Forecast evolution of en-route costs, service units and unit costs over 2016-2024

This section presents the trend in the forecast real en-route unit costs since 2016 (last year for which actual cost data is available at the time of writing this report) and until the end of RP3. The data is aggregated in €$_{2009}$ for the 24 States having provided their data (25 charging zones), complemented with the assumptions detailed above.

The aggregated data for the 24 States is provided in Table 13 below, while Figure 34 shows the evolution of the forecast real en-route costs, total service units and Determined en-route Unit Cost (DUC) based on an index 100 in 2016. These highlight that:

(i) The forecast traffic growth in TSUs presented by the States for RP3 is somewhat below the STATFOR February 2018 baseline forecast (-2.0% lower than STATFOR baseline forecast by 2024). This is explained by the fact that, although the majority of States have reported STATFOR baseline forecast (for 14 charging zones, in addition to France for which the baseline forecast was taken as assumption), 2 charging zones have reported the STATFOR low forecast and the remaining 8 charging zones have chosen their own forecasts, which are in most cases lower than the STATFOR baseline forecast.

(ii) As far as the forecast traffic growth for the remaining years of RP2 (2017-2019) is concerned, a greater difference with the STATFOR February 2018 baseline scenario is observed, due to the fact that a number of States have reported the determined values from the performance plans and have not provided revised forecasts.

(iii) Real en-route costs are forecast to remain rather stable within RP3 (+0.6% between 2020 and 2024), after an increase of +9.5% between 2016 and 2020. Details on the trend at EU-wide level per entity type, nature of costs and charging zone are presented in items 5.3.1.2 and 5.3.1.3 below.

(iv) As was the case for the traffic forecast, costs reported for the 3 remaining years of RP2 include a mix of determined and revised forecast data. This fact and the limited qualitative information supporting the data for this period raise questions on the validity of the forecast data covering years 2017 to 2020 and hence on the reliability of the increases in costs reported for this period, while historically, as shown in item 5.2.2, actual costs have remained stable overall since 2009 and are forecasted by the States to remain stable within RP3.

(v) This concern also highlights the difficulty encountered for the selection of a proper starting point for setting the RP3 targets. Indeed, setting the starting point (or anchor) for RP3 targets in 2019 requires taking assumptions for the 2019 value(s) as the actual financial data for the year will only be available in June 2020 after the beginning of RP3 and will not be available at the moment of the adoption of both EU-wide and local targets. It would be more robust and fairer in terms of local targets assessments to anchor the RP3 targets to the latest available actual data available at the time of setting the EU-wide targets (2017 data to be submitted by the States on 1 June 2018).

(vi) Although some of the States' submissions provide some pieces of information on SESAR deployment costs and benefits expected for RP3, it is not clear to what extent these have been reflected in the overall States' forecasts at system level.

(vii) Overall, over the 8-year period from 2016 to 2024, the forecast Determined Unit Cost (DUC) based on the 24 States' inputs shows a decrease by -12.0% (or by -1.6% per year on average), as costs are forecast to increase by +10.2% over the period (or +1.2% per year on average), while the number of TSUs is forecast to increase by +25.3% (or +2.9% per year on average).

Aggregated RP3 forecasts	2016 A	2017 F	2018 F	2019 F	2020 F	2021 F	2022 F	2023 F	2024 F	2016-2024 overall	2016-2024 CAGR
Real en-route costs (EUR2009)	5 479 572 254	5 478 750 170	5 678 015 332	5 767 786 795	5 999 870 528	6 032 638 850	6 006 961 619	6 045 368 277	6 037 391 592	10.2%	1.2%
% YoY		0.0%	3.6%	1.6%	4.0%	0.5%	-0.4%	0.6%	-0.1%		
Total en-route service units	105 839 814	110 396 148	112 636 441	115 481 585	122 245 532	124 637 451	127 290 160	129 866 555	132 584 401	25.3%	2.9%
% YoY		4.3%	2.0%	2.5%	5.9%	2.0%	2.1%	2.0%	2.1%		
DUC (EUR2009)	51.77	49.63	50.41	49.95	49.08	48.40	47.19	46.55	45.54	-12.0%	-1.6%
% YoY		-4.1%	1.6%	-0.9%	-1.7%	-1.4%	-2.5%	-1.4%	-2.2%		

