FABEC Implementation Phase

Cost-Benefit Analysis
EC Information

Annex R

Co-financed by the European Union
Trans-European Transport Network (TEN-T)

DOCUMENT SUMMARY

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R.1	AFG/PMG	Final	1.0	24.03.2012	FABEC Cost-Benefit Analysis
R.2	AFG/PMG	Final	1.0	30.03.2012	FRA Cost-Benefit Analysis
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1. BACKGROUND

In accordance with the SES regulation, in particular §4 of Part Two of the Annex to Commission Regulation (EU) N° 176/2011, a cost-benefit analysis has been carried out in order to show there is overall added value in creating the functional airspace block FABEC.

As a matter of fact, it is already the second CBA for FABEC, as such an analysis was also conducted during the FABEC Feasibility Phase (2006-2008). It is unavoidable that results from the currently submitted FABEC Implementation Phase CBA – referred to as IP CBA – are compared to the ones emerging from the FABEC Feasibility Study CBA (further referred to as FS CBA).

When appreciating a CBA, the main focus is always on the overall financial result – in the case of the FABEC CBA the Net Present Value (NPV).

It cannot be denied that the downward revision in terms of NPV between the FS CBA and the IP CBA is most striking: while the former promised an overall positive result of €7,295m until 2025, the latter provides a relatively more modest NPV of €734m.

Neglecting some improvements and further fine-tuning, there is no difference in the model used for both CBAs which could account for the gap in terms of NPV.

Although a sensitivity analysis clearly demonstrates the huge impact of the applied parameter “IFR cost per km” on the NPV, through the conversion into monetary values of reductions in distance flown, this factor neither explains the drop in NPV.

A closer look into the FS CBA document shows that five main areas of uncertainty were identified, each of which would have the potential to substantially impact the NPV. It is stated that the “uncertainty in various assumptions could cause the NPV for the FABEC project to vary from €3,600m to €9,800m” (although, cf. infra, the effect of the traffic downturn is even stronger than indicated by this range).

The first – and at the same time most important – area of uncertainty which is listed, is the degree to which there is a capacity shortfall in the reference case. The reference case relies on continuing improvements which are planned and to be expected if there were no FABEC. The capacity shortfall in the reference case is in turn affected both by uncertainty in the ability of the ANSPs to provide capacity, and by uncertainty in the demand growth. It turns out that on both sub-areas of uncertainty, the assumptions made in the FS CBA caused a far too pessimistic reference case compared to what is now observed.

Indeed, as for the ANSPs’ ability to provide capacity, a considerable amount of local initiatives has recently been implemented, thus improving the current reference case with respect to the one developed as part of the FS CBA. At the same time, the latter sub-area of uncertainty, the demand growth, equally improves the current reference case as it was foreseen during the production of the FS CBA that traffic would grow so rapidly that ANSPs (in the absence of FABEC) would soon hit the capacity wall.

The incorrect (although at that time justified) assumption in the FS CBA with respect to the degree to which there is a capacity shortfall in the reference case hence plays a major role in explaining the substantial gap between the NPVs of the FS versus IP CBA. Due to the substantially improved reference (or “without FABEC”) case, there is less room for creation of benefits in the “with FABEC” case.

As the FS CBA sensitivity analysis shows, the NPV already shrank from the above-mentioned €7,295m to €3,590m when applying (what was then considered as) a low traffic growth scenario. In view of the current STATFOR Medium-Term Forecast (as published in Feb. 2012), this scenario is rather close to the current Base scenario and substantially higher than the current Low scenario.

Finally, it has to be admitted that progress within FABEC is slower than anticipated.

It can therefore be concluded that

1. There is overall added value in creating the functional airspace block FABEC, as is shown by the IP CBA, which results in an NPV of €734m.
2. As a consequence of the unanticipated economic downturn, ANSPs are not (yet) facing the "capacity wall" in a "without FABEC" case, hence leaving less room for improvement in a "with FABEC" case;
3. ANSPs did respond to the new performance-driven SES paradigm, but until now rather at individual ANSP than at FABEC level, which both improves the reference case and negatively impacts the "with FABEC" case.

2. PURPOSE AND CONTENT OF THE DELIVERABLE

1. FABEC COST-BENEFIT ANALYSIS

This deliverable consists of a document showing the CBA was conducted according to industry standard practice, using discounted cash flow analysis. It provides a consolidated view of the impact of the establishment of FABEC on the airspace users. In view of the resulting Net Present Value (NPV), it clearly demonstrates the overall positive financial result of establishing FABEC as a functional airspace block.

Furthermore, the deliverable provides detailed insight in the set of FABEC initiatives which have been used to calculate the NPV. The values for costs and benefits are given, as well as the assumptions which underlie the analysis. Finally, a sensitivity analysis describes the possible impact of the areas of uncertainty.

2. FRA COST-BENEFIT ANALYSIS

In view of its importance for FABEC, in particular for the cost-benefit analysis, a dedicated CBA for the Free Route Airspace has been carried out.

3. CBA STAKEHOLDER CONSULTATION

As required by Commission Regulation (EU) N° 176/2011, the main stakeholders were consulted and provided feedback on the costs and benefit estimates which are applicable to their operations. The result of this consultation is described in this deliverable.

FABEC Implementation Phase

Cost-Benefit Analysis

EC Information

Attachment R.1

Co-financed by the European Union
Trans-European Transport Network (TEN-T)

Document Summary

Objective : Describe the costs and benefits of the FABEC programme	
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1 EXECUTIVE SUMMARY

AFG/PMG has undertaken a cost-benefit analysis of the FABEC programme as it exists today. The work has been performed under the direction of the Standing Committee Finance. A justification of the FABEC programme by a cost-benefit analysis is a requirement of the legislation, but is also sound practice for any major investment in ATM.

The results of the cost-benefit analysis show that implementation of the FAB initiatives put forward by the various projects, Tasks Forces or initiatives brings substantial net benefits. Financial cost-effectiveness can be improved, and a high quality of service maintained.

The analysis has shown that the NPV of the FABEC project is most likely to be in the region of €750m, taking account all costs and benefits up to the horizon of 2025.

A key element of any cost-benefit analysis is the reference case – a realistic assessment of what the future scenario would be in the absence of the project. In the case of FABEC, this is the situation in which cooperation between ANSPs continues at similar levels to those in the past. The reference case was based, in the period to 2015, on ANSPs' plans, and in the longer term, to 2025, on extrapolation and plausible assumptions about the development of key performance parameters such as ATCO productivity and wage rates, in the absence of the FABEC. This reference case shows between 2011 and 2025 an increase in en-route financial cost-effectiveness of 2%. The reason for this increase can be found in the years 2012 and 2013, whereas the plans for the years after 2013 show a decreasing development, reaching a 5% reduction in en-route cost per flight-hour by 2025.

In contrast to this rather poor development in financial cost-effectiveness a long-term improvement can be found in the quality of service provided. The ANSPs put huge effort in the last years since the Feasibility Study into capacity and flight efficiency. The reference case shows, that they are able to provide adequate capacity for growing traffic; delays decrease from more than 1 minute per flight to nearly 0.2 minutes per flight in 2025. Also the development in flight efficiency shows a decreasing level of inefficiency. Compared to the reference case used in the CBA for the Feasibility Study the current reference case shows a by far better performance especially in the field of delay resp. capacity. It is obvious, that this positive development reduces the possibilities of the FABEC initiatives to generate significant benefits.

One important factor contributing to the positive developments in the reference case is the reduced traffic forecast compared to the forecast used in the Feasibility Study in 2008. For 2025 the forecast based on the STATFOR MTF from February 2012 estimates 6.2m flight hours controlled, whereas the Feasibility Study calculated with 8m flight hours.

A wide range of initiatives and projects in the FABEC were considered and their impact quantified. They are mostly based on ideas and proposals made during the work on the Feasibility Study. The initiatives considered in the analysis are those which are achievable through FABEC cooperation. They are considered to be independent of those achieved by SESAR. They comprised:

In the Operational domain:

- improvements to airspace design, producing:
  - Short-term gains in flight efficiency and capacity through cross-border sectorisation and introduction of more direct routes. The relevant projects are the AMRUFRA project, the Night Network project and the City Pairs project;

- Medium-term gains in flight-efficiency through optimisation of so called “hotspots”. In this category there are projects like the AD South-East, the AD West, the AD CBA-Land, Central West and the AD LUX-project; and
- progressive further gains in flight-efficiency through the introduction of elements of the new FABEC airspace strategy, namely the Free route airspace and enhanced arrival management functions;

in the Technical domain:

- improved CNS infrastructure and related support, producing cost savings through joint planning, procurement, and provision; and

in the HR domain:

- common training and qualification of personnel and optimization of training, producing cost savings.

Also considered in the cost-benefits analysis were the necessary costs for the overall programme management.

For each FABEC initiative or project, the likely magnitude and timing of the benefits was assessed, drawing on the work of the individual project team. An assessment of the transition costs was also made, including the required set-up costs, training costs, and the investment required to bring the initiatives about.

The characterisation of the reference case and the description of the initiatives were carried out in extensive consultation with members of the SC Finance and the Performance Management Group, as well as other experts in the ANSPs.

Our overall conclusions are that the described FABEC projects will bring substantial benefits. The benefits of this FABEC programme will grow over time as the elements of some projects are successively implemented. In the short and the medium term, the EIP-projects and the AD projects (formerly “hot spots” projects) will contribute to significant reduction in flight inefficiency, leading to direct cost savings for the customers.

In the longer term, the benefits, especially from the FRA project, will result in much greater savings in terms of reduced flight inefficiency. Benefits will be in 2014 of around € 54m a year, in 2020 around € 98m, and in 2025 around € 108m a year.

In the longer term, as well, benefits in terms of saved ANSP costs will be added, achieved through improvements especially in the area of CNS. ANSPs’ cost savings are expected to be € 7m in 2014, rising to € 18m in 2020 and € 20m in 2025.

The FABEC project shows a positive NPV, even over relatively short time horizons. The vast bulk of the benefits arise through the ability to generate improvements in flight efficiency. However, there are also some benefits from ANSP cost savings. The NPV of the FABEC project is expected to be approximately € 100m taking account of benefits up to 2014, rising to € 449m if benefits to 2020 are taken into account and to € 732m if the horizon is 2025.

It has to be noted, that some of the FABEC projects are currently not in a status to assess the performance increase and some FABEC projects are insufficiently mature to provide quantitative performance data (the work on Performance cases just started). The results of these projects would even increase the NPV of FABEC in the future.

We also analysed how sensitive the impact of the project is to a number of areas of uncertainty. Most importantly, the values of the benefits are sensitive to the level of benefits the projects will reach. We also analysed the reaction of the NPV towards a variation of the traffic forecast. However, the NPV remains positive in all cases. Uncertainty in various assumptions could cause the NPV for the FABEC programme to vary from € 611m to € 864m.

For flight-efficiency the FABEC initiatives are expected to contribute towards meeting the Feasibility Study target of a cumulated reduction of 10km in the average route extension by 2018. The results of the FABEC study show that a reduction of 3km at that time could be possible. But taking into account, that the reference case already incorporates a reduction in route extension of about 6km, due to national measures, the target is nearly met. The increased flight-efficiency brought about by the FABEC initiatives will lead directly to lower emissions, hence reducing the impact of each flight on the environment. In regard to the flight efficiency target laid down in the FABEC Performance Plan for RP1 the national improvements in the reference case are already sufficient to reach the target. The gains reached by the FABEC initiative only help to exceed this target and make sure that future targets will also be met.

As the reference case shows that the future capacity based on national capacity improvement measures will be sufficient to maintain a high quality of service for the projected growth in traffic, with delays remaining at an acceptable level for RP1 consistent with the targets laid down in the FABEC Performance Plan. The conclusion may be that there is no need for FABEC initiatives contributing to a significant improvement in this domain.

The FABEC initiatives provide a rather small improvement in financial cost-effectiveness. The reference case, which relies on continuing improvements without the FAB embodies a 2% rise in en-route cost per flight-hour by 2025. The FAB projects, added to the improvements expected without FABEC, achieve to reduce this increase to 1% of the ANSPs' en-route cost per flight hour. It is obvious that the ANSPs need to find more initiatives especially delivering cost savings in the middle and long term. It has to be noted, that the cost figures representing the reference case reflect the ANSPs’ plans from 2010, and therefore do not take in account the impact of the national parts of FABEC Performance Plan on cost efficiency on the future ANSPs’ cost figures in 2011.

2 INTRODUCTION

2.1 *Purpose of this Document*

This document has been produced to summarise the results of a cost-benefit analysis (CBA) for the Implementation Phase of the Functional Airspace Block Europe Central (FAB EC)[1].

2.2 *Context of the Analysis*

Art. 9a.2(d) of Regulation (EC) No. 550/2004 (the airspace Regulation), amended by Art. 2.5 of Regulation No. 1070/2009, requires that "*a FAB shall, in particular, be justified by its overall added value, including optimal use of technical and human resources, on the basis of a cost-benefit analysis"*.

All requirements regarding the cost-benefit analysis are laid down in the "Guidance Material for the establishment and modification of Functional Airspace Blocks (FAB)" written by Eurocontrol[2].

2.3 *Content of the Analysis*

A major project of the nature of FABEC will have a wide impact on a range of affected parties (in the ANS world, these are often referred to as "stakeholders").

Cooperation in the context of a FAB will entail a number of cooperative initiatives or projects between the ANSPs participating in the FAB. Such initiatives/projects will bring benefits. The benefits can on the one hand accrue **directly** to airspace users, in terms of improved quality of service and reduced costs of using the airspace. On the other hand, benefits can accrue **indirectly** through reductions in ANSPs' costs which will in the fullness of time be passed through to airspace users as reduced user charges.

The benefits will be to some extent counterbalanced by costs. Each initiative/ project might have operating costs on its own – we allow for this by examining the **net benefits** of each initiative. More significantly, each initiative/ project is likely to bring with it certain **transition costs** – the costs of attaining the required level of cooperation that will bring net benefits. These transition costs could comprise:

- **set-up costs** required to define, design and plan the initiative/ project,
- **capital costs** of investments required to develop and implement the initiative/ project,
- **training costs** required to enable staff to operate new systems and procedures and
- **social costs** if the new collaborative arrangements involve the need for staff to relocate or be redeployed.

In addition there may be costs and benefits to other parties, or to the environment, and benefits in terms of improved safety.

The framework for the comparison of these various costs and benefits is provided by a cost-benefit analysis. The cost-benefit analysis comprises the assessment of the totality of these costs and benefits over time, for each initiative or project and for the totality of beneficial

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[1] The FAB EC implementation programme is driven by the ministries of transport and defense of Belgium, France, Germany, Luxembourg, The Netherland and Switzerland together with the respective civil and military Air Navigation Service Providers (ANSP) including the Eurocontrol Maastricht Upper Area Control Centre (MUAC).

[2] European Commission Guidance Material for the establishment and modification of Functional Airspace Blocks (FAB), Version 1.2, 01.07.2011

initiatives. A conventional cost-benefit analysis will also examine the relative importance of costs and benefits at different times, using discounted cash flow techniques.

3 WORKING METHOD

This chapter presents a high-level overview of the working method that was used to develop the Implementation Phase CBA framework. It focuses on the methodology used in the CBA, which is based on the methodology of the Feasibility Study CBA[3], with some additional changes required to have a better view on certain aspects.

One of the major differences between the framework of the Implementation Phase CBA and the one of the Feasibility Study CBA is the disaggregation at ANSP level. This disaggregation concerns the elements of the cost framework and elements of the benefits not only at FAB-level.

The scope and parameters of the cost-benefit analysis were agreed with the Standing Committee Finance. They are summarised in chapter 4 of this report.

The approach to produce the cost-benefit analysis was as follows:

- determine the features of a "reference case" – this is the description of what the situation would be in air navigation service provision in the FABEC states if international collaboration remained at the levels planned before the initiation of the FAB project,
- define a list of proposed "FAB initiatives" – these are cooperative projects that result from the FAB and are expected to bring net benefits to the stakeholder community,
- determine as far as possible the costs and benefits of these initiatives and
- summarise the overall impact of the FAB initiatives, both in terms of their net benefits and in terms of their impact on performance indicators for the FAB, resulting in a "with-FAB" case.

Once the inputs and scenarios are defined, the impact of the scenarios on the various performance areas is analysed. This process is presented, at a high level, in Figure 3.1.

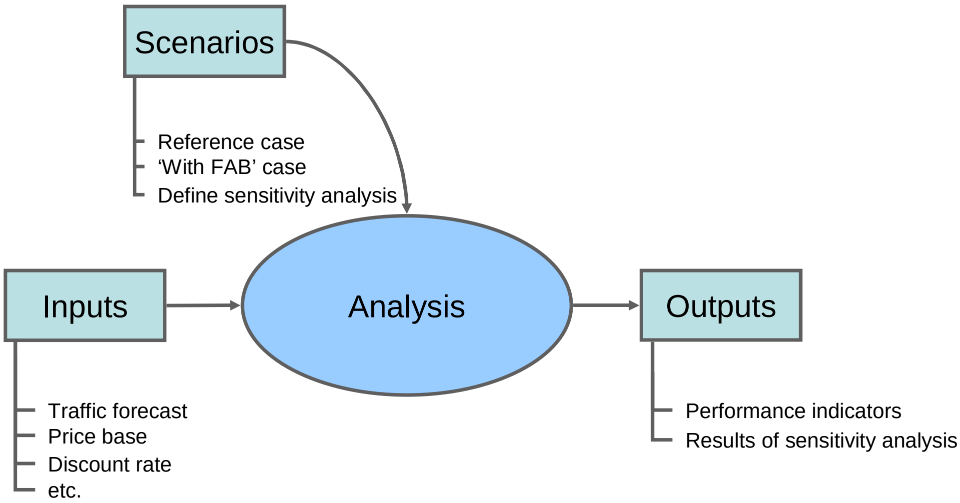

Figure 3.1: High level structure of the approach

AFG/PMG and SC FIN have also defined a range of areas where the analysis should examine the uncertainty associated with some of the assumptions concerning the initiatives. The areas of uncertainty were as follows:

- Traffic demand being lower than anticipated

[3] FAB Europe Central Detailed Feasibility Study, WP3.4.5 – Cost-benefit analysis, Version 1.0, Reference: FABEC-FIN-D3.4.5-v1.0, 13 June 2006.