Table 13: Forecast real en-route unit costs – 25 charging zones

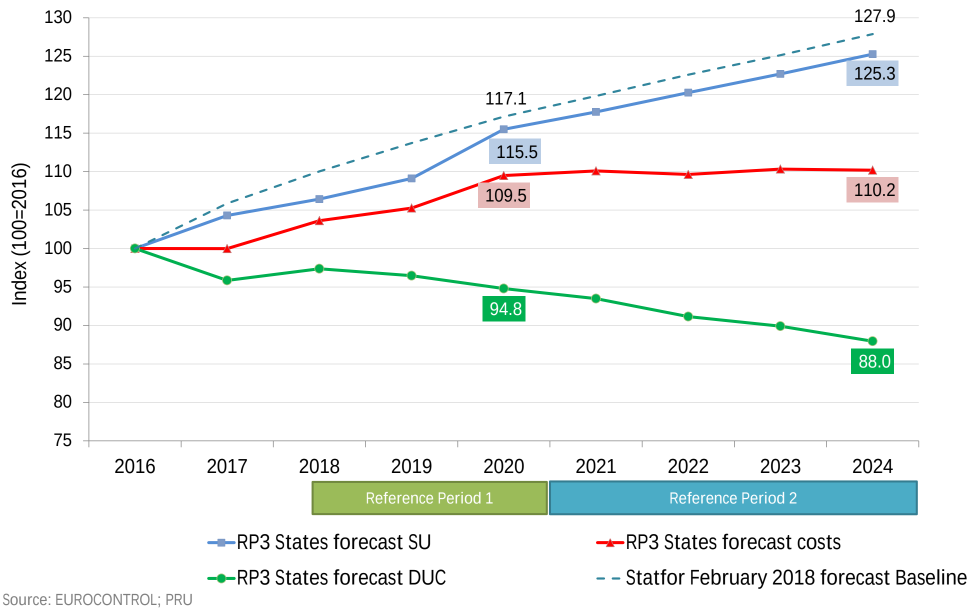


Figure 34: Forecast en-route cost-efficiency DUC trends 2016-2024 (index 2016=100) – 25 charging zones

5.3.1.2 Forecast evolution of the total real en-route costs per entity type and cost nature 2016-2024

This section presents the structure of the forecast real en-route costs reported by the 24 States, per entity type and per cost nature, as well as their evolutions over the period 2016-2024. The data is aggregated in €$_{2009}$ for the 24 States having provided their data.

Figure 35 below presents the evolution of the actual real en-route costs per entity type based on an index 100 in 2016, as well as the shares of the costs in the total forecasted for 2024. Table 14 shows the differences in costs per entity type for 2016-2020, 2020-2024 and 2016-2024. They show that:

(i) As mentioned in item 5.3.1.1 above, real en-route costs are forecast to remain quite stable within RP3 (+0.6% between 2020 and 2024), after an increase of +9.5% between 2016 and 2020 (corresponding to +520.3 M€$_{2009}$).

(ii) The large majority of real en-route costs are incurred by the ANSPs (88% in 2016 growing to 90% in 2024 forecast). ANSPs costs are forecast to remain stable overall within RP3 (+0.8% between 2020 and 2024), after an increase of +12.1% between 2016 and 2020. At aggregated level, the 2020 ANSPs costs' are higher by +581.7 M€$_{2009}$ compared to 2016 actual costs. ANSPs' costs increases that have the largest impact between 2016 and 2020 at aggregated level are:

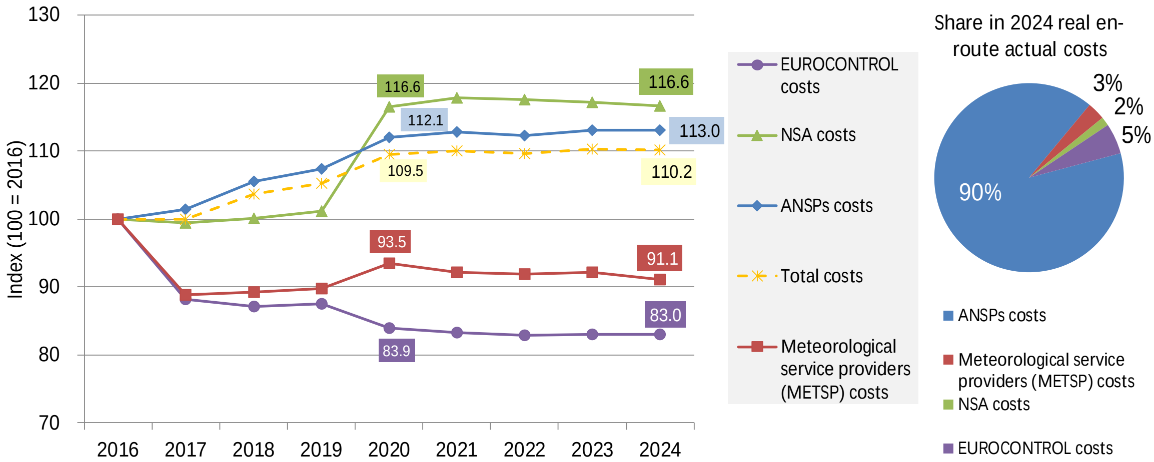
- DFS (Germany): +106.2 M€$_{2009}$ (+15.1%), mainly driven by the end of the DFS Corporate Action that was reducing costs during RP2 (-82.0 M€$_{2009}$ in 2016) and is not applied in RP3 (see also below);
- PANSA (Poland): +60.7 M€$_{2009}$ (+50.8%), mainly in staff and investment costs;
- ROMATSA (Romania): +59.1 M€$_{2009}$ (+44.0%), mainly in staff costs
- NATS (United Kingdom): +56.4 M€$_{2009}$ (+10.1%) in operating costs;
- DSNA (France): +45.8 M€$_{2009}$ (+4.5%) mainly in staff costs and depreciation.

- NAV (Portugal): +37.3 M€$_{2009}$ (+43.3%): principally in staff costs;
- BULATSA (Bulgaria): +28.1 M€$_{2009}$ (+34.3%) mainly in staff costs and depreciation.

(iii) The EUROCONTROL costs as recorded in the forecast costs of the States (accounting for 7% of the total costs in 2016 and 5% in the 2024 forecast) are also forecast to remain stable overall between 2020 and 2024 (-1.1% over the period), after a significant decrease of -16.1% between 2016 and 2020 mainly due to the decision of the German MoT to finance the German contribution to Part I of EUROCONTROL budget through the federal budget from 2017 onwards.

(iv) The METSPs costs (accounting for 4% in 2016 and 3% in the 2024 forecast) show a planned decrease of-2.6% within RP3, after a decrease of -6.5% between 2016 and 2020, mainly as a result of a significant decrease in Germany in 2017.

(v) The NSA costs (around 1.5% of the total en-route costs) show a significant increase over the period 2016-2020 (+16.6% over the 4-year period) and are foreseen to remain stable within RP3 (+0.1% over the 4-year period between 2020 and 2024).



Source: EUROCONTROL; PRU

Figure 35: Forecast real en-route costs trends (index 2016=100) and shares per entity – 25 charging zones

Entity type	2016-2020		2020-2024		2016-2024	
	In MEUR2009	In %	In MEUR2009	In %	In MEUR2009	In %
ANSPs	581.7	12.1%	45.9	0.8%	627.6	13.0%
METSPs	-13.1	-6.5%	-5.0	-2.6%	-18.1	-8.9%
NSAs	13.0	16.6%	0.0	0.1%	13.1	16.6%
EUROCONTROL	-61.4	-16.1%	-3.4	-1.1%	-64.8	-17.0%
Total	520.3	9.5%	37.5	0.6%	557.8	10.2%

Table 14: Differences in real en-route costs per entity type – 25 charging zones

Figure 36 below presents the forecast evolution of the real en-route costs by nature for the main items based on an index 100 in 2016, as well as the shares in the total costs for 2024. Table 15 shows the differences in costs per entity type for 2016-2020, 2020-2024 and 2016-2024.

The exceptional costs (representing -0.2% of the 2016 actual costs) and the deduction of costs incurred for services provided to exempted VFR flights (representing -0.3% of the 2016 actual costs) are excluded from Figure 36 due to their limited impact on the overall trend. They are however considered in Table 15.

Figure 36 and Table 15 indicate that:

(i) The staff costs account for the largest part of real en-route costs (60% in the 2024 forecast). The forecast staff costs at the beginning of RP3 (2020) are +9.9% higher than the actual 2016 staff costs (a difference of +323.7 M€$_{2009}$). Within RP3, they are forecast to increase by +2.1% (between 2020 and 2024).

(ii) The other operating costs are the second largest component (accounting for 21% in the 2024 forecast). In 2020, they are forecast to be +6.2% higher than the actuals 2016 (+76.7 M€$_{2009}$). The forecasts present a slight decrease by -0.8% between 2020 and 2024. The dip in 2017 is due a decrease in the EUROCONTROL costs included in the German cost-base (see above).

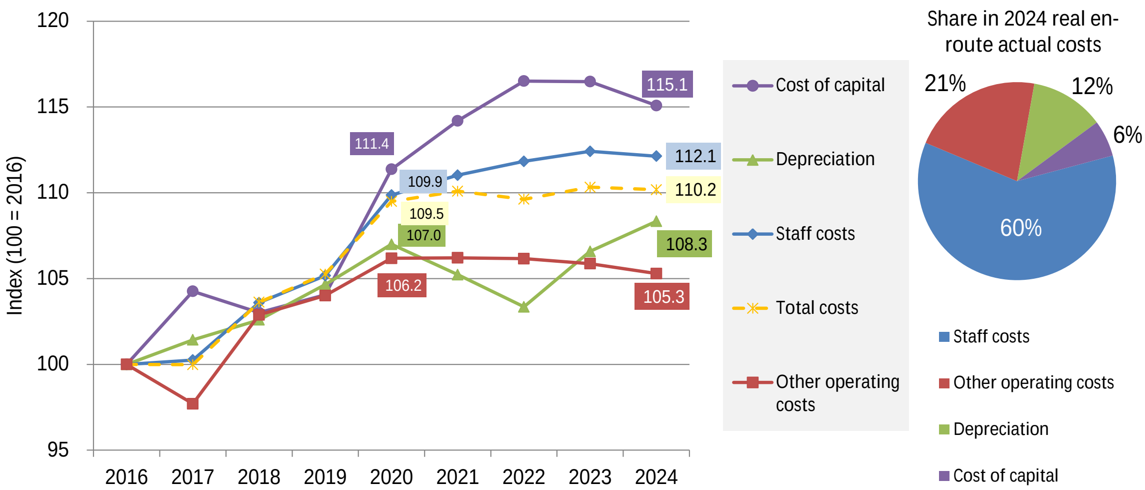
(iii) The investment costs represent around 18% of the en-route actual total costs (12% for depreciation and 6% for the cost of capital).

(iv) Depreciation costs for 2020 are +7.0% higher than the 2016 actuals (47.5 M€$_{2009}$). Within RP3, they are foreseen to increase by +1.2%. The decreases observed in 2021 and 2022 reflect decreases in depreciation for the United Kingdom.

(v) The cost of capital for 2020 is +11.4% higher than the 2016 actual. Within RP3, it is foreseen to increase by +3.3%, mainly as a result of forecast increases in the asset bases of the ANSPs in France, Poland and Bulgaria. It should be noted that rate of Return on Equity (RoE) reported for the main ANSPs are generally lower than in RP2, except for 6 ANSPs. The main increases in forecast RoE are observed in PANSA (to 11.5%) and ENAV (to 9.0%).