- Uncertainty in the benefits of the operational and technical initiatives
- The impact of the discount rate on the NPV
- The influence of lower cost plans of the ANSP in the reference case
- Adjustment of delay figures in the reference case

These uncertainties are further examined in the sensitivity analysis in chapter 9.

It should be noted that this cost-benefit analysis only reflects the current status of the FABEC programme. It contains all projects and initiatives known today. But one should be aware that due to the long time horizon of this CBA it is most likely that new projects, not known today will be started in the future and have a positive influence on the calculated NPV.

For this CBA it was assumed that all inputs are independent of the institutional setup. This means, that every project included in CBA can be implemented regardless of the level of institutional cooperation, be it a contractual cooperation of independent ANSP on the one side or a single ANSP- model on the other side (and of course every possible model in between).

4 SCOPE AND PARAMETERS

4.1 Introduction

In consultation with the Standing Committee Finance, the scope and parameters of the cost-benefit analysis were determined. Areas where the scope and parameters were to be determined comprised:

- the scope of the analysis,
- the price base,
- the discount rate,
- the time horizon of the analysis,
- the range of stakeholders to be considered,
- the method of valuation of user benefits and
- the performance indicators that should be considered.

The decisions adopted on each of these matters were as explained in the next paragraphs.

4.2 Scope of the Analysis

The analysis has been carried out to account for operations that are considered to be within the **en-route cost base** of the ANSPs. This is consistent with the approach of the Feasibility Study CBA.

4.3 Price Base

The analysis was carried out in **real terms** and all monetary values were expressed in Euros in constant 2010 prices. The Skyguide figures were taken out of the 2010 PRU submission, which were already converted into Euros. Skyguide applied an exchange rate of 1.382 CHF.

The year 2010 was chosen as it was the year for which the most recent and comprehensive financial information was available at the time, the reference case was established.

4.4 Discount Rate

The analysis was carried out using a discount rate of **6% per year in real terms**. This was supplemented with sensitivity tests using discount rates of 4% and 8%.

4.5 Time Horizon

The time horizon for the cost-benefit analysis was until **2025**. This is consistent with decisions of the Standing Committees OPS and TECH to look at major initiatives being implemented between 2011 and 2020; the time horizon of the analysis will need to include some years in which benefits are generated.

As the Feasibility Study CBA had also the same time horizon, a comparison of both results is easily possible.

4.6 Stakeholders Considered

The range of stakeholders considered in the cost-benefit analysis comprised the States, the ANSPs, commercial airspace users, and military airspace users. It was agreed however, that the interests of the States would not be explored further in this work.

4.7 User Benefits

User benefits comprise both direct and indirect user benefits. Direct benefits arise from improved quality of service whereas indirect user benefits arise from ANSP cost reductions which in turn could lead to lower en-route charges. It was agreed that the indirect user benefits will not be included explicitly, as the cost reductions for the ANSPs from which they result will already be counted as benefits to the ANSPs.

Direct user benefits arising from improved quality of service comprise:

- improved flight-efficiency (horizontal and vertical),
- reduced delays and
- reduced unaccommodated demand.

It was agreed that improved **horizontal flight-efficiency** would be valued by using the same parameters laid down in the "Standard Inputs for Eurocontrol CBA" document[4]. This would lead to a value of **€ 4 per km[5]** saved. No attempt to disaggregate the benefits by aircraft type was made. As the calculation of fuel savings because of route length reductions proved to be rather easy by using the SAAM Tool[6], the relevant results were taken into account. As the SAAM simulations always take a representative day/week of the past to calculate the future gains in flight efficiency, we included a weighting factor in the model to calculate correct benefits.

Remark on the cost per km parameter: During the development of the FABEC CBA this parameter was changed dramatically. Whereas in the 2009 edition of the standard inputs document the value was estimated with 8.8€ per km, the current value lies at 7.3€ per NM which equals 3.94€ per km. This change by more than 50% was explained by Eurocontrol by wrong calculations made in the former version of the document. As the benefits for the FABEC programme presented in this document rely heavily on improving the horizontal flight efficiency this had a very significant impact on the NPV.

In some projects (especially in the TMA area) improvements in **vertical flight-efficiency** were found. For these improvements also the corresponding fuel savings were used in the benefit calculations.

It was agreed that **reductions in delays** will be valued by using the Standard inputs document which is in turn based on work done for the PRU by the University of Westminster. This work, at last updated in 2011[7], valued delays at **€ 81.3 per minute[8]**.

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[4] Standard inputs for EUROCONTROL cost-benefit analyses, EUROCONTROL, V 5.0 Dec 2011 (Edition date JAN 2012).

[5] Marginal costs, base scenario

[6] SAAM (System for traffic Assignment and Analysis at a Macroscopic level) is an integrated system for wide or local design, evaluation, analysis and presentation of Air Traffic Airspace / TMA scenarios, developed and operated by Eurocontrol.

[7] European airline delay cost reference value, V3.2, University of Westminster, March 2011

[8] Tactical delay, Ground, base scenario

The level of **unaccommodated demand** has also been estimated. The “Standard inputs for EUROCONTROL CBAs”, document estimates a value of **€ 700** for each additional flight that is accommodated.

Other elements of user benefits include for instance **predictability**. There are no obvious ways of assessing the benefits quantitatively. Therefore it was agreed not to investigate this element within this CBA.

4.8 Environmental impact

This cost-benefits analysis does not reflect environmental impacts of the relevant FABEC initiatives. The consequences of i.e. improvements in flight efficiency are discussed in Annex O, the FABEC environmental case.

4.9 Performance Indicators

The performance indicators used are based largely upon those used by the PRU. However, the indicators were adjusted to allow for the fact that the FABEC programme is principally concerned with elements of ANS that appear rather in the en-route than the terminal cost base.

Therefore the following performance indicator for ANSP financial cost-effectiveness was used:

- en-route cost per flight-hour.

This corresponds to the PRU’s financial cost-effectiveness indicator, revised in scope to include the en-route cost base only. We also assessed the:

- ATCO productivity at ACCs.

For direct user benefits the following indicators were used:

- of flight-efficiency, the percentage excess of actual km flown over great circle distance within FABEC airspace,
- of delay, the average ATFM delay per movement generated for which a portion of FABEC airspace is the most penalising component of the flight and
- of unaccommodated demand, the number of flights that are unable to be accommodated by ANS provision.

A performance indicator is introduced for the economic cost-effectiveness of ANS provision. It is based on that used by the PRU which includes the cost of flight inefficiency, delay and unaccommodated demand to the user. The proposed indicator is:

- en-route cost per flight-hour (including cost of flight inefficiency per flight-hour, delay per flight-hour and levels of unaccommodated demand per flight-hour).

The CBA framework excludes a number of cost elements from the calculations of performance indicators. These are:

- aeronautical meteorology (MET) costs,
- regulatory, NSA (National Supervisory Authority) and State costs and
- Eurocontrol costs.

These costs are excluded from the assessment of ANS cost because they are considered to be outside the control of the ANSP and are therefore not appropriate to be included in an indicator of ANSP performance. This is consistent with the approach taken by the Performance Review Commission.

4.10 Performance Targets

Feasibility Study Targets

During the FABEC feasibility study a set of performance targets were set by the CEOs of the ANSPs. The targets were set in the following five performance areas:

- safety;
- flight-efficiency;
- environment;
- capacity and delay; and
- financial cost-effectiveness.

Safety was not investigated in the cost-benefit analysis.

For flight-efficiency the target was expressed in terms of an average reduction of excess kilometres flown per flight. The target was a 2km annual reduction until 2010, increasing to an accumulated total of 10km by 2018.

For the environment, the target was to reduce the impact on the environment by improvements of routes, flight profiles and distances flown. It was implied that if the flight-efficiency target is met then the environment target will also be met.

For capacity and delay, the target was to meet the demand of increased civil air traffic by 2018, based on the EUROCONTROL STATFOR baseline forecast, taking into account the European target of one minute of delay per flight (during the summer period) and taking into account the military needs.

Finally, for cost-effectiveness the target was that the expected increase of civil traffic by 2018 shall not result in more than a 25% increase of total cost, based on current rules of cost recovery (leading to a 17% reduction of the real en-route unit cost). It also stated that a decrease in ATM costs to the military should be realised.

EU-wide Performance targets for RP1 broken down on FABEC Level

In the provisional FABEC Performance Plan (FPP), sent to the European Commission at the end of June 2011 different performance targets for the reference period (RP) 1 for the en-route activities were set.

In this Performance Plan is stated that in the Safety Performance area three performance indicators will only be monitored:

- PI #1: Effectiveness of Safety Management
- PI #2: Application of the Severity Classification of the Risk Analysis Tool (RAT)
- PI #3: Reporting of Just Culture

As mentioned before in this CBA safety issues were not assessed.

In the environment performance area the FABEC states decided to use the

- KPI #1: Percentage of route extension represented in distance flown compared to the great circle distance

as an intra-FABEC performance indicator instead of the EU-wide performance indicator “Average horizontal en-route flight efficiency”. The target is an improvement by 5% of the average horizontal en route flight efficiency extension in 2014 as compared to the situation in 2011 measured in km.

The second environmental KPI defined in the FABEC Performance plan is the

- KPI #2: Approach procedures in place supporting Continuous Descent Operations (CDO) (ICAO Doc 9931)

This KPI was not assessed in this CBA.

In the capacity performance area the FABEC states decided to use the EU-wide key performance indicator

- KPI #1: En route average ATFM delay per controlled flight

also as a FABEC KPI. KPI #1 target is set as shown in Table 4.1, as a maximum, for each year 2012, 2013 and 2014:

Year	2012	2013	2014
KPI #1 (min per flight)	0,77	0,68	0,50

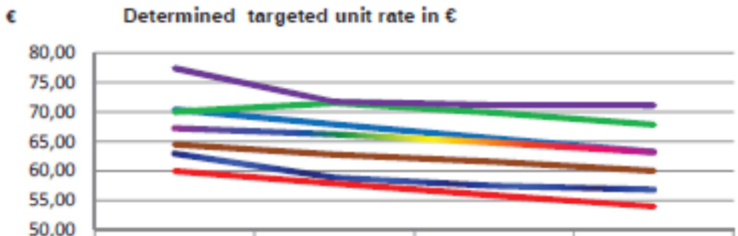
Table 4.1: EU/FABEC KPI #1 delay per flight, values 2012 to 2014

As the key performance indicator in the performance area cost-efficiency the

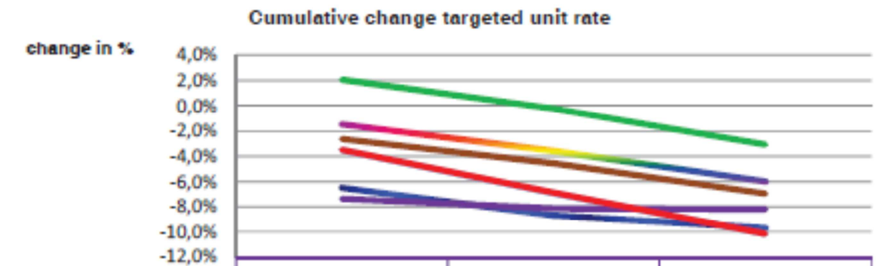
- KPI #1: Determined unit rate for en-route ANS

was defined.

The targets in this performance area cost-efficiency were nationally set, as FABEC has yet not implemented a single unit rate. Hence, no common FABEC-wide target for cost efficiency was set. But in the FABEC Performance Plan an aggregation of the national targets was included. Figure 4.1 shows the developments of the determined targeted unit rates and the cumulative change of the unit rates per state and for FABEC (information only).



	2011	2012	2013	2014
Belgium/Luxembourg	70,34	67,86	65,47	63,21
France	64,48	62,78	61,54	59,99
Germany	69,97	71,42	69,81	67,82
The Netherlands	62,94	58,86	57,47	56,84
Switzerland	77,40	71,71	71,11	71,06
FABEC	67,19	66,21	64,79	63,16
EU-wide target	59,97	57,88	55,87	53,92



	2012	2013	2014
Belgium/Luxembourg	-3,5%	-6,9%	-10,1%
France	-2,6%	-4,6%	-7,0%
Germany	2,1%	-0,2%	-3,1%
The Netherlands	-6,5%	-8,7%	-9,7%
Switzerland	-7,4%	-8,1%	-8,2%
FABEC	-1,5%	-3,6%	-6,0%
EU-wide target	-3,5%	-6,9%	-10,1%

Figure 4.1: Cost efficiency KPI #1 determined unit rate, development 2012 to 2014

5 THE REFERENCE CASE

5.1 Derivation of the Reference Case

The reference case has been determined as far as possible from the forecasts and plans of the individual ANSPs. We have examined each State's Local Single Sky Implementation Plan (LSSIP), individual ANSPs' submissions to the PRU of forward projections in the context of the ACE-reporting, and further information provided in consultation with the ANSPs. We have also used the traffic forecast laid down in the FABEC Performance Plan and background information from SESAR and EUROCONTROL.

The specification of the reference case comprises the trajectories over time of the following variables:

- traffic;
- capacity;
- ATCO-hours on duty;
- delays;
- flight-efficiency;
- investment;
- costs; and consequently
- the performance indicators.

The LSSIPs and ACE submissions, as well as ANSP business plans, where available, have a much shorter time horizon (2014) than the cost-benefit analysis. AFG/PMG therefore asked each ANSP to deliver growth rates for several parameters needed in the CBA (for instance traffic, flight hours or ATCO hours on duty) for the years after 2014, at ANSP level as well as at local ACC level.

The following paragraphs discuss each of the variables at aggregated FAB-level in turn.

5.2 Traffic

The traffic forecast for FABEC is derived from the forecast of each state. These are taken from the EUROCONTROL STATFOR MTF baseline scenario forecasts[9].

The traffic growth for the FABEC region is illustrated in Figure 5.1. Between 2009 and 2015, the annual average growth rate is quite volatile showing rather high year to year differences with a average increase of 2% per year. After 2015 the growth is expected to be around 2%.

9 EUROCONTROL Medium-Term Forecast: IFR Flight Movements 2012-2018 , Version 1.0 , 28.02.2012

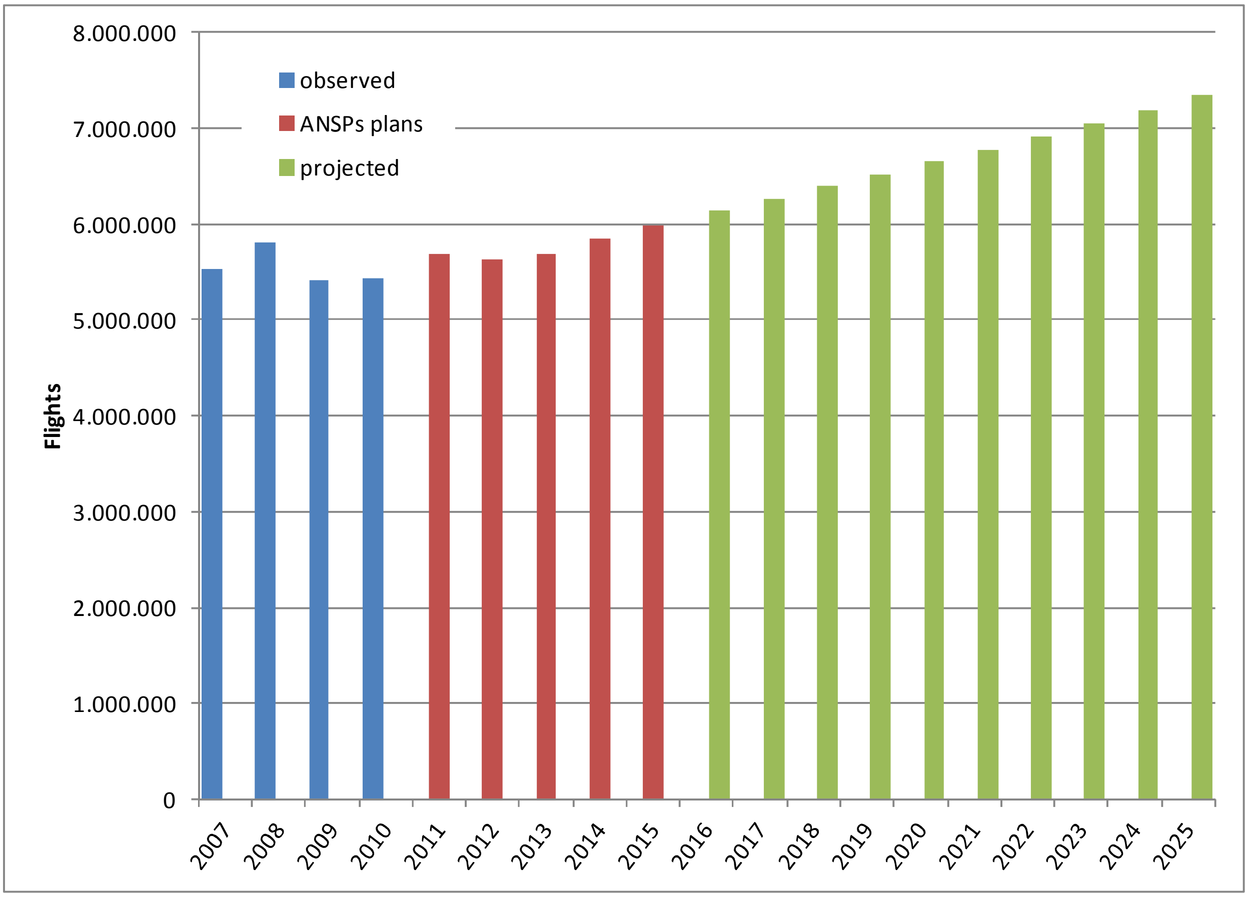


Figure 5.1: Traffic in the FABEC region, observed, planned and projected

The traffic growth in terms of flight-hours (the variable that, according to the PRU framework, best measures the output of en-route ANS) is also derived from the forecast of each state respectively ANSP.

Figure 5.2 illustrates the growth of flight hours in the FABEC region.