(vi) The exceptional items include a mix of positive and negative amounts. Their significant increase between 2016 and 2020 is mainly due to the DFS Corporate Action applicable in RP2 and not in RP3 (see above) and recorded as negative exceptional item in RP2. In this respect, it should be pointed out that, in a number of cases, RP2 determined and actual costs are presented net of subsidies, whereas the SES regulations foresee that these would not be reflected in the cost-bases but should be deducted as other revenue for the calculation of the unit rate charged to airspace users. This should be corrected for RP3 and the impact of such correction on the historical data should be assessed in view of setting the EU-wide and local targets for RP3. These subsidies include both Union assistance programmes and National public funding.

(vii) The deduction of costs for services provided to exempted VFR flights have not been reported for 4 of the charging zones which historically deduct these costs from their cost-bases. The deductions for these 4 charging zones represented 2.7 M€$_{2009}$ in 2016. Hence the annual aggregated forecast costs should be lower than reported by an amount of similar magnitude.



Source: EUROCONTROL; PRU

Figure 36: Forecast real en-route costs trends (index 2016=100) and shares per cost nature – 25 charging zones

Cost nature	2016-2020		2020-2024		2016-2024	
	In MEUR2009	In %	In MEUR2009	In %	In MEUR2009	In %
Staff	323.7	9.9%	74.4	2.1%	398.1	12.1%
Other operating	76.7	6.2%	-11.1	-0.8%	65.7	5.3%
Depreciation	47.5	7.0%	9.1	1.2%	56.6	8.3%
Cost of capital	35.7	11.4%	11.7	3.3%	47.4	15.1%
Exceptional items	33.9		-47.2		-13.3	
Deduction for VFR	2.8	-16.2%	0.6	-4.4%	3.4	-19.8%
Total	520.2	9.5%	-6.2	-0.1%	557.8	10.2%

Table 15: Differences in real en-route costs per cost nature – 25 charging zones

5.3.1.3 RP3 additional costs compared to 2016 actuals

This section looks at the cumulated additional en-route costs forecast by the States for RP3 compared to 2016, so as to identify the main drivers for the forecasted increases in costs in RP3. It presents the results by entity type, by cost nature and by charging zone.

The cumulated additional en-route costs forecast by the States for RP3 compared to the 2016 actual costs represent 2 724.4 M€$_{2009}$ over the 5 years of RP3.

Figure 37 below shows that this increase is entirely attributable to the ANSPs and primarily in staff costs.

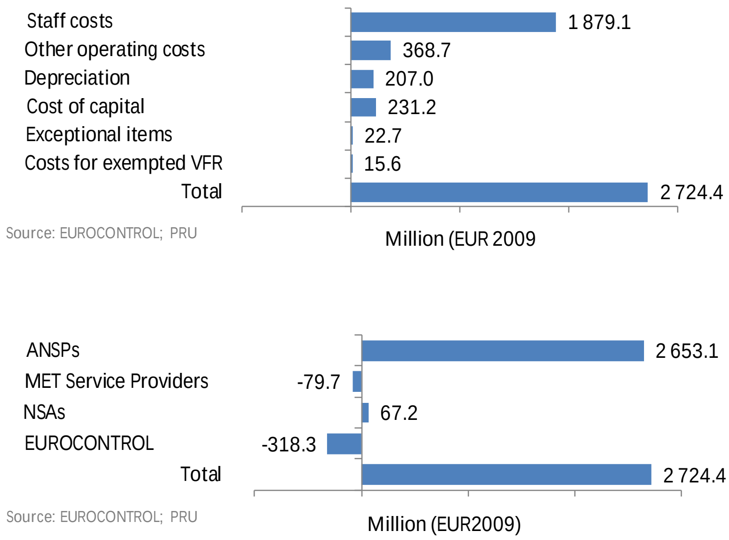


Figure 37: Cumulated additional en-route costs for RP3 vs. 2016 actuals by entity type and cost nature – 25 ch.zones

Figure 38 and Table 16 below show the results per en-route charging zone and show that:

(i) The charging zones which forecast the largest amounts of cumulated additional costs in RP3 compared to the actual data of 2016 are Romania, Poland, France, Portugal, the United Kingdom, Bulgaria and Germany (see item 5.3.1.2 above). For France, Germany and the United Kingdom, these additional costs correspond to a large number of additional service units compared to 2016 and will lead to a decrease in the forecast RP3 DUCs compared to the actual unit cost for 2016. For Romania, Poland, Portugal and Bulgaria, the opposite is true and the additional costs will lead to an increase in the forecast RP3 DUCs compared to the actual unit cost 2016.

(ii) Two charging zones forecast lower costs in RP3 than in 2016: Italy and Spain Canarias. As far as Spain is concerned however, RP3 presents additional costs for the two Spanish charging zones combined.

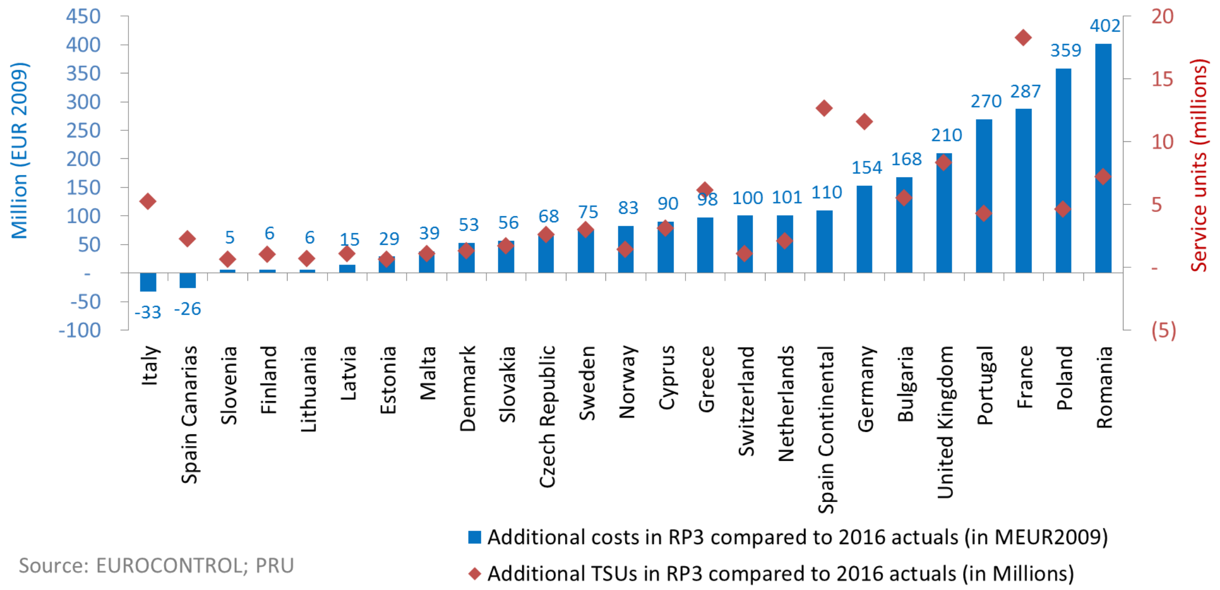


Figure 38: Cumulated additional en-route costs for RP3 vs. 2016 actuals by charging zone – 25 charging zones