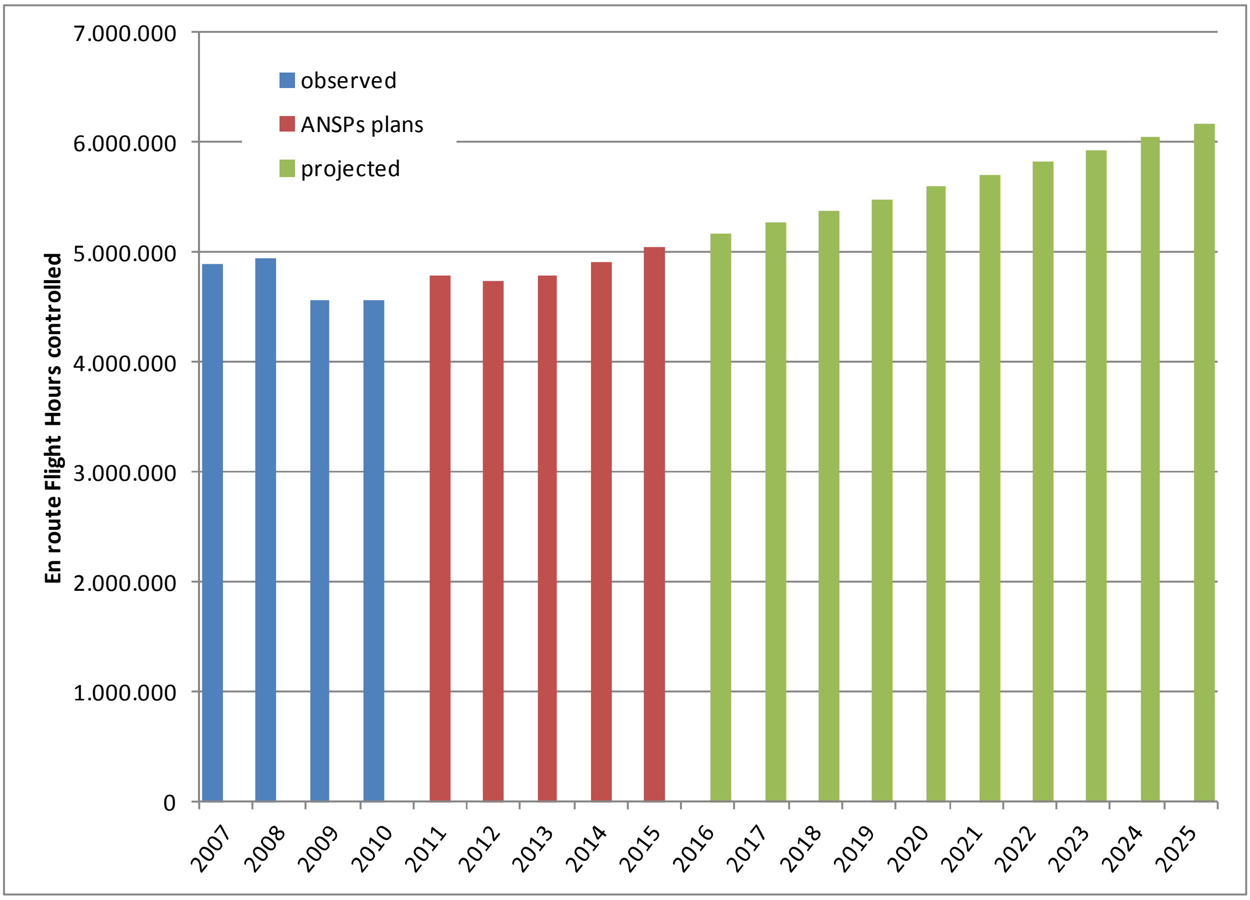


Figure 5.2: Controlled flight hours in the FABEC region, observed, planned and projected

<u>Comparison with Feasibility Study CBA</u>

The Feasibility Study assumption for traffic growth until the year 2015 was 3.7% per year. Afterwards, there was a reduced growth rate of 2.5% expected. Main reasons for the currently lower figures are the financial and economic crisis as well as increasing fuel prices. This leads to less demand which is especially in regard to capacity resp. delay calculations of high importance.

There is despite the lower figures the concern if even the reduced expected traffic growth is still likely, given an environment of high fuel prices, the growing pressure to cut emissions and the current economical situation. This document therefore, in Chapter 9, looks at the outcome of an even lower traffic growth scenario.

5.3 Capacity

ANSPs can increase en-route capacity in several basic ways:

- improved technology and procedures can improve ATCO productive efficiency (the traffic that ATCOs can handle at peak capacity utilisation);
- more sectors can be opened:
- increased traffic predictability:
- best practices to set regulation
- STAM

The first way improves both ATCO productivity and en-route capacity in parallel.

The second way can lead to either status quo, increase of ATCO productivity or diminish ATCO productivity according to the cases. Indeed the same or even a lower number of sectors that fit better to traffic patterns can impact positively the traffic demand throughput with the same level of sector-hours. On the contrary a greater number of open sectors is likely to diminish ATCO productivity, since there are diminishing returns to sector sub-division. Each additional sector requires additional ATCOs (depending on sector opening hours), while providing successively diminishing increments of capacity. As sectors are subdivided, more of the ATCO workload is spent on handover tasks. This problem is more acute in some parts of FABEC than in others.

In addition, we understand that when a re-sectorisation of the airspace – or any major system change – is required to provide additional capacity it takes a period of time to implement before drawing real benefits of it. Therefore, whilst the requirement for a new sector may have been established, the re-sectorisation of the airspace will not be immediately available. When the change is implemented safety issues impose to decrease capacity during a period of time which will increase delay but ensure a smooth and reduced flow of traffic. After the end of this period, an assessment of the capacity has to be made before being able to increase capacity to initial expected levels.

Furthermore, it is understood that there are real limits on the expansion of sectors in this way. These can be “hard” limits; as sectors become smaller, the diminishing returns mean that eventually no increment in capacity is obtainable. There could also be “soft” limits, determined by the physical capacity of the infrastructure. Such “soft” limits can be lifted by expansion of the physical infrastructure.

AFG/PMG has explored the limits to sector sub-division with the ANSPs. Their conclusions are broadly that there are “hard” limits on the expansion of sectors. The values for these “hard” limits have been estimated with the assistance of ANSPs members of the AFG/PMG. The limits constrain the number of sectors that can be opened by an ACC, and result in an increase in ATFM delay if an ACC is unable to open sufficient sectors to cope with forecast traffic demand.

AFG/PMG has been provided with the planned number of sectors in 2009; the “hard” limit revealed by ANSPs and a parameter indicating the extent to which incremental capacity is reduced with each new sector opened if capacity may be expanded beyond the 2015 figure, (e.g. if this “diminishing returns parameter” is 20%, this means that the opening of a single new sector will add 20% less capacity to the total than the average of existing sectors).

AFG/PMG notes that diminishing returns to sector subdivision will lead to a reduction in ATCO productivity. It is assumed that this reduction is already in the plans, and in the projections of ATCO productivity discussed above.

A further constraint on capacity is the ability to recruit, train and retain ATCOs. A number of ANSPs have suggested that this constrains their ability to provide capacity. ANSPs have identified that, amongst other constraints, the capacity to provide on-the-job training (OJT) is a significant bottleneck to the number of ATCOs that can qualify in a year.

AFG/PMG has therefore assumed a ceiling on ATCO qualification for each ANSP, based on discussions with ANSPs. AFG/PMG has also accounted for the attrition of ATCOs by asking the ANSPs for a figure per ACC, how many ATCOs in operations leave their operational posts each year. Therefore, the recruitment and qualification process must replace these ATCOs, as well as increasing ATCO numbers to enable the ANSP to man sufficient sectors and provide sufficient capacity.

ANSPs are assumed to open sectors to provide capacity in a way that meets delay targets as far as possible, but subject to the constraint that qualification of new ATCOs does not exceed these limits.

5.4 ATCO-Hours

ANSPs have provided us with projected numbers of ATCO-hours required to control future traffic for the period up until 2014.

The number of ATCO-hours required to handle the traffic is determined by the ATCO productivity. ATCO productivity is defined as the number of flight-hours controlled per ATCO-hour on operational duty.

Consultation with ANSPs regarding the average number of ATCO-hours on duty indicated that a reasonable assumption for long-term planning would be to use a constant value, although in some ANSPs there may be pressure for the average hours on duty to be reduced. For the purposes of these projections we have assumed a constant value for each ANSP (the average in 2009) for the entire period.

Given this assumption, we find that for the period 2011-2014, ATCO productivity is assumed in the ANSPs' plans to decrease by about -2 % per year (depending on ANSP)[10].

Beyond 2014 the growth rates we got from the ANSP indicate, that ATCO productivity will continue to increase but at a quite reduced pace of around 1%. The rationale is that relevant productivity gains are not really necessary at the moment due to the low traffic figures and that business-as-usual improvements over a long term period are situated more realistically around 1%. This low rate of increase reflects in addition the diminishing returns to sector subdivision discussed in the previous section. The development of ATCO productivity in the reference case is shown in Figure 5.3.

We have also taken account in the reference case projections the constraints on recruitment and qualification of ATCOs discussed above. Some ANSPs within the FAB are not able to recruit as many ATCOs as they need to provide sufficient ATCO-hours on duty to cope with the traffic demand. Furthermore, even if there are not direct constraints on the number of ATCOs that can be recruited, the duration of the training process implies that there can be a deficit in the number of controllers required to man the sector opening schedule.

We have assumed that if the number of ATCO-hours required is bigger than the number of ATCO-hours available then there will be a deficit of sectors available during peak hours, which results in ATFM delay.

[10] The drop in productivity in the years between 2009 and 2012/2014 can be explained by a decrease of traffic due to the financial crisis wheras the number of ATCOs was kept stable or even increased.

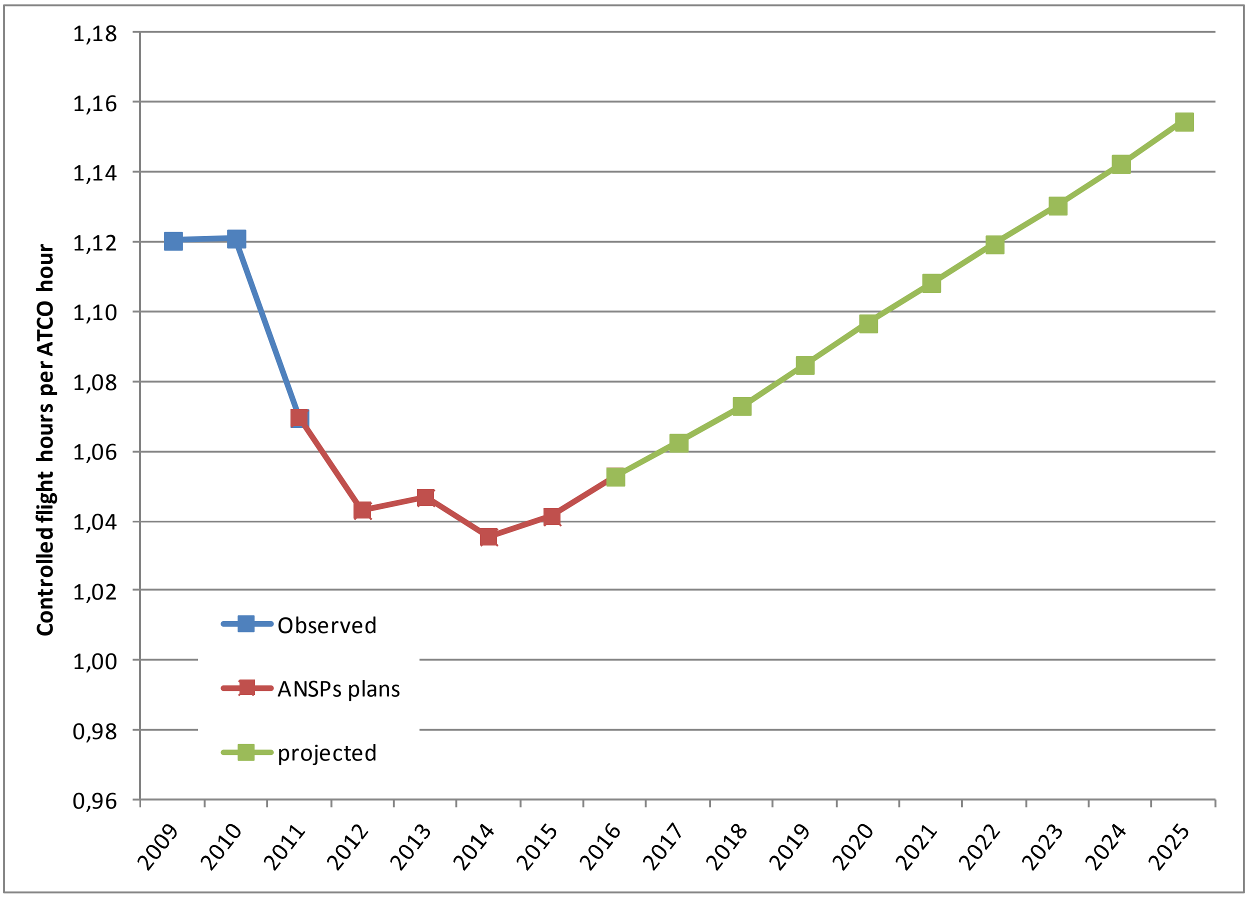


Figure 5.3: ATCO productivity, observed, planned and projected

The resulting increase in ATCO-hours on duty[11] is shown in Figure 5.4.

[11] The quantity shown is equivalent to the PRU's "ATCO-hours on operational duty" but adjusted to allow for the fact that some ATCOs provide terminal services. The figure shown here is an estimate of the ATCO-hours providing en-route services.

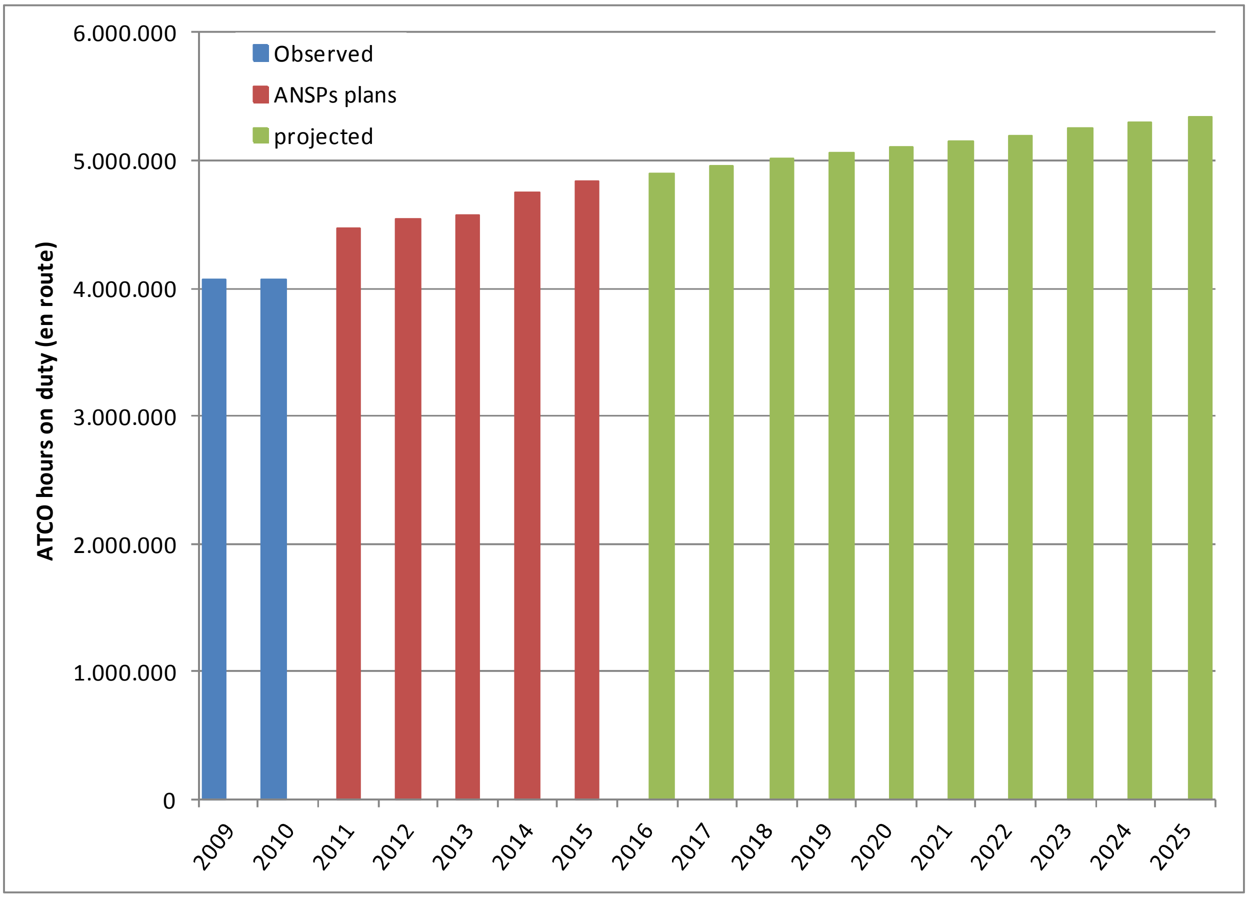


Figure 5.4: ATCO hours on duty, observed, planned and projected

5.5 Delays

5.5.1 Delay Model

If capacity falls short of that required to meet demand, delays will ensue.

The delay was estimated by examining the relationship between the demand-capacity ratio (averaged over a year) and the delay.

A methodology for analysing the relationship between demand, capacity and delay was developed by Helios for the Franco-Swiss FAB, which focused on Zurich ACC. The Franco-Swiss methodology demonstrated that the relationship between daily delay at Zurich ACC and the ratio between capacity and demand gave rise to a relationship between annual demand and delay. Delays for other ACCs were not sufficiently widespread to be able to confirm the applicability of this relationship elsewhere.