En-route charging zone	2020				2021				2022				2023				2024			
	Add. real en-route costs		Add.en-route TSUs		Add. real en-route costs		Add.en-route TSUs		Add. real en-route costs		Add.en-route TSUs		Add. real en-route costs		Add.en-route TSUs		Add. real en-route costs		Add.en-route TSUs	
	MEUR2009	in%	States forecast	STATFOR base	MEUR2009	in%	States forecast	STATFOR base	MEUR2009	in%	States forecast	STATFOR base	MEUR2009	in%	States forecast	STATFOR base	MEUR2009	in%	States forecast	STATFOR base
Romania	59.1	41.1%	23.0%	23.0%	69.3	48.2%	27.6%	27.6%	80.0	55.7%	32.4%	32.4%	90.9	63.2%	37.0%	37.0%	102.8	71.5%	41.9%	41.9%
Poland	62.8	46.2%	16.2%	16.2%	66.3	48.8%	19.4%	19.4%	73.1	53.8%	22.5%	22.5%	77.8	57.2%	25.1%	25.1%	78.6	57.8%	27.7%	27.7%
France	44.0	3.8%	14.2%	14.2%	54.2	4.7%	16.4%	16.4%	52.9	4.6%	18.5%	18.5%	62.3	5.4%	20.4%	20.4%	74.0	6.4%	22.3%	22.3%
Portugal	38.2	37.1%	19.8%	19.8%	50.2	48.7%	22.2%	22.2%	54.3	52.7%	24.5%	24.5%	60.5	58.8%	26.6%	26.6%	66.2	64.3%	29.0%	29.0%
United Kingdom	58.5	9.1%	11.4%	15.9%	39.8	6.2%	12.7%	17.8%	42.0	6.5%	15.2%	19.7%	44.0	6.8%	17.5%	21.6%	25.3	3.9%	19.7%	23.7%
Bulgaria	29.6	34.0%	23.5%	23.4%	30.9	35.5%	26.8%	26.8%	33.8	38.8%	30.2%	30.2%	36.8	42.3%	33.6%	33.5%	36.5	41.9%	37.2%	37.2%
Germany	55.0	6.2%	14.0%	15.8%	55.7	6.3%	15.6%	18.0%	17.3	2.0%	17.4%	20.5%	14.3	1.6%	18.6%	22.4%	11.3	1.3%	20.0%	24.6%
Spain Continental	26.1	4.8%	31.0%	37.0%	28.3	5.2%	35.7%	44.5%	20.7	3.8%	40.5%	52.0%	18.5	3.4%	45.3%	59.8%	16.6	3.0%	50.3%	68.2%
Netherlands	16.0	9.4%	11.0%	11.0%	17.6	10.3%	12.0%	12.0%	20.7	12.1%	13.5%	13.5%	22.8	13.4%	14.8%	14.8%	23.9	14.0%	16.3%	16.3%
Switzerland	18.4	19.1%	12.2%	16.4%	19.0	19.7%	13.1%	18.2%	19.4	20.2%	14.2%	20.1%	21.3	22.1%	15.1%	21.7%	22.5	23.4%	16.2%	23.6%
Greece	26.0	19.5%	21.9%	28.5%	22.6	16.9%	23.9%	32.7%	19.8	14.8%	26.2%	37.0%	16.5	12.4%	28.4%	41.4%	12.5	9.4%	30.9%	46.1%
Cyprus	13.9	29.7%	19.1%	22.1%	16.4	35.0%	25.5%	27.4%	18.8	40.0%	32.1%	32.8%	19.8	42.2%	38.9%	38.4%	21.2	45.2%	45.9%	44.3%
Norway	9.7	10.3%	8.7%	8.7%	15.6	16.7%	9.8%	9.8%	17.6	18.8%	11.3%	11.3%	21.4	22.8%	12.9%	13.0%	18.6	19.8%	14.8%	14.8%
Sweden	15.3	8.2%	13.7%	13.7%	13.1	7.0%	15.6%	15.6%	12.5	6.7%	17.6%	17.5%	16.7	8.9%	19.3%	19.3%	17.1	9.1%	21.1%	21.1%
Czech Republic	11.0	10.4%	10.9%	16.7%	14.1	13.4%	12.7%	20.8%	12.8	12.1%	15.2%	24.8%	15.4	14.6%	23.6%	28.2%	14.8	14.0%	32.6%	31.8%
Slovakia	8.2	15.1%	20.4%	20.4%	11.0	20.4%	24.8%	24.8%	11.8	21.7%	29.5%	29.5%	12.0	22.2%	34.1%	34.0%	13.3	24.6%	38.8%	38.8%
Denmark	9.0	10.4%	12.1%	12.1%	9.8	11.4%	14.1%	14.1%	11.0	12.8%	16.4%	16.4%	11.4	13.2%	18.6%	18.6%	12.0	13.9%	20.8%	20.8%
Malta	7.9	48.8%	13.9%	13.8%	7.7	47.9%	18.5%	18.6%	7.6	46.9%	23.6%	23.6%	7.6	47.3%	28.9%	28.8%	7.7	47.7%	34.6%	34.6%
Estonia	5.1	27.4%	9.6%	16.0%	5.5	29.6%	11.9%	18.4%	5.5	29.4%	14.6%	21.4%	6.1	32.7%	17.1%	24.2%	6.7	36.0%	19.8%	27.2%
Latvia	2.6	13.2%	23.1%	23.1%	2.6	13.0%	24.8%	24.9%	2.9	14.6%	27.1%	27.1%	3.5	17.5%	29.1%	29.2%	3.6	18.2%	31.3%	31.3%
Lithuania	1.3	6.2%	22.5%	18.5%	1.4	6.6%	24.2%	20.2%	1.4	6.8%	26.5%	22.4%	1.3	6.1%	28.5%	24.3%	1.1	5.2%	30.7%	26.4%
Finland	0.3	0.7%	23.2%	23.1%	1.2	3.0%	25.0%	25.1%	1.1	2.6%	27.3%	27.3%	1.6	3.9%	29.2%	29.3%	2.0	4.9%	31.4%	31.4%
Slovenia	1.1	3.5%	19.7%	19.7%	1.4	4.8%	22.5%	22.4%	1.2	4.0%	25.3%	25.3%	0.7	2.4%	28.0%	28.0%	0.9	2.9%	30.8%	31.0%
Spain Canarias	-6.1	-6.9%	20.2%	20.2%	-5.3	-6.0%	23.2%	23.2%	-5.3	-6.0%	26.1%	26.1%	-4.9	-5.6%	28.6%	28.6%	-4.8	-5.4%	31.2%	31.2%
Italy	7.5	1.3%	10.3%	13.5%	4.6	0.8%	11.3%	15.8%	-5.5	-0.9%	12.6%	18.2%	-12.6	-2.2%	13.9%	20.4%	-26.6	-4.6%	15.2%	22.9%
Total 25 charging zones	520.3	9.5%	15.5%	17.1%	553.1	10.1%	17.8%	19.8%	527.4	9.6%	20.3%	22.6%	565.8	10.3%	22.7%	25.1%	557.8	10.2%	25.3%	27.9%

Table 16: Additional en-route costs for RP3 vs. 2016 actuals per year and by charging zone – 25 charging zones

5.3.2 Extrapolation of the forecast en route costs, service units and unit costs over 2016-2024 at Union-wide level

This section attempts to extrapolate the trends at EU-wide level in the forecast en-route unit costs since 2016 and until the end of RP3. The data has been computed from the information reported for the 24 States having provided the data (25 charging zones) and complemented with the following assumptions to replace the missing data for the 5 charging zones:

- Total real en-route costs are based on the same year on year increase from 2016 as for the total real en-route costs of the reporting States in €$_{2009}$;
- Total en-route service units are based on STATFOR February 2018 baseline forecast.

The resulting consolidated data at EU-wide level is presented in Table 17 and the results at charging zone level are shown in Table 18. Figure 39 shows the evolution of the forecast real en-route costs, total service units and Determined en-route Unit Cost (DUC) based on an index 100 in 2016.

These results indicate that overall, over the 8-year period from 2016 to 2024, the forecast Determined Unit Cost (DUC) based on the extrapolation of the States' inputs shows a decrease by -12.2% (or by -1.6% per year on average), as costs are forecast to increase by +10.2% over the period (or +1.2% per year on average), while the number of TSUs is forecast to increase by +25.5% (or +2.9% per year on average).