During the CBA for the FABEC Feasibility Study Helios therefore examined annual delay figures for all ACCs in the FAB for the years 2003 to 2006, assuming that the Zurich equation applied, but with a different capacity. They were able to derive equations that fitted observed annual figures at all 14 ACCs. They adjusted the model to ensure that it produced 2006 delay figures, so that growth in capacity started from an accurate baseline. The relationship derived, and the fit to existing data, is illustrated in Figure 5.5.

This methodology proved during the Feasibility Study CBA to be a good compromise between a rather simple way of calculation and a detailed enough picture of reality. To improve the correctness of the results Helios introduced so called “calibration factors” for each relevant ACC. This led to a further improvements in the delay calculation per ACC.

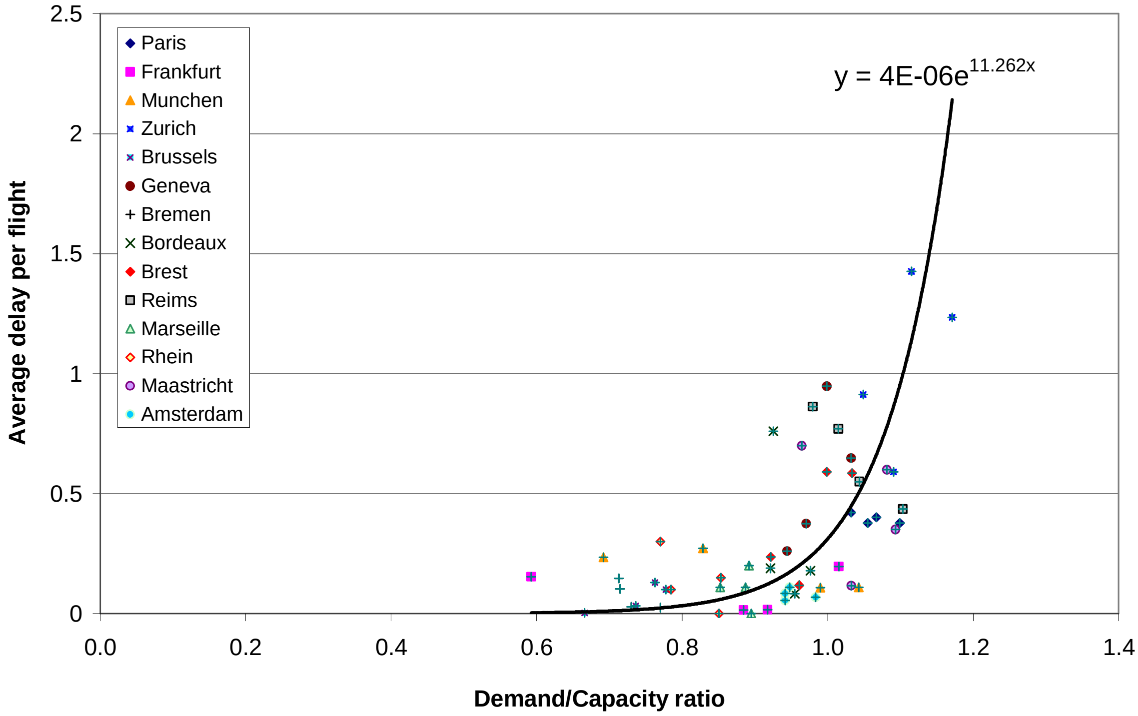


Figure 5.5: Illustration of demand-capacity-delay relationship

The exponential relationship shown in Figure 5.5 appears to apply over a wide range of demand-capacity ratios. It cannot, however, be extrapolated indefinitely. After a certain point, delays will not be tolerated by users and flights will be cancelled or diverted. There was no recent evidence, however, of the magnitude of this effect, since delays in recent years have not been of such magnitude to generate appreciable quantities of such "unaccommodated demand". Helios was not able to gain access, either, to simulations that would give guidance on the likely magnitude of the effect. Nevertheless, Helios was sure that it was an important effect to include in the analysis. Simple extrapolation of the delay curve beyond the point for which there is evidence could give unrealistic results. Helios therefore made its own judgement as to how that curve would continue.

They assumed that unaccommodated demand would become appreciable when annual demand exceeds capacity by 15% (a demand-capacity ratio of 1.15). They have further assumed that where demand exceeds capacity by more than 30% (a demand-capacity ratio of 1.3), no further demand can be accommodated. The resulting relationship between the demand/capacity ratio, delay and unaccommodated demand is shown in Figure 5.6.

It should be emphasised that this curve is simply one possibility. The choice of curve is a matter of judgement, rather than inference from evidence or from simulations. A range of possible relationships would be consistent with both observations and with the features of the system.

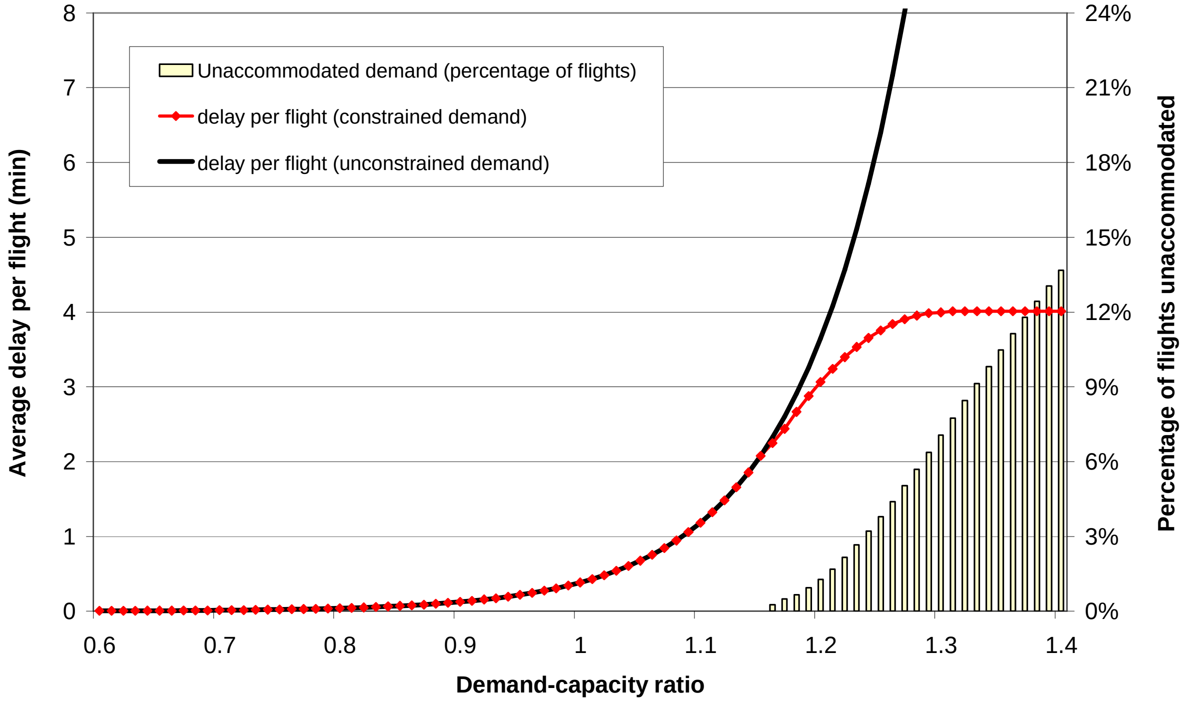


Figure 5.6: Demand/capacity ratio, delay and unaccommodated demand

The ratio of demand to capacity and the relationship derived above allows producing projections of both delay and unaccommodated demand.

The growth in ACC capacity was projected for each ACC, applying planned and projected increases in numbers of sectors, taking into account:

- diminishing returns;
- “hard” limits on the number of sectors within an ACC;
- limits on the availability of qualified ATCOs; and
- expected increases in ATCO productivity.

The expected evolution of the average annual en-route ATFM delay per flight from 2010 to 2025 is presented in Figure 5.7. It shows that the delay per flight is projected to decrease or being stable steadily until 2025. This forecast is far better than the delay forecast in the CBA prepared for the Feasibility Study. The area of delay, where unaccommodated demand is generated (Demand-capacity ratio > 1.15) will never be reached during the next 15 years.

Because of this positive development of the delay until 2025 no unaccommodated demand is calculated.

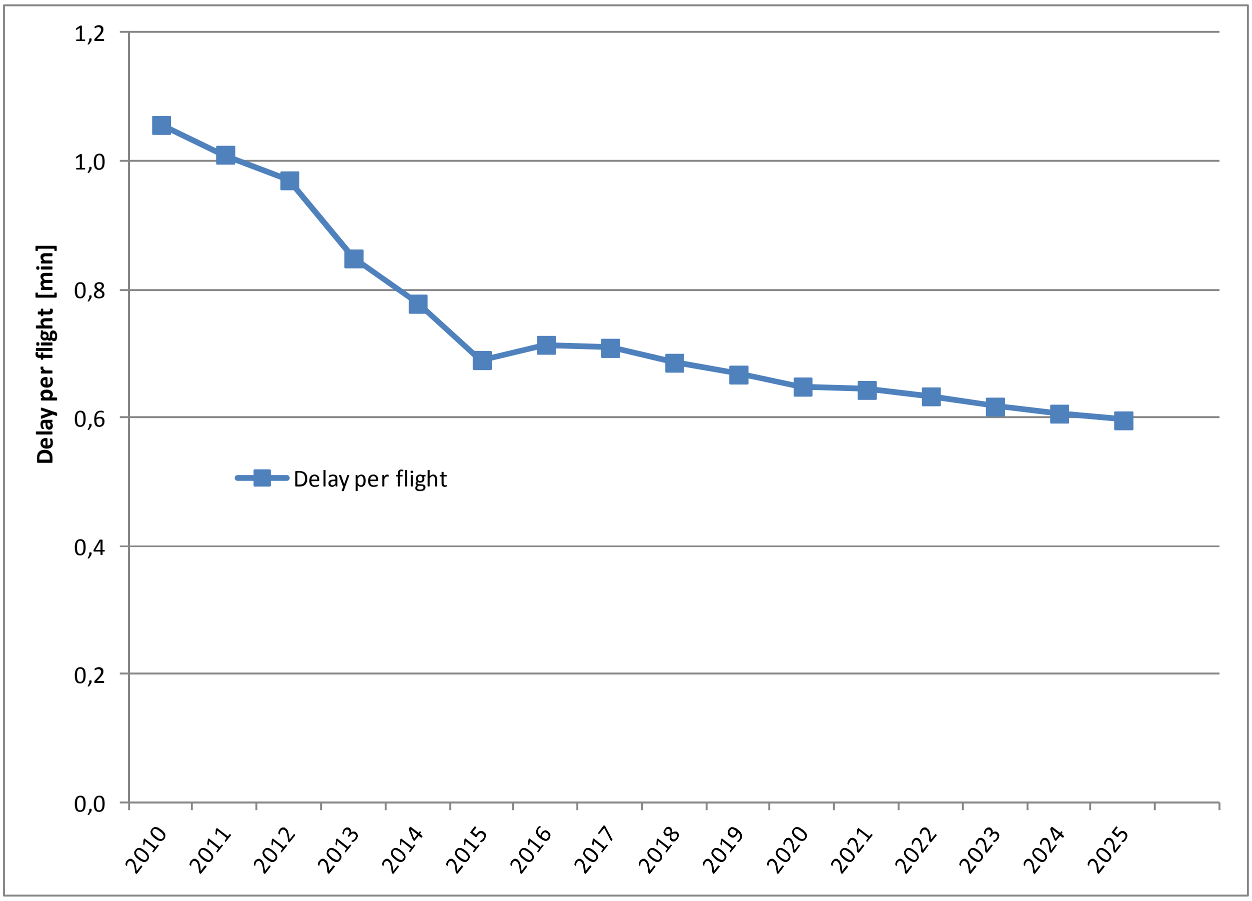


Figure 5.7: Delay per flight in FABEC

The estimation of delay per flight represents a 'best case' scenario. It relies on the assumption that ANSPs are implementing the capacity enhancing measures they have indicated and that these measures are available throughout the period of the analysis. If they are not able to do so, the reference case delay will be correspondingly bigger, which may result in improved benefits arising from the FAB.

<u>Comparison with Feasibility Study CBA</u>

The development of the delay is very different to the results presented in the Feasibility Study CBA. In that CBA the average en-route delay per flight was projected to rise from 0.65 minutes per flight to nearly 2.5 minutes per flight in 2025. This development led to an increasing level of unaccommodated demand up the estimation, that in 2025 nearly 1% of the demand would be unaccommodated.

This shows that all ANSP put a lot of effort in improving the capacity situation in their airspace during the last 3 years. But this also leads to fewer possibilities for the ANSP to reach significant benefits in delay by implementing FABEC projects. This can be seen in chapter 7.3.1.

5.5.2 Comparison with Bottom-up Model

Figure 5.8 shows the development of the delay per flight 2012-2014 calculated in the so called "Bottom-up-model", which was developed in the beginning of 2011 during the preparation of the FABEC-Performance Plan (FPP) for RP1. The model was developed as an alternative to the top-down approach to define a delay target for the FABEC region for the first reference period, calculated by Eurocontrol. This top-down target was assessed as to be too ambitious and not reachable. Therefore AFG/PMG developed the bottom-up model; considering the current ANSP capacity plans for each ACC (bottom-up methodology).By this the model also addresses the achievability of the calculated delay target.

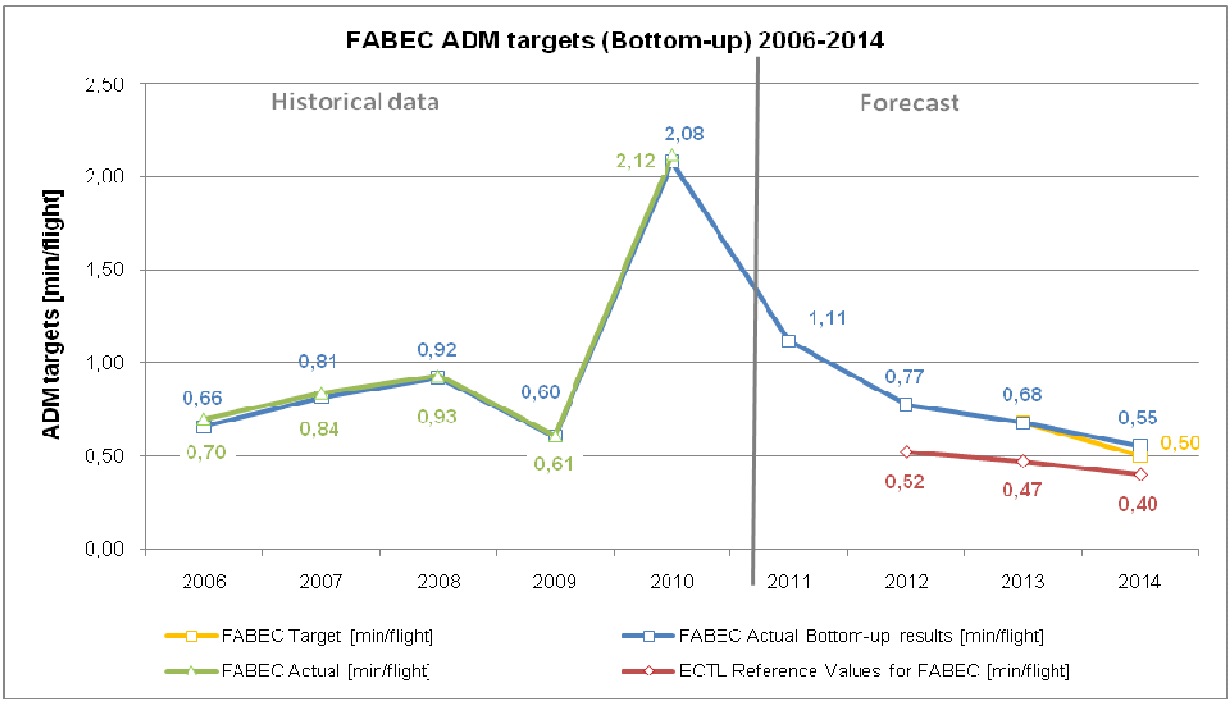


Figure 5.8: FABEC Delay per flight "Bottom-up-model"

A comparison of the delay figures of both models (CBA-model and bottom-up model) for the years 2011 – 2014 in Table 5.1 shows a deviation per year of ± 0.1-0.2min per flight.

Model	2011	2012	2013	2014
CBA model	1,01	0,97	0,85	0,78
Bottom-up model	1.11	0.77	0.68	0.55/0.50
Deviation	0.10	-0.20	-0.17	-0.22

Table 5.1: Delay per flight 2011 – 2014
CBA-model vs. Bottom-up model

The reasons for that are explained as follows

Whereas the CBA-model assumes that there is a certain relationship between traffic and capacity on one hand and delay per flight on the other hand, which can be expressed in one formula (see Figure 5.5) and which is assumed to be valid for every traffic situation and every ACC/UAC, the bottom-up model ("the real life") applies a different philosophy. Its delay per flight figures are rather forecasted than calculated and take into account various constraints for each ACC, which can lead to results that are very different from the outcomes of the CBA model. Among others, if ACC operations are far away from the capacity limit, or on the contrary, if ACC operations are really close to its capacity limit or if it is not possible to open new sectors. This leads to different developments of the delay figures. A solution to solve this ambiguity regarding delay would be to introduce a totally new delay-model in the CBA, which is not feasible, because it is not sure, if it is possible at all to define a formula fitting to all situations and all ACCs.

5.6 Flight-Efficiency

The Description of some parameters is leading to the FABEC development which is presented in Figure 5.14. The start value of 4.5% distance excess per flight is taken from the PRR 2010.

It is assumed that the rate will be improved on national basis by 0.15% every year until 2018. It will remain stable afterwards because all measures to reduce flight inefficiency on single ANSP side have been taken.