Aggregated RP3 forecasts	2016 A	2017 F	2018 F	2019 F	2020 F	2021 F	2022 F	2023 F	2024 F	2016-2024 overall	2016-2024 CAGR
Real en-route costs (EUR2009)	6 060 071 682	6 059 162 509	6 279 537 587	6 378 819 332	6 635 489 743	6 671 729 503	6 643 332 056	6 685 807 471	6 676 985 744	10.2%	1.2%
% YoY		0.0%	3.6%	1.6%	4.0%	0.5%	-0.4%	0.6%	-0.1%		
Total en-route service units	120 135 471	125 201 232	128 051 128	131 426 441	138 696 558	141 519 294	144 614 720	147 611 648	150 782 533	25.5%	2.9%
% YoY		4.2%	2.3%	2.6%	5.5%	2.0%	2.2%	2.1%	2.1%		
DUC (EUR2009)	50.44	48.40	49.04	48.54	47.84	47.14	45.94	45.29	44.28	-12.2%	-1.6%
% YoY		-4.1%	1.3%	-1.0%	-1.4%	-1.5%	-2.6%	-1.4%	-2.2%		

Table 17: Forecast RP3 real en-route unit costs (RP2 States and RP2 formula)

		AUC	Forecast DUC					CAGR costs		CAGR TSUs		CAGR AUC/DUC	
En-route charging zone	Notes	2016	2020	2021	2022	2023	2024	2016-2020	2020-2024	2016-2020	2020-2024	2016-2020	2020-2024
Belgium-Luxembourg	1&2	58.87	56.34	55.70	54.51	54.06	53.17	2.3%	0.2%	3.4%	1.6%	-1.1%	-1.4%
Germany		65.36	60.89	60.10	56.77	55.99	55.15	1.5%	-1.2%	3.3%	1.3%	-1.8%	-2.4%
Estonia		22.34	25.97	25.87	25.23	25.32	25.36	6.2%	1.6%	2.3%	2.2%	3.8%	-0.6%
Finland		52.84	43.19	43.55	42.61	42.51	42.16	0.2%	1.0%	5.4%	1.6%	-4.9%	-0.6%
United Kingdom	4	59.10	57.85	55.68	54.67	53.74	51.32	2.2%	-1.2%	2.7%	1.8%	-0.5%	-3.0%
Netherlands		55.03	54.26	54.19	54.38	54.32	53.94	2.3%	1.0%	2.6%	1.2%	-0.4%	-0.1%
Ireland	1&2	23.80	24.38	23.91	23.25	22.87	22.29	2.3%	0.2%	1.7%	2.4%	0.6%	-2.2%
Denmark		53.08	52.29	51.83	51.43	50.68	50.03	2.5%	0.8%	2.9%	1.9%	-0.4%	-1.1%
Norway		37.62	38.17	39.97	40.14	40.91	39.25	2.5%	2.1%	2.1%	1.4%	0.4%	0.7%
Poland		32.57	40.98	40.60	40.88	40.94	40.25	10.0%	1.9%	3.8%	2.4%	5.9%	-0.4%
Sweden		54.95	52.29	50.89	49.88	50.18	49.53	2.0%	0.2%	3.3%	1.6%	-1.2%	-1.3%
Latvia		25.05	23.04	22.67	22.58	22.80	22.56	3.1%	1.1%	5.3%	1.6%	-2.1%	-0.5%
Lithuania		40.71	35.28	34.92	34.36	33.61	32.77	1.5%	-0.2%	5.2%	1.6%	-3.5%	-1.8%
Spain Canarias		59.55	44.92	44.14	42.99	42.10	41.07	-1.8%	0.4%	5.4%	2.7%	-6.8%	-2.2%
Bulgaria		25.50	28.69	27.53	26.80	26.13	24.81	7.6%	1.4%	4.5%	5.2%	3.0%	-3.6%
Cyprus		30.42	30.12	30.26	30.32	29.77	29.40	6.7%	2.9%	7.0%	3.5%	-0.2%	-0.6%
Croatia	1&2	45.26	43.52	42.48	41.06	40.19	38.99	2.3%	0.2%	3.3%	2.9%	-1.0%	-2.7%
Spain Continental		55.84	48.67	47.67	45.96	44.90	43.84	1.2%	-0.4%	4.7%	2.2%	-3.4%	-2.6%
France	2	57.90	52.62	52.08	51.09	50.71	50.38	0.9%	0.6%	3.4%	1.7%	-2.4%	-1.1%
Greece		28.53	27.97	26.93	25.96	24.97	23.84	4.6%	-2.2%	5.1%	1.8%	-0.5%	-3.9%
Hungary	1&2	30.06	26.22	25.38	24.31	23.59	22.70	2.3%	0.2%	5.8%	3.8%	-3.4%	-3.5%
Italy		70.07	64.31	63.46	61.66	60.21	58.06	0.3%	-1.5%	2.5%	1.1%	-2.1%	-2.5%
Slovenia		59.79	51.71	51.18	49.64	47.83	47.01	0.9%	-0.2%	4.6%	2.3%	-3.6%	-2.4%
Czech Republic		38.60	38.43	38.80	37.55	35.81	33.21	2.5%	0.8%	2.6%	4.6%	-0.1%	-3.6%
Malta		17.85	23.33	22.28	21.22	20.40	19.59	10.4%	-0.2%	3.3%	4.3%	6.9%	-4.3%
Austria	1&2	58.98	54.19	53.44	52.16	51.59	50.55	2.3%	0.2%	4.5%	1.9%	-2.1%	-1.7%
Portugal Continental		29.35	33.58	35.71	36.00	36.80	37.38	8.2%	4.6%	4.6%	1.9%	3.4%	2.7%
Romania		32.36	37.12	37.58	38.06	38.55	39.11	9.0%	5.0%	5.3%	3.6%	3.5%	1.3%
Switzerland		64.43	68.39	68.20	67.79	68.34	68.39	4.5%	0.9%	2.9%	0.9%	1.5%	0.0%
Slovakia	3	47.56	45.48	45.89	44.70	43.34	42.68	3.6%	2.0%	4.7%	3.6%	-1.1%	-1.6%
Total/weighted average		50.44	47.84	47.14	45.94	45.29	44.28	2.3%	0.2%	3.7%	2.1%	-1.3%	-1.9%

Assumptions for missing data

1 Year on year increase from 2016 as for the total of the reporting States in EUR2009
2 STATFOR February 2018 Baseline forecast
3 Estimates made for NSA, EUROCONTROL and METSPs costs
4 Estimates made for EUROCONTROL costs

Table 18: Forecast RP3 real en-route unit costs (RP2 States and RP2 formula)

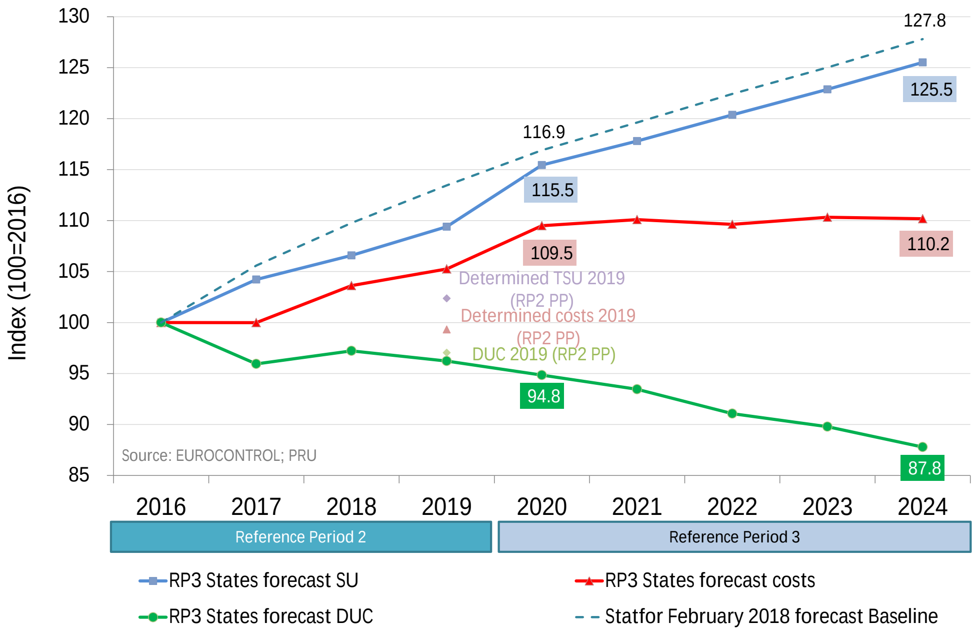


Figure 39: Forecast RP3 real en-route unit costs (RP2 States and RP2 formula)

5.3.3 Key points for RP3 target setting

- States preliminary en-route forecast costs and traffic data has been provided for 25 out of the 30 charging zones in the RP2 SES area, with strong caveats indicating that the final forecasts for RP3 may vary significantly. In addition, assumptions had to be made in case of missing key data to enable the consolidation of the forecasts at EU-wide level.
- The resulting consolidated RP3 forecast data presents a decrease in the en-route DUC by -12.2% between 2016 (last actual data available) and 2024 (last year of RP3), from 50.44€$_{2009}$ in 2016 to 44.28€$_{2009}$ in 2024, corresponding to -1.6% per year on average over the 8-year period. This downward trend in the DUC corresponds to a forecast increase in costs by +10.2% over the 8-year period (or +1.2% per year on average) and an increase in the number of TSUs by +25.5% (or +2.9% per year on average).
- The forecast TSUs presented by the States are lower than the STATFOR February 2018 baseline scenario (by -2.0% by the end of RP3).
- Real en-route costs are forecast by the States to remain rather stable within RP3 (+0.6% between 2020 and 2024), after an increase of +9.5% between 2016 and 2020.
- Although some of the States' submissions provide some pieces of information on SESAR deployment costs and benefits expected for RP3, it is not clear to what extent these have been reflected in the overall States' forecasts at system level.
- Costs reported by the States for the 3 remaining years of RP2 include a mix of determined and revised forecast data and are poorly documented. This raises questions on the validity of the forecast data covering the period up to 2020 and hence on the reliability of the increases in costs reported for this period. This concern also highlights the difficulty encountered for the selection of a proper starting point for setting the RP3 targets at both EU-wide and local level.
- It should also be pointed out that, in a number of cases, RP2 determined and actual costs are presented net of subsidies, whereas the SES regulations foresee that these should instead be deducted as other revenue for the calculation of the unit rate charged to airspace users. This should be corrected for RP3 and the impact of such correction on the historical data should be assessed in view of setting the EU-wide and local targets for RP3. The subsidies include both Union assistance programmes and national public funding.

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