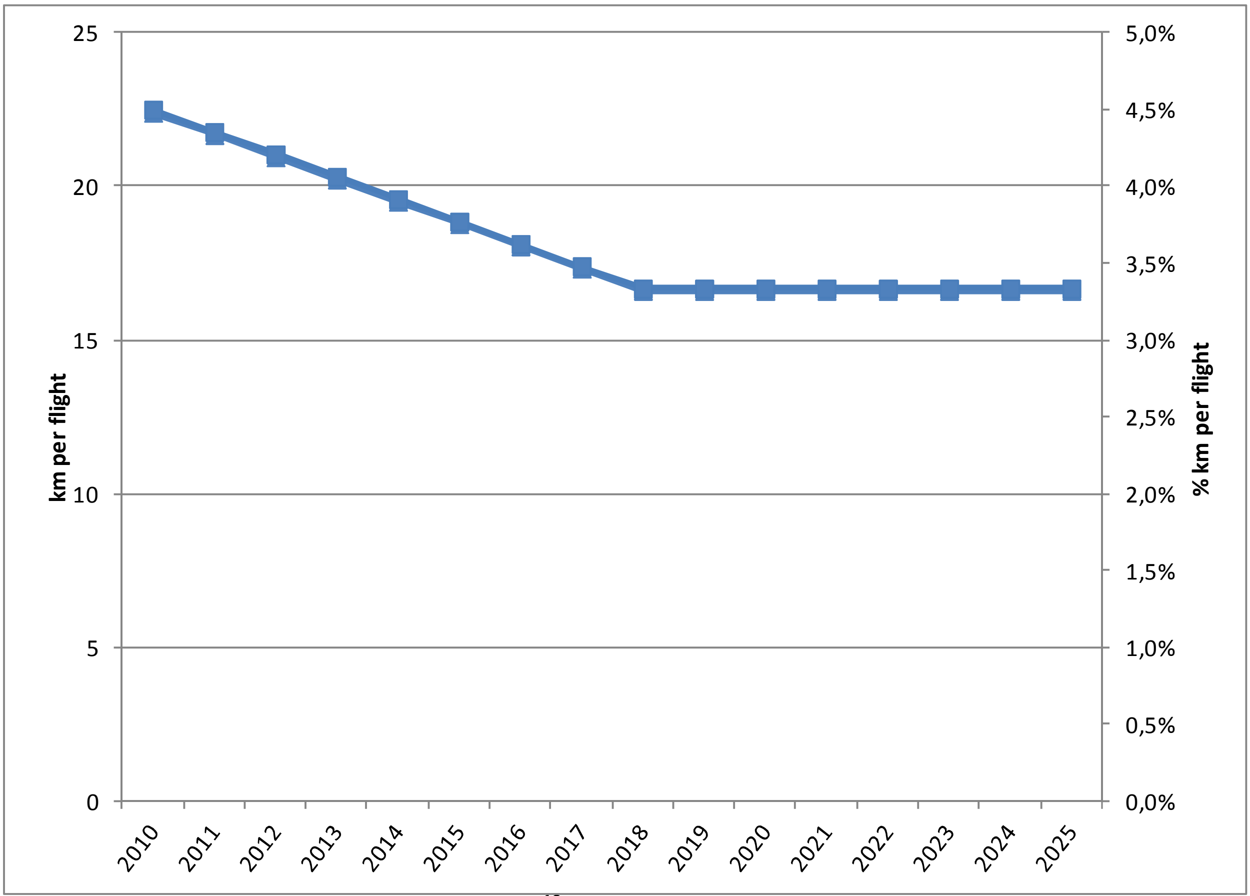


Figure 5.9: Excess km flown per flight[12]

The reference case projection displays that by 2025 there will be 3,774 million kilometres flown. The flight inefficiency will result in an average overall excess of 114 million km per year, with costs of € 450m.

Comparison with Feasibility Study CBA

The results of simulations performed during the Feasibility Study showed that, in the absence of a FAB flight-efficiency would worsen in the future. The simulation estimated an average excess route length of flights in the FABEC area starting from 5.6% in 2006 up to 6.1% in 2025.

The actual inputs from the ANSP show a by far better picture for this period of time.

The reasons behind this development are on the one hand a reduced traffic forecast, giving the ATCOs more freedom to give directs, and on the other hand the fact, that ANSP spent more effort than previously planned in internal measures to improve flight efficiency.

5.7 Investment

It is not strictly necessary to have a profile of investment costs in the reference case to undertake a cost-benefit analysis. It is sufficient to know the incremental impact of the FAB initiatives.

We need however, to have some understanding of proposed investments to set the FAB improvements in the context of performance indicators (which include an allowance for finance and depreciation costs).

For this purpose, it is sufficient to have projections of the elements of the cost base. Those are derived from ACE submissions, LSSIPs and other information from ANSPs, in the same

[12] It was assumed that the average flight length remains constant.

way as other costs. Beyond ACE and LSSIP projections it is assumed that depreciation and interest cost would be more or less kept at the same level, so no increase was calculated in the reference case.

5.8 Costs

5.8.1 Employment Cost per ATCO-Hour

In 2001-2006 the average ATCO employment cost per ATCO-hour for FABEC ANSPs rose by about 2.0% per year in real terms. In the years 2007-2010 a decrease in the ATCO hours per year can be observed, which leads together with increasing ATCO employment costs to increasing cost per ATCO hours shown in Figure 5.10. Consultation with ANSPs, including both SC FIN (Standing Committee Finance) and the PMG, indicated that in the longer term a growth between 1,0% and 3,0% per year (depending on the ANSP) should be assumed, leading to an average annual growth of 1,8% for the FABEC-region.

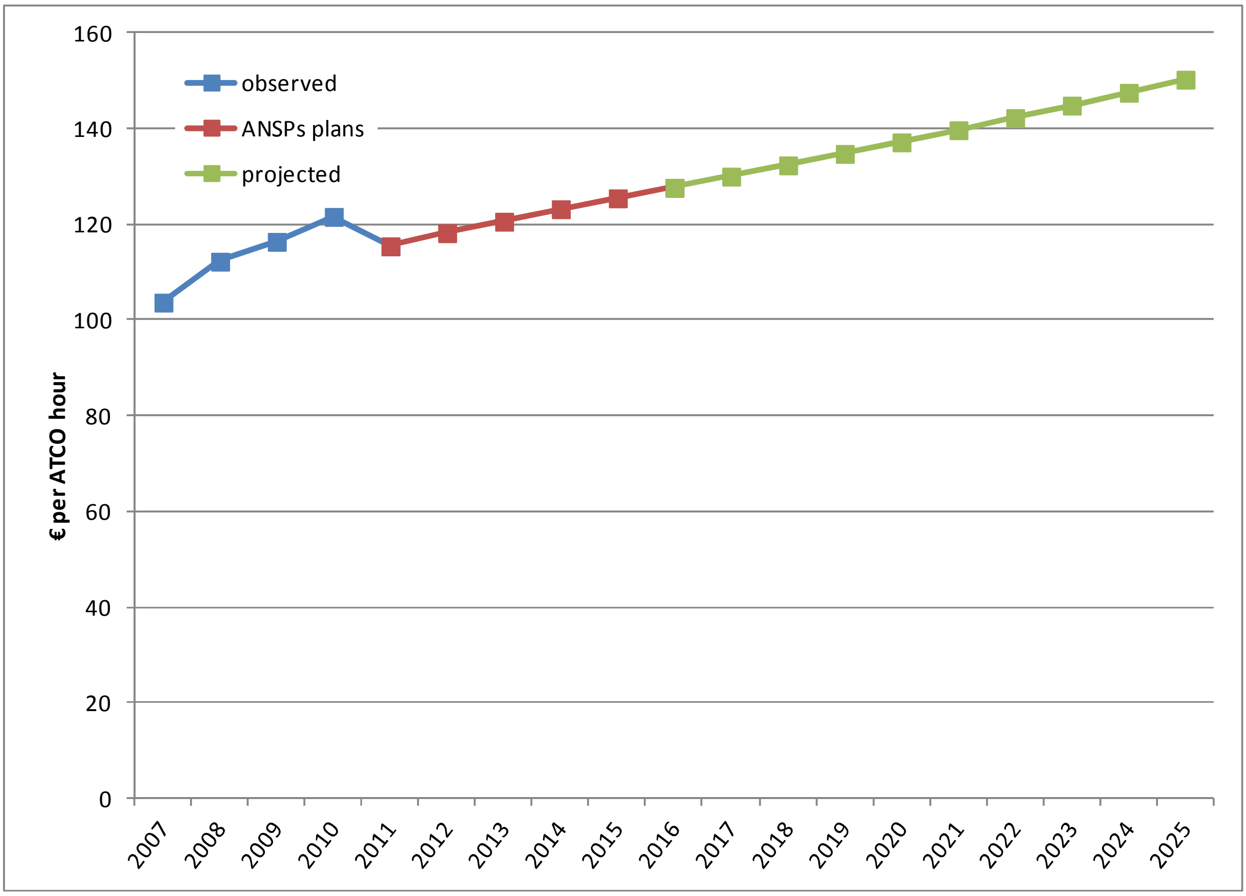


Figure 5.10: Employment costs per ATCO-hour, observed, planned and projected

The employment costs for ATCOs in operations are the product of the number of ATCO-hours and the average employment costs per ATCO[13]. The reference case projections for this quantity are shown in Figure 5.11. These employment costs are approximately € 473m in 2009. By 2025 the reference case indicates costs of about € 803m (an overall increase of 60%, bigger than the 43% increase in traffic for the same period). The reason is that in later years the assumed rate of increase in ATCO wages (1.8% a year on average) is bigger than the assumed increase in ATCO productivity (1% a year).

[13] For the purposes of these results, we have assumed that ATCO-hours and hence their employment costs are allocated between en-route and terminal in proportion to each ANSP's ratio of en-route and terminal costs.

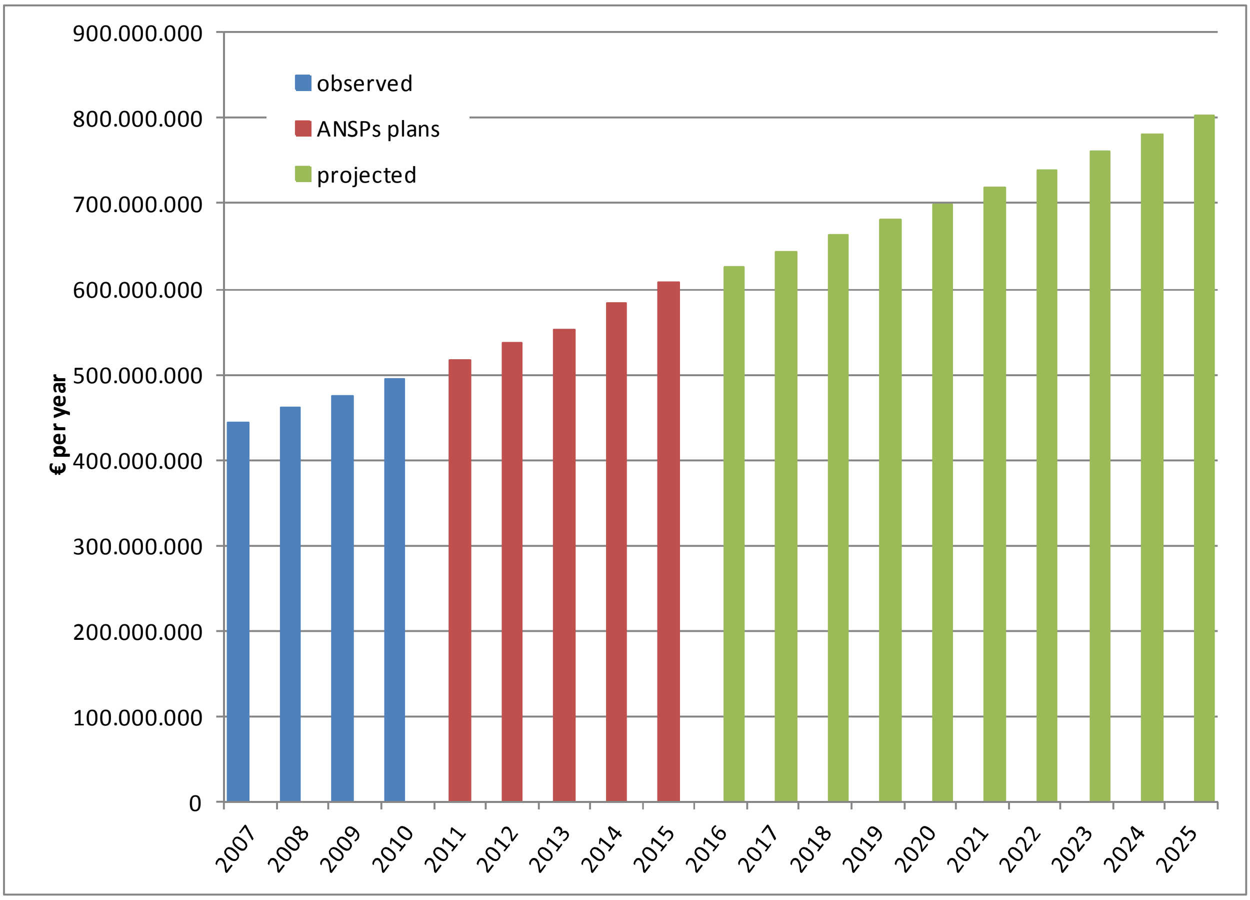


Figure 5.11: Employment cost for ATCOs, observed, planned and projected

5.8.2 *Non-ATCO Staff Cost*

Between 2007 and 2014, the non-ATCO staff cost is inferred as the difference between the total staff cost (as declared in ACE submissions and in LSSIPs) and the employment cost for ATCOs in OPS (estimated above). In 2009 this amount summed up to € 957m. From 2015 onwards, we assumed that ANSPs will be able to keep the number of non-ATCO staff constant, despite increases in traffic.

In discussions with the Performance Management Group it was agreed to realistically assume an increase in the unit employment cost per non-ATCO staff member, but to a lower extent than for ATCOs. The ANSP assumed an annual increase of 1%, in real terms, in the average unit employment cost per ANSP. The resulting changes in costs on FABEC-level are shown in Figure 5.12.

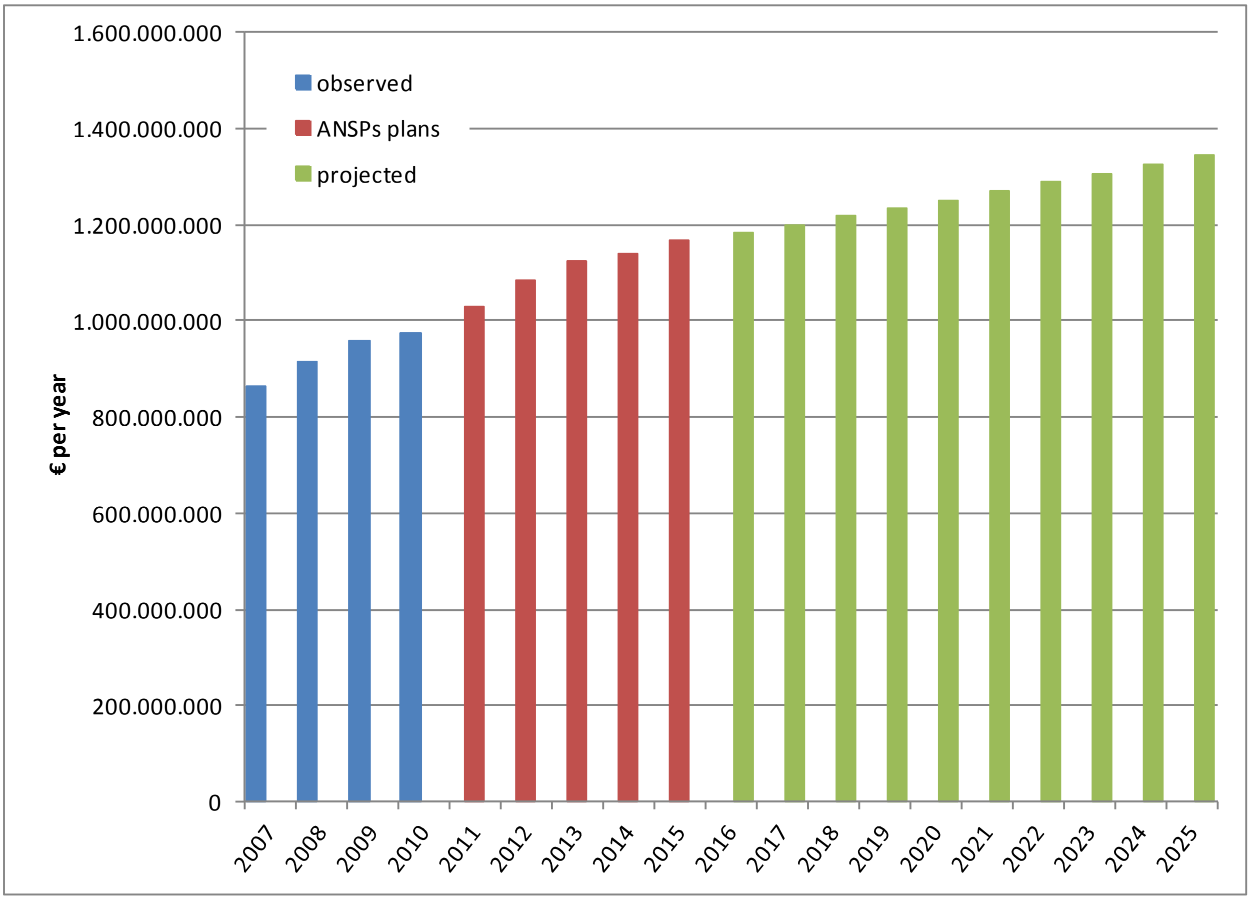


Figure 5.12: Non-ATCO staff cost, observed, planned and projected

5.8.3 Non-staff Operating Cost

Between 2007 and 2015, the non-staff operating costs were taken from the ANSPs ACE submissions and LSSIPs. From 2015 onwards, we assumed that the support cost would stay at the same level, hence no increase was assumed. In 2009, non-staff operating costs amount to € 322m; they increase by 10% to € 357m in 2015 and remain on that level afterwards. This development is shown in Figure 5.13.

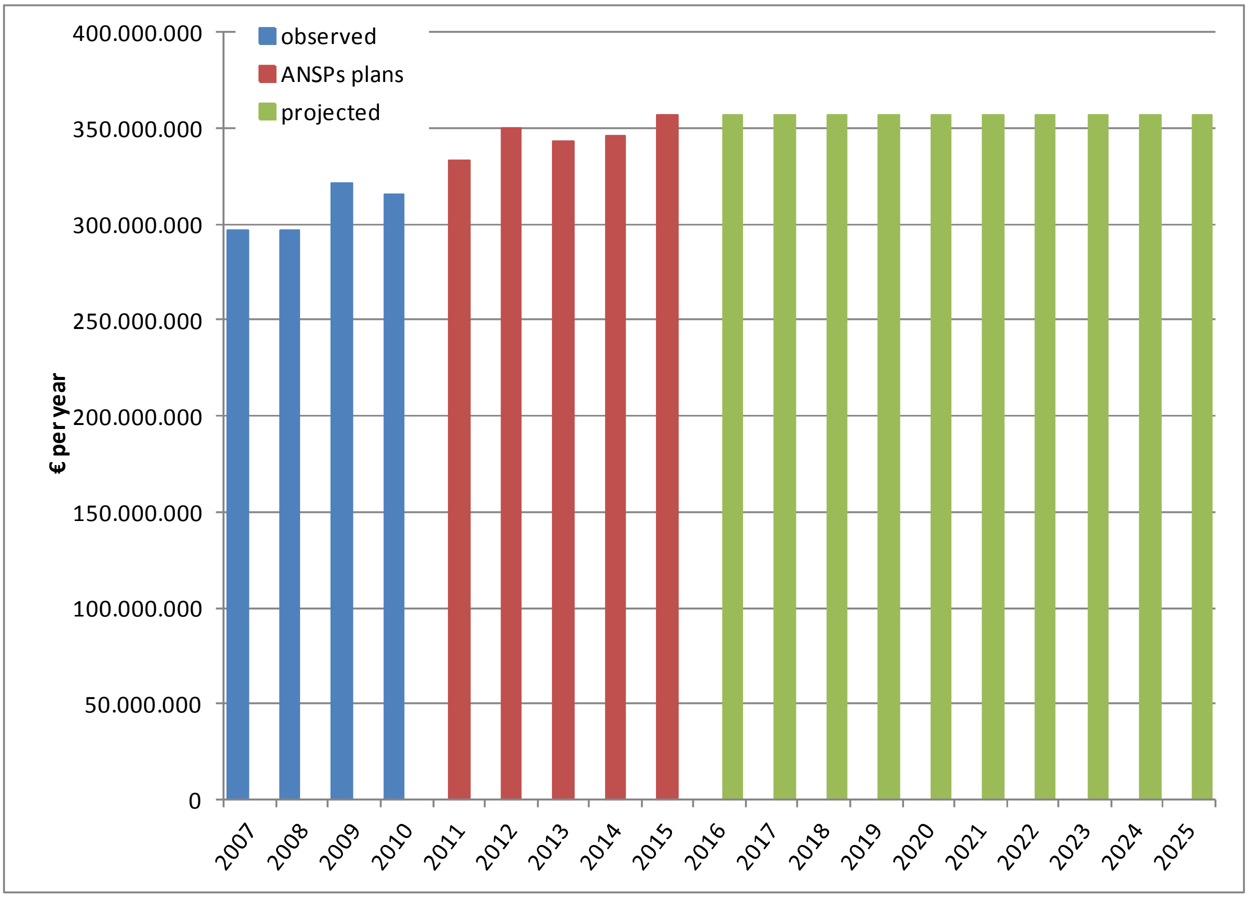


Figure 5.13: Non-staff operating cost, observed, planned and projected

Comparison with Feasibility Study CBA

In the Feasibility Study the assumption was made that the support cost would increase at the same rate as the number of ACTO hours. In this CBA this assumption was changed into a stable development without any increases or decreases after 2014. This assumption seems to be more realistic when looking at the past development of this cost category. With regard to the planned development of these costs in 2011-2015 for each ANSP and taking into account the need for the ANSP to reduce costs because of the new performance targets on cost efficiency laid down in the FABEC Performance Plan even a small decrease would be more realistic than an increase.

5.8.4 Total ATM/CNS Cost

The total ATM/CNS cost is as planned by ANSPs up until 2014, and is the sum of the cost categories presented above, plus the depreciation and interest cost[14]

[14] Values and assumptions for depreciation and interest costs are based on a similar logic to non-staff operating cost.

	Total ATM/CNS provision cost (m€)
2008	2.004
2009	2.090
2010	2.111
2011	2.233
2012	2.349
2013	2.404
2014	2.461
2015	2.531
2016	2.567
2017	2.602
2018	2.638
2019	2.673
2020	2.709
2021	2.747
2022	2.785
2023	2.824
2024	2.864
2025	2.905

Table 5.2: Total en-route ATM/CNS provision cost

Due to the low traffic growth forecast the overall increase in ATM/CNS cost (38% until 2025), as shown in Figure 5.14, is nearly on the same level as the expected increase in traffic (+35%).

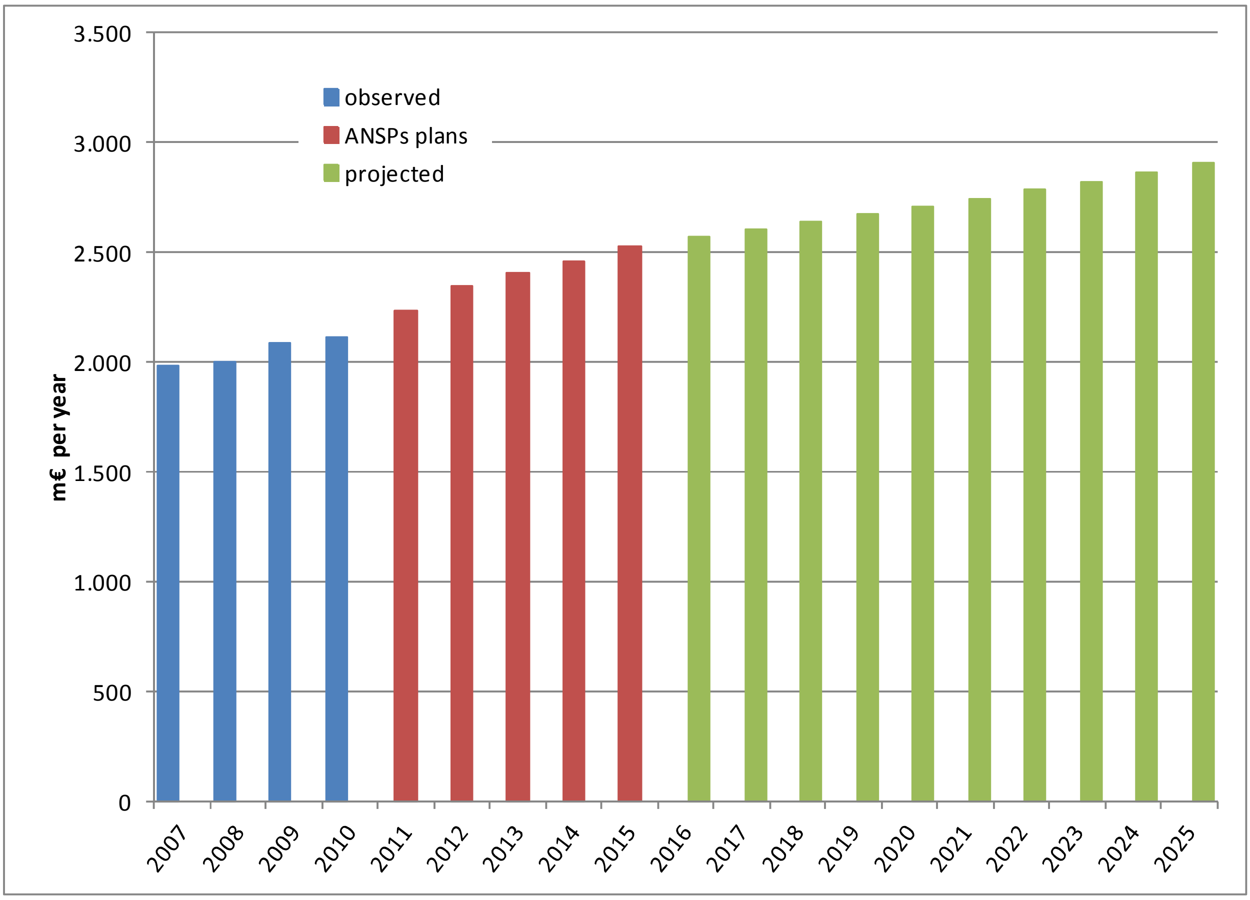


Figure 5.14: Total en-route ATM/CNS costs, observed, planned and projected

The reference case embodies nearly no improvements in financial cost-effectiveness by 2025, as shown in Figure 5.15. The development makes visible, that in the reference case the ANSPs costs show only a limited degree of flexibility to react on traffic downturn. But it has to be noted that the cost efficiency targets laid down in the FABEC Performance Plan for RP1 will have an influence on the cost curves 2012-2014 and the following years. This development is not shown in Figure 5.15, as the underlying data represents the ANSPs plans from 2010.

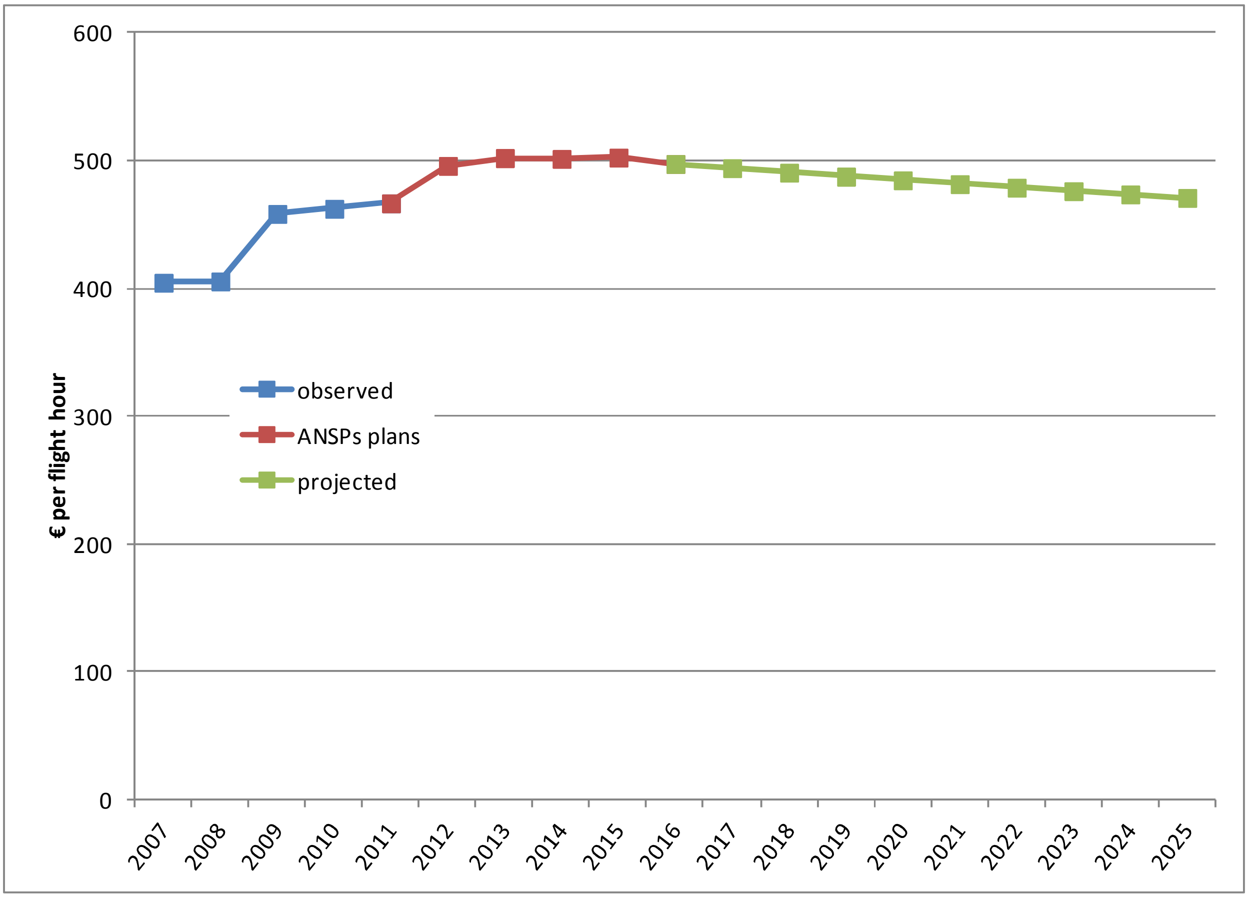


Figure 5.15: En-route financial cost-effectiveness in the reference case

Comparison with Feasibility Study CBA

In the Feasibility Study CBA the reference case showed an improvement in financial cost-effectiveness of 9%. But it has to be noted, that the traffic forecast is now significantly lower than in the Feasibility Study. Especially the traffic downturn because of the financial crisis 2008-2012 is responsible for this development.

In Figure 5.16 the economic cost-effectiveness of service provision in the reference case is presented. It includes the estimated cost of delays and flight inefficiency to airspace users. The total economic cost per flight-hour is displayed, and is broken down into its constituent parts[15]. It shows that the increase in financial cost-effectiveness, presented in Figure 5.15, is further improved by decreasing costs to users as a result of an improvement in the quality of service to users, through decreased delay and an improvement in flight-efficiency.

[15] This "economic cost-effectiveness" indicator is not the same as that used by the PRU. Unlike the PRU's indicator, it includes the costs of flight inefficiency. In addition, this indicator, like all those used in this report, is an en-route indicator, because of the en-route focus of the FAB. The PRU indicators, by contrast are "gate-to-gate". The unit of output selected for our indicators is therefore simply en-route flight-hours.

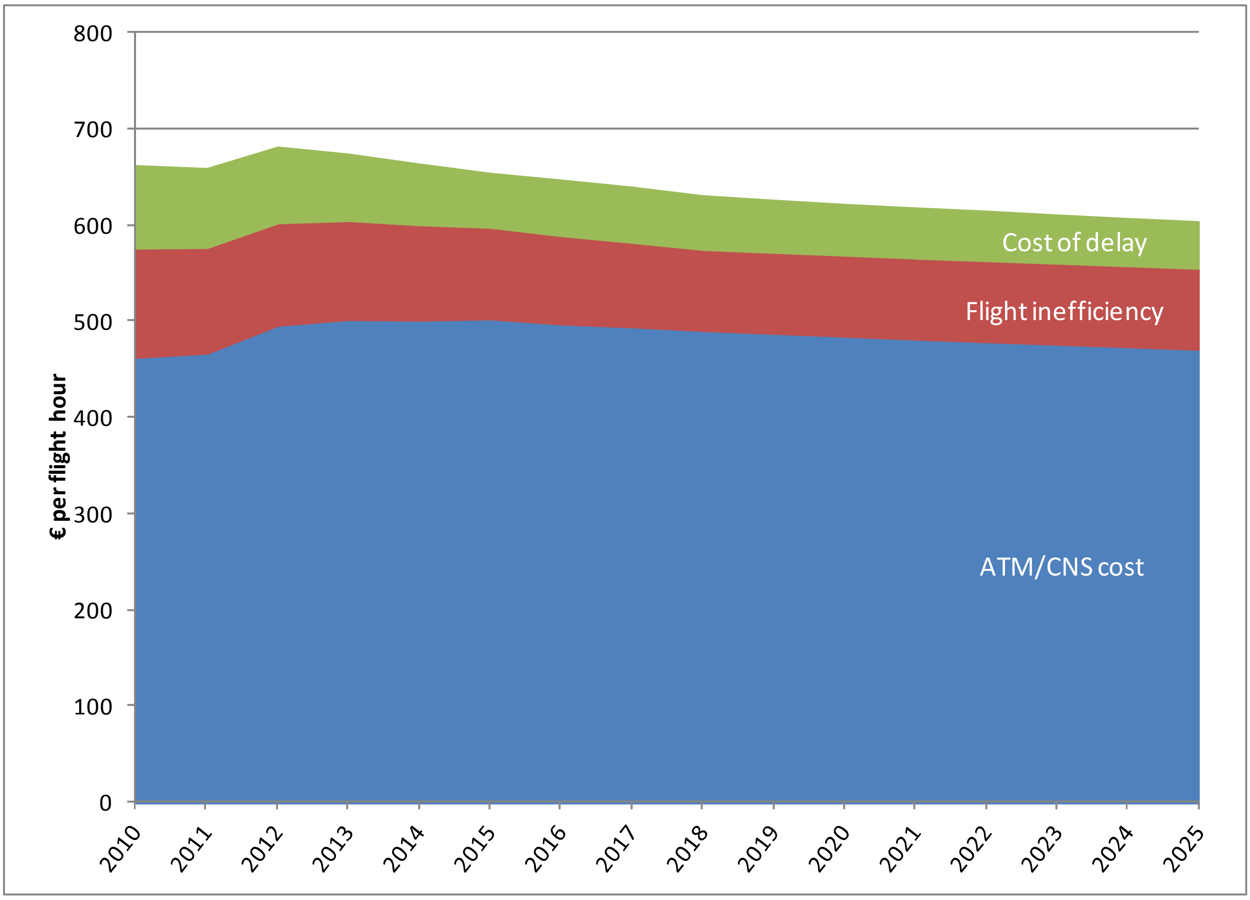


Figure 5.16: En-route economic cost-effectiveness in the reference case

All factors described above lead to a reduction of the economic cost per flight hour from € 662 in 2010 to € 604 in 2025.

Comparison with Feasibility Study CBA

The comparison with the results of the Feasibility Study CBA (Figure 5.17) shows huge improvements in the reference case. Especially at the cost of delay as a part of the economic cost-effectiveness the relevant results are far better than five years ago. The ATM/CNS costs on the other hand are on a slightly higher level than in the Feasibility Study. Nevertheless the forecasted development of this cost part is the same, only on a higher level.

This result shows that the FABEC-ANSP spend a lot of effort in improving the performance in the quality of service provision, namely capacity and flight efficiency, whereas the cost performance shows rather no improvement.

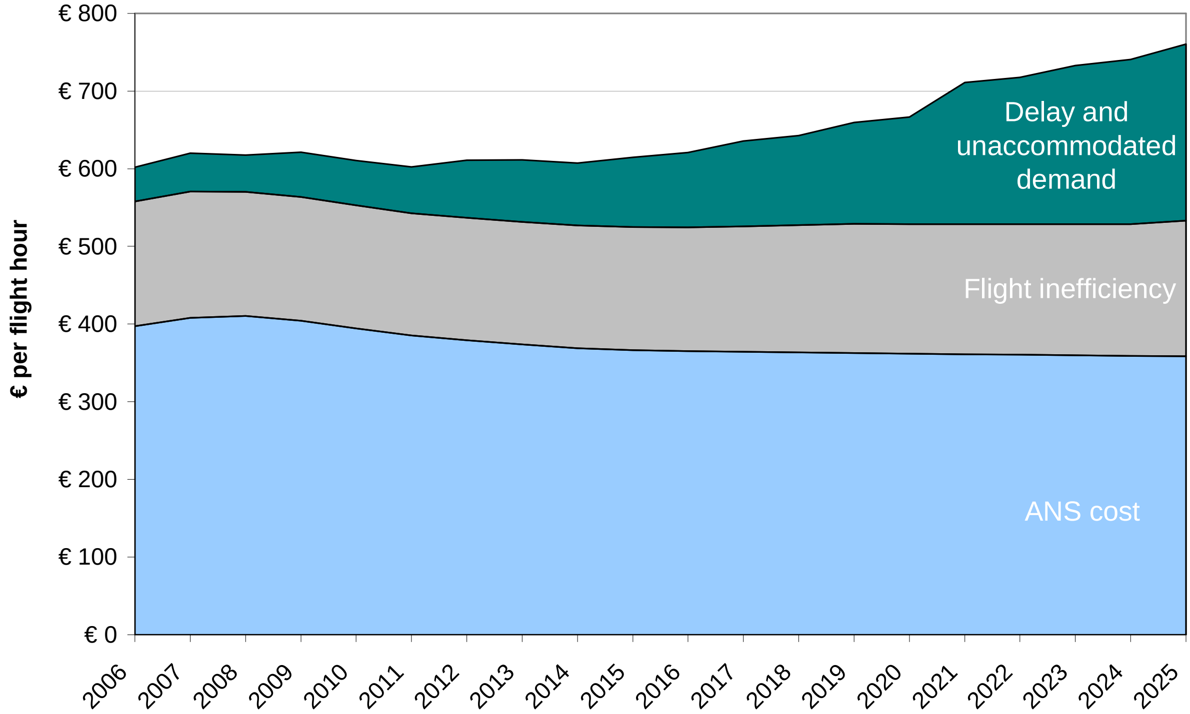


Figure 5.17: En-route economic cost-effectiveness in the reference case; Feasibility Study

6 INITIATIVES AND THEIR CHARACTERISTICS

6.1 List of FAB initiatives for the Cost-Benefit Analysis

Based on the proposals made in the FABEC Feasibility Study Report the FABEC partners started a number of initiatives for the development of a deeper cooperation.

Some were set to an end because the Business Cases showed no economical advantage in comparison to the current status.

Additionally some new projects were started.

In the following chapter all projects are listed with a short description, including the current status and a description of the costs/benefits, which went into the NPV-calculation. It starts with the projects in the OPS-domain (mainly Airspace Design Projects), proceeds with all initiatives in the TECH-domain and in the HR-domain and ends with all other cost elements relevant for a complete CBA for the FABEC project.

Due to the fact, that this CBA reflects the current status of these projects, it is not avoidable, that for some projects no estimation on benefits can be made. These project are for instance at the beginning of the design phase. At this stage of the project an estimation of future benefits in the capacity or flight efficiency area are not possible. AFG/PMG is currently developing a performance measurement methodology to harmonise and accelerate the estimation and calculation of performance benefits.

We made for these projects no assumption on benefits to include in the NPV calculation, but give in this report some indication on the level of capacity gains or improvements in flight efficiency, if possible for instance on the basis of similar studies.

6.2 OPS-Domain

6.2.1 Early Implementation Projects (EIP)

Besides the packages defined to solve the hotspots areas (see 6.2.2) during the Feasibility Study the OPS Working Group defined three so called "Early Implementation Packages", which could be implemented in a rather short timeframe. These EIPs are the AMRUFRA EIP, the Night Networks EIP and the City Pairs EIP. These EIPs are described in the following paragraphs.

6.2.1.1 AMRUFRA

Description

AMRUFRA - named after the AMsterdam East sector, the RUhr sector and the Langen sectors surrounding FRAnkfurt - aims to optimize the main civil air traffic flows from/to a pair of major expanding European hubs - Frankfurt and Amsterdam airports - and to balance both civil and military airspace requirements in the Netherlands and Germany.

The basic principle of the AMRUFRA project is to split Amsterdam and Frankfurt departures laterally and to rearrange surrounding flows in a more effective way. In order to optimize the main traffic flows, a common airspace re-design has been developed by the main partners: DFS, LVNL, Maastricht UAC and the Dutch and German military partners.

AMRUFRA was implemented on 11 March 2010.

Expected costs and benefits

During the execution of the AMRUFRA project for project management itself, real time simulation and ATCO training around € 3.8 m were needed.

The benefits of this project accrue in form of less delay through capacity increases and savings in fuel consumption for the users because of shorter routes in the relevant area.

The delay savings were estimated by DFS with on average € 8 m per year.

In a SAAM-simulation it was found, that around 355 flights were positively impacted by the AMRUFRA changes. The average route reduction was estimated with 3.3 NM per flight. These reductions were transferred into monetary values, leading to a yearly saving between € 2m and 4m for the airspace users.

These costs and benefits lead to a project NPV of € 77m.

A macroscopic study indicates that the new airspace structure created by AMRUFRA provides additional sector capacity for all sectors affected, enabling for traffic growth in the future. The monetary effects of this additional capacity were not regarded in this CBA.

As route reductions also lead to an improvement in the flight efficiency performance indicator the impact of all route reductions in this and the following projects was calculated and used in the performance assessment.

6.2.1.2 Night Network

<u>Description</u>

Under the aegis of the FABEC Airspace Design TF, the FABEC Night Network Working Group (FABEC NN WG) was tasked to deliver an early implementation package for a night network by the end of 2010 with an immediate implementation target.

The work of the FABEC NN WG is generally related to the geographical area of FABEC. The work programme also comprises the coordination with other WGs or neighbouring ANSPs as appropriate. The general airspace design and airspace management principles, identified during the Feasibility Study also apply to the airspace design process of the Night Network WG.

In line with the agreed ToRs the FABEC NN WG has developed a night network composed so far of 189 (one hundred eighty nine) proposals.

The NN-WG is newly tasked to look into further night network development:

- by extending the applicability period where and when feasible
- by opening new proposals stemming from above extended applicability period.

<u>Expected costs and benefits</u>

For the project management of this project around € 600k were needed.

The solutions found for the night network in FABEC airspace were fed into a SAAM-simulation. This simulation brought the result that routes could be reduced by around 800k NM per year during the night. These reductions result in savings of about € 6m to 8m per year.

These costs and benefits lead to a project NPV of € 71m.

Further developments in the Night Network are not considered in this CBA.

6.2.1.3 City Pairs

<u>Description</u>

In 2009, FABEC started to work on improving the so-called 50 most penalised city pairs. Based on a list provided by Eurocontrol, civil and military experts were investigating solutions for specified routes connecting major airports which deviate significantly from the ideal great circle routings. Most prominent examples are Amsterdam/Madrid or Paris/Munich. They have been notorious for decades and are often used by aircraft operators to illustrate the inefficiency of ATC as such.

FABEC experts proposed several shorter routes given the situation in which the core area is affected by a combination of main civil en-route flows, a huge amount of vertical movements and a lot of segregated military areas.

For implementation the working group divided its work into packages. Packages I to V are already implemented. The working group found further city pairs to analyze in a next phase of the project.

<u>Expected costs and benefits</u>

The more or less only effort needed to find solutions for these 50 city pairs was spend for working group meetings. The project teams calculated € 780k for these meetings (staff and mission costs).

As this project is rather similar to the night network project, the benefits also accrue from fuel savings for the airspace users through shorter routes on these city pairs. These reductions amount to 17,100 NM per week leading to cost savings between € 6m and 8m per year.

The described costs and benefits lead to a single project NPV of € 65m.

The impact of the currently found new city pairs is not yet calculated. In this CBA it was assumed that all costs/benefits of the Night Network and the City Pairs projects stop at the moment the FRA project implementation starts to prevent double counting.

6.2.2 Airspace Design Projects

Three 'hotspots' were identified in the FABEC area for consideration within the Feasibility Study. These three areas contain some of the busiest and most complex airspaces in the region as both the north-south and the east-west axis traffic flows cross through this airspace. Additionally the areas are located at the interface between multiple ANSPs and are therefore not sufficiently treated yet (Figure 6.1):

- ARKON/Rekken (RKN) - interface area in the northern Netherlands and North West Germany with LVNL, DFS, MUAC, RNLAF and GAF
- Nattenheim (NTM)/Diekirch (DIK) - interface area around Luxembourg with DSNA, Belgocontrol, MUAC, DFS, BAF, DIRCAM and GAF
- Trasadingen (TRA) - interface area in South West Germany, East France and Western Switzerland with Skyguide, DFS, DSNA and SAF

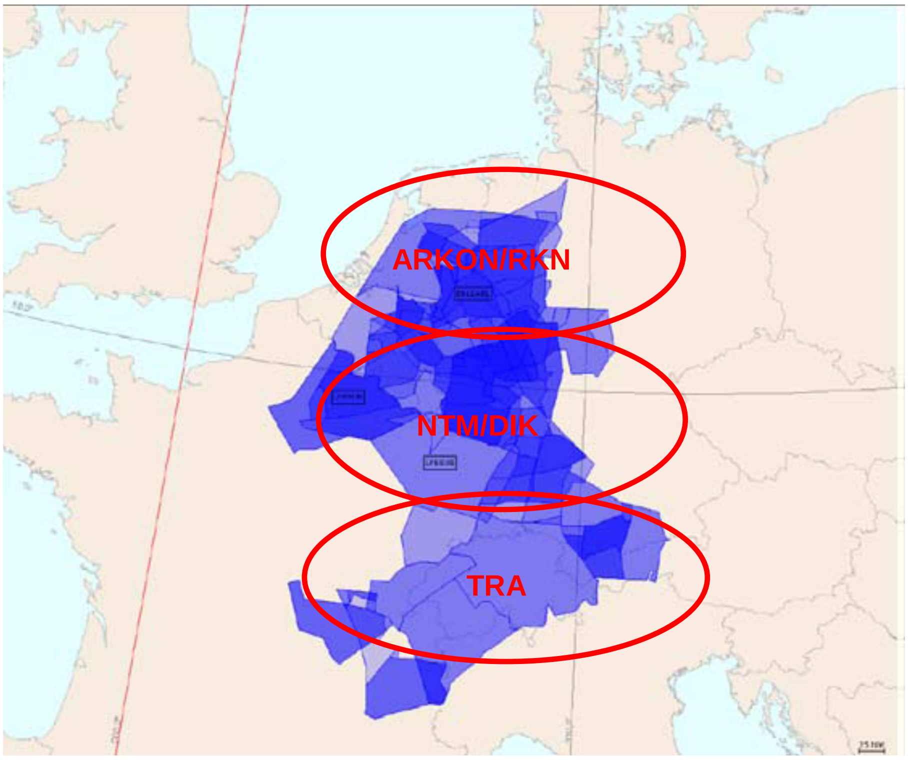


Figure 6.1: Central core area of the FABEC with identified hotspots

Additionally, the interface between FABEC and London in the Dover area was identified as a hotspot which affects Airspace Design in FABEC.

In the implementation phase of the FABEC project work on these Hotspots was started by defining four Airspace Design (AD) projects

- AD South-East (TRA Hotspot)
- AD West (FABEC/DVR interface)
- AD CBA-Land/Central-West (ARKON/RKN Hotspot)
- AD LUX (NTM/DIK Hotspot)

In the following chapters these four AD projects are described including figures on necessary costs and possible benefits.

6.2.2.1 AD South-East

Description

The objective of the South East airspace project, led by Skyguide, is to implement the airspace changes required to achieve the CBA 22 and the SWAP, a.o. tackling the TRA(sadingen) Hotspot identified in the Feasibility Study.

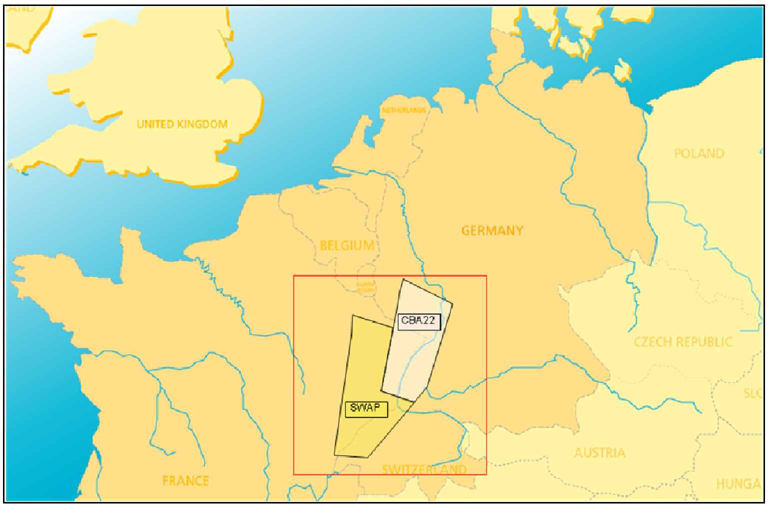


Figure 6.2: AD project South-East; geographical scope

Given that parts of the SE airspace project are closely linked with the LUX airspace project it was envisaged to implement the airspace changes in two phases:

Phase 1: SWAP

- Swap the one way traffic flows on routes UN852 and UN853;
- Create duplicate parallel routes to allow for segregation of over flights from climbing and descending flights.

Target date for implementation: Quarter 1 2013

Phase 2: CBA 22

- Establish a new Cross Border Area (CBA) 22 for use by the French, German and United States Air Forces:
  - o Merge the current French TSA 22, R322 and R323 military areas with the German TRA Lauter (R205 and R305) military areas;
  - o Modify the shape (lateral and vertical boundaries) of the merged areas to allow for optimization of the civil route network whilst continuing satisfying Military requirements.

Target date for implementation: First Quarter 2014**.**

Expected costs and benefits

During the design phase € 1.2m for staff costs are needed. In the implementation phase staff involvement is reduced to € 0.8m for both parts SWAP and CBA 22.

The project assumes on the basis of a SAAM simulation the following benefits: SWAP will lead to flight route reductions of 3500 NM per day leading to benefits between € 9m and 13m per year for airlines. CBA 22 may have a negative impact on some civilian traffic. This penalisation represents the equivalent of approximately € 0.7-0.8m per year. Additional Benefits will be seen as it will allow the full completion of the UN852/UN853 SWAP. That means that more than € 3m will be saved in regard to the saved 1,300 NM/day.

The described costs and benefits lead to a single project NPV of € 95m.

6.2.2.2 AD West

Description

The WEST project is the new name for the Hotspot KOK/DVR identified during the FABEC Feasibility Study. A final solution for this hotspot was not proposed during the FS and due to the complexity of the subject, it was agreed that development and implementation will be done in three steps (phases).

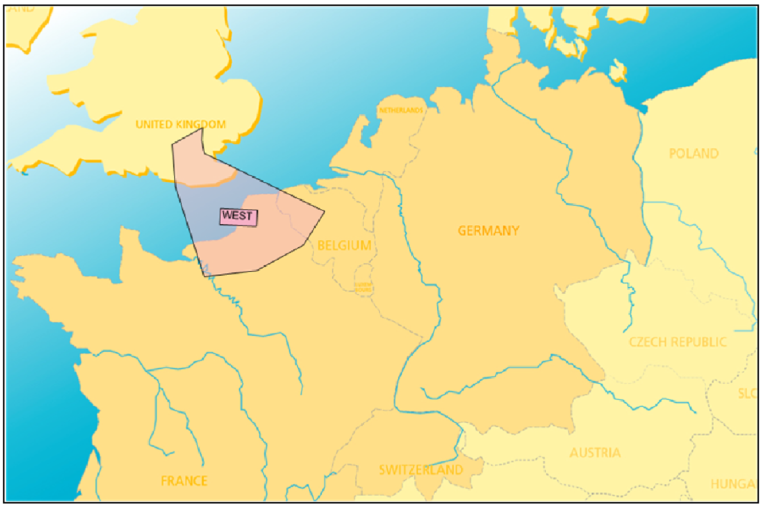


Figure 6.3: **AD project West; geographical scope**

Phase I:

Project West, Phase I, deals with the introduction of new routes at the interface between Reims ACC and London ACC.

Implementation date: 17th Nov 2011 (subphase 1A, interface Paris, Reims and London) and end of 2012 (subphase 1B, Paris arrivals via DPE/EGLF Group inbounds)

Phase II:

Project West, Phase II, shall improve the interface between the UK and Belgium and involves the following CIV/MIL ANSPs (Units):

- NATS (LAC);
- MUAC;
- DSNA (Reims and Paris);
- Belgian Air Component;
- French Air Force;
- Belgocontrol.

The foreseen major changes are:

- Creation of a new route structure;
- Reshape of CBA1.

Those changes will be implemented whilst maintaining the current sector boundaries and DFL. The new route structure will be connected to the current route structure further to the east.

Target date for implementation: End 2012 to First quarter 2013

Phase III:

Phase III is foreseen to review the current airspace structure (sectorisation and route) to support better flight profiles and cross border operations.

Target date for implementation: 2014+

Phase I and Phase II can be implemented separately whilst Phase III is the continuation of the previous phases and will deliver the envisaged benefits of the entire West project (e.g. connection of the three eastbound route structure within the LUX area).

The project has progressed into the validation phase of phases I and II whereby a PRTS and RTS were performed. Leadership for this project lies at Belgocontrol.

Expected costs and benefits

West Phase I:

This project does not bring any tangible improvements on FABEC side, but has positive effects on the performance of NATS.

West Phase II:

Costs:

For the design phase, the real time simulation and finally the implementation of this project, costs are estimated to reach about € 2.2m (Design Phase € 160k, Simulation € 530k, implementation € 1.4m).

Benefits:

A SAAM-Simulation estimated savings for the users through route reductions of about 220,000 NM per year resulting in fuel savings of about 2300 tons per year. The resulting improvement in flight efficiency of this route reduction seems to be negligible (-0.01%) but leads to yearly benefits between € 1m and 2m.

Besides these flight efficiency benefits the project forecasts also a capacity improvement at the interface to UK airspace. After implementation of AD West II the existing CBA156, a restriction always in place, when military area CBA1 is active, will no longer be needed. Thus all delays accumulated from the restriction in the past will be potentially gained. The average delay minutes imposed by this CBA over the last 3 years cumulate to a benefit of € 4.5m per year.

The described costs and benefits lead to a single project NPV of € 49m.

Recent developments in the project may lead to different figures in regard to the flight efficiency benefits, but the current figures are still included in the NPV.

West Phase III

As the AD LUX project is actually not in a status to have a closer look at the interfaces between the West project and the LUX project, no estimates about cost and benefits of the West Phase III project can be made.

6.2.2.3 AD Cross Border Area (CBA)-Land/ Central-West

Description

CBA Land/Central West airspace project is the new denomination of the former ARKON/RKN Hotspot that has been identified during the FABEC Feasibility Study.

The objective of the CBA Land/Central West airspace project is to create and validate an airspace design compliant with the FABEC Feasibility Study for the Central-West area and the North area including a CBA Land.

See the following excerpt from the relevant Feasibility Study document on Airspace Design:

"Since several years, the ARKON/RKN area is being recognised at ECAC level as one of the problematic core areas to be improved in order to cope with the rapid traffic growth. It involves 3 civil ANSPs and 2 military partners and has to accommodate major evolving traffic flows to/from Schiphol, Frankfurt and Düsseldorf airports together with numerous over-flying European traffic flows.
Internal Dutch civil-military negotiation, begun within the AMRUFRA framework, led to the

possibility of establishing some conditional ATS routes above TMA D thereby offloading the ARKON/RKN area, providing that sufficient compensation airspace for training purposes can be found in the North.
The permanent opening of actual military training airspace above TMA D for civil traffic offers the opportunity to segregate GAT flows and thereby significantly alleviate the ARKON/RKN area."

The project team, under the leadership of LVNL, will develop the necessary airspace and route designs as a follow-up on the work of the former ARKON/RKN WG that has been done between September 2008 and October 2009. The scope is to provide finalized designs and operational concepts and an implementation plan for single implementation steps.

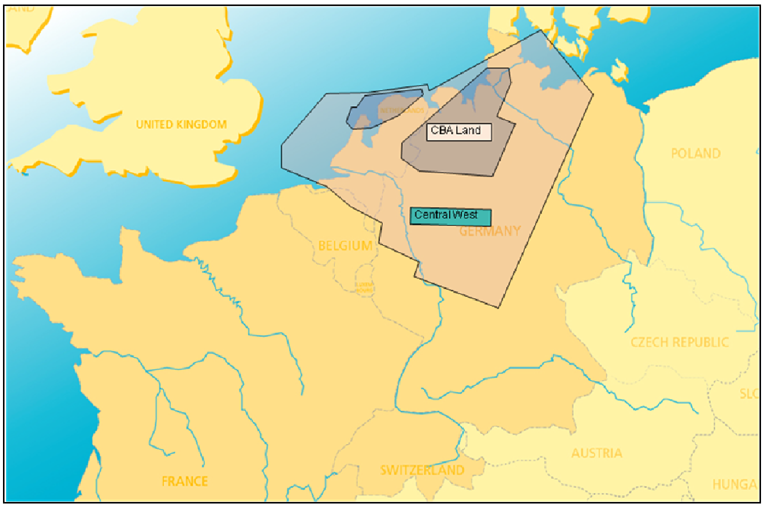


Figure 6.4: AD project CBA Land / Central West; geographical scope

At the moment the project is in the design phase. A stepwise implementation is planned for the 4.Q 2015 and 4.Q 2016.

<u>Expected costs and benefits</u>

Due to the early stage of this project a definition of potential benefits is not possible at the moment. The estimated costs necessary until beginning of implementation are already included in the CBA. The main cost positions are project management and real time simulation (€ 6.2m until 2014). These costs do not include necessary training and other implementation costs.

6.2.2.4 AD LUX

<u>Description</u>

The LUX Airspace Design project, under leadership of DFS, will address the key bottleneck in the core area around Luxembourg. The challenge for this project is, despite several failed attempts in the past, to achieve 3 main objectives, being:

- To realise GAT route network connections for all other projects connecting with the LUX area
- To alleviate the persistent GAT route network bottleneck in the LUX area
- To realise adequate capacity improvements to absorb increased GAT traffic demand, enabled by the other FABEC and local ANSP airspace projects

In addition, a military Cross-Border Area CBA116 across France and Belgium shall be realised replacing existing military areas.

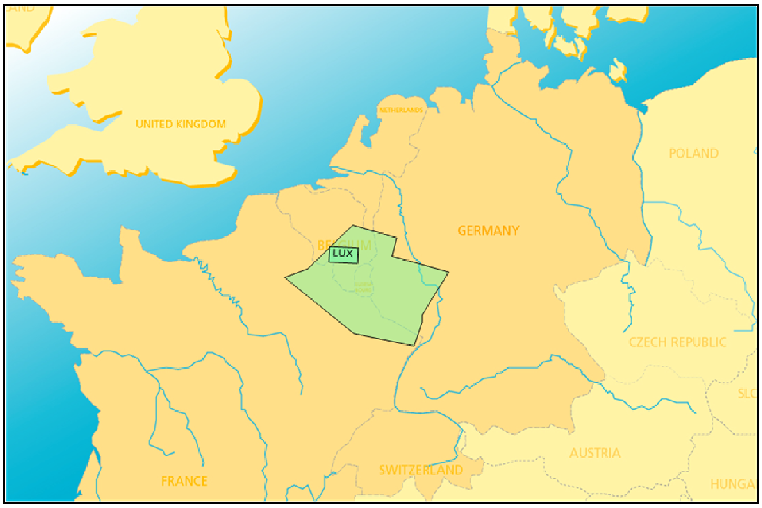


Figure 6.5: AD project LUX; geographical scope

To support the realization of these goals, the project will deliver:

- a validated airspace design compliant with the FABEC feasibility study with the target to enable implementation of these structures;
- a corresponding implementation plan for each of the implementation steps.

All implementation activities shall actively contribute to the FABEC performance targets (safety, efficiency, mission effectiveness etc.)

For the implementation of the different elements of the project a stepped approach will be utilised. First an overall design will be made and then the different steps will be identified, validated and implemented one by one. The LUX area is geographically situated in the centre of the FABEC AD areas. It therefore plays a key role in achieving the FABEC performance goals. To ascertain results, it is essential that a high level overall design/concept is made on FABEC level, thus providing strategic direction and coherence for the different AD projects. Next to this FABEC overall concept, the IP LUX project will make a high level overall design for the area as specified in the scope of the project.

To ensure seamless connections of the proposed route structure and airspace design with the adjacent FABEC AD projects, the IP LUX project will be focus on into 5 smaller areas of interest:

1. LUX Core, comprising of the LNO/DIK/LUX axis, the major area within the IP LUX scope and essential for any improvement of the envisaged performance improvement.
2. LUX South-West, the area that interfaces with TRA South/CBA16 and the Point Merge System for Paris Charles de Gaulle.
3. LUX South-East, connecting to the SWAP area and the CBA22 and crucial for the accommodation of a third North/South route.
4. LUX West, interfacing with the West 2 package and essential to connect to the extra West/East route resulting from the design of this package.
5. LUX North-East, interfacing with Central West.

The project started working in March 2011.

Expected costs and benefits

Due to the very early stage of this project a definition of necessary costs and potential benefits is not possible at the moment.

6.2.3 *ATFCM/ASM Live Trial*

Description

Goals and Objectives of the Live Trial

The initial idea of a centralized flow and airspace management unit at the FABEC level was developed during the FABEC feasibility study. The trigger for the Live Trial was the need to move from the conceptual description of the ATFCM/ASM pre-tactical process, which was initially described and tested in the 2009 field trial, towards identification of concrete improvements. In other words, there was a need to put theory into practice, and the only way to accomplish that goal was through the execution of a FABEC-wide Live Trial.

The objective of the trial was to validate operationally a FABEC ATFCM/ASM function that provided air traffic flow, capacity management and airspace management services at the FABEC level. In detail this should include to:

- prove its applicability in real operations
- provide an analysis of the achievable benefits that is required as a base for the application to finally implement a FABEC ATFCM/ASM function
- offer more insight on the strategy of how to evolve towards an ATFCM/ASM model E (co-located FABEC ATFCM and FABEC ASM functions)
- apply generic booking principles and priority rules in order to optimize CIV/MIL cooperation and the use of airspace for all users
- implement quick-wins identified in the previous field trial, e.g. the application of network delay attribution (NDA) procedures

These objectives were reinforced by SC OPS in January 2011 as follows:

The strategic objective of the LT is to demonstrate the feasibility of the FABEC function, build trust between parties and to demonstrate the requirement to take additional steps in harmonizing pre-tactical planning between D-7 and D-1.

The expected benefits of the trial were

- to enhance CIV/MIL coordination,
- to optimize the network through more efficient use of airspace,
- to reduce network delay through the application of network delay attribution (NDA) procedures,
- to provide a regional FABEC Pre-Tactical Outlook
- to foster harmonization or at least interoperability of the ATFCM and ASM tools within FABEC.

The trial started at 2 May 2011 and ended 31 July 2011. For the purpose of the trial, the new FABF (FAB Function) unit was located in the DNM (Directorate of Network Management) premises in Brussels, Belgium. The working arrangements for the FABF operators consisted of 3 working positions in the CFMU operations room, two of them were dedicated for ATFCM and one for ASM.

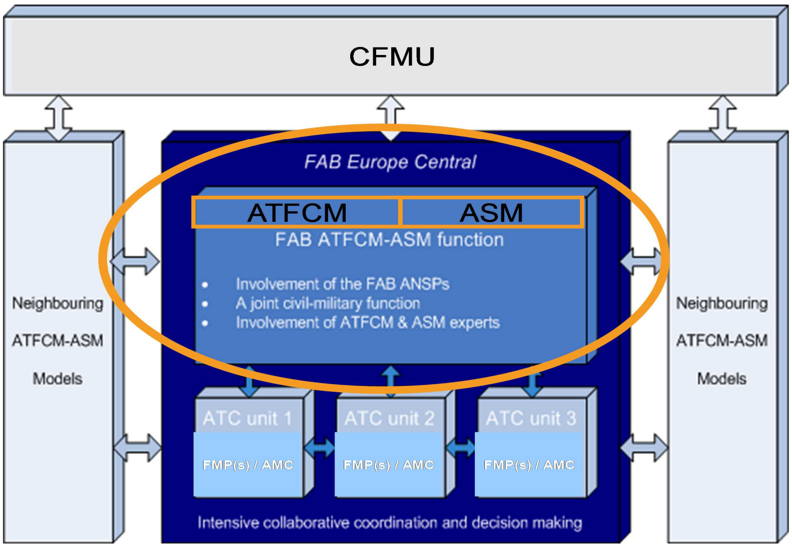


Figure 6.6: Setup of the ATCFM/ASM Life Trial

Conclusion

The FABF staff involved in the preparation, execution and operation of the Live Trial unanimously agreed that a separate FABEC ATFCM unit that runs as an additional layer between the NMC and the local functions does not add value to the pre-tactical process.

The experts also agreed that more in depth knowledge of local and regional conditions at the network management level would be of benefit providing improved ATFCM solutions. The opinions differ about the question, whether this knowledge and its practical application should be established at the NMC itself or by a FABEC level ATFCM function, which is set up considering the lessons learned from the Live Trial and thus avoiding the "additional layer" and its disturbing effects.
Based on these results a new initiative will be started to establish the latter solution through a FABEC ATFCM function.

With respect to the centralized ASM unit, all FABEC partners agreed that a centralized ASM unit is necessary, but not all agreed that a network-wide ASM unit is the best solution. Some experts proposed a FABEC ASM unit that is specifically dedicated to FABEC, whereas the majority of the experts proposed a solution for a network-wide ASM unit that could also serve the specific needs of FABEC. Based on the detailed results of the 2011 ATFCM/ASM Live Trial further development towards a FABEC level ASM function will be initiated through a step-wise approach via

1a) extended exchange of ASM booking data,

1b) implementation of an enhanced lead-AMC concept,

2) a FABEC level ASM coordination function towards – possibly – finally a FABEC AMC.

A decision on a future model regarding a centralized ATFCM/ASM function for FAEBC is not taken yet.

Expected costs and benefits

The Live Trial itself did not demonstrate any measurable benefit, neither for customers nor for the ANSPs, only qualitative benefits were observed; it has been seen and therefore mainly is expected that a FABEC ATFCM function may fine-tune solutions to local/regional conditions, thus saving some additional delay minutes but this cannot be reliably measured and attributed to that function.
So the ATFCM function performance part depends on the actual solution, meaning whether it can be nearly completely provided without additional staffing and limited infrastructure investment.

More quantifiable benefits out of CIV-MIL cooperation depend on the fulfillment of a prerequisite, which is the fully harmonized application of all FUA levels, but especially of FUA level 2 by the Belgian Air Force / Air Component (BAF / BAC).

From the current status no information, so nothing quantifiable, is available on possible cost of the envisaged future developments.

6.2.4 Border Triangle

Description

In 2009/2010 FABEC ANSPs reviewed different scenarios to cope with infrastructure and airspace fragmentation. The most challenging scenario to investigate was one on centre consolidation. Resulting from an ambition to study even the most difficult and sensitive areas of cooperation, a decision was taken to study an Area Control Centre consolidation in a specific and real situation. This case was called the Border Triangle project investigating the feasibility of a common Swiss-French-German centre in the 3 countries' border triangle close to Basel, which should manage Swiss and parts of French and German airspace.

It was investigated whether such a consolidated centre could provide sufficient gains in cost efficiency to at least compensate in reasonable time the required investment for its implementation. A jointly operated centre should lead to an optimised use of the airspace in one of the hot spots of FABEC airspace and might be a contribution of FABEC to the Single European Sky objective to reduce the fragmentation of Area Control Centres. The objective of the Activity was to perform a feasibility study on a new tri-national centre in the border triangle area of Switzerland, France and Germany:

- Provide recommendations for the institutional set-up to operate services
- Provide recommendations for the envelope of the airspace concerned & OPS concept
- Study infrastructure requirements, HR & staffing issues, military requirements and financial aspects

The study contained very valuable information and insight on the feasibility within a European or FAB context to de-fragment centres and airspace between multiple partners. Lessons learnt will be used to define realistic levels of ambitions within FABEC.

The result of the Feasibility Study Report led to a decision taken at the highest political and ANSP level by the end of 2010, not to follow the approach to establish a tri-national centre at the border between Switzerland, Germany and France any longer. The study showed that such a centre would be feasible in general, but at the same time it is financially not attractive for all partners under the given working assumptions.

Expected costs and benefits

As this Feasibility Study was conducted in 2009/2010 it is assumed that all costs are already included in the reference case. Benefits cannot be shown.

6.2.5 Point Merge project

Description

Definition of Point Merge

Point Merge presents a method to merge arrival flows of aircraft without using heading instructions. The principle is to achieve the aircraft sequence on a point with conventional direct-to instructions, using predefined legs at iso-distance to this point for path shortening or stretching. Figure 6.7 shows the necessary route structure in principle.

The Eurocontrol Experimental Centre in Brétigny conducted a series of small scale experiments with air traffic controllers to assess benefits and limits of the method. The method was found comfortable, safe and accurate, even under high traffic load, although less flexible than today with heading instructions. Predictability was increased, workload and communications were reduced. Even under high traffic load, the inter-aircraft spacing on final was as accurate as today (runway throughput maintained), while descent profiles were improved (continuous descent from flight level 100). As heading instructions were no longer used, aircraft remained on lateral navigation. The flow of traffic was more orderly with a contained and predefined dispersion of trajectories. All these elements should contribute to improving safety.

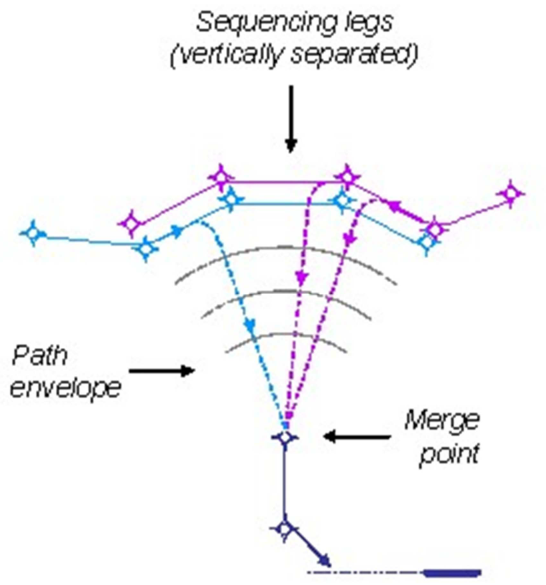


Figure 6.7: Point Merge route structure in principle

The Point Merge method is already implemented at the Oslo airport.

After CONOPS development in the context of SESAR, the French DSNA set up a project to implement the principle for the approach to Paris Charles-de-Gaulle. This project is called PMS TE (Point Merge System Terminal Extended). As one part of the project, which covers the approach from the North-East, has influence on operations in MUAC and probably Belgocontrol, DSNA asked the FABEC ASB to include this part of the project into the list of FABEC projects. The new proposed route structure at the French-Belgian border is shown in Figure 6.8

This also means that Point Merge System Terminal Extended North-East (PMS TE NE) should be included in the FABEC CBA.

At the moment the following phases are considered:

- - Nov 2011/Nov 2012 : CONOPS validation within the framework of SESAR x427
- - Nov 2012/Nov 2013 : PMS-TE NE implementation preparation
- - Nov 2013 : PMS-TE NE implementation
- - Nov 2013/Nov 2014 : PMS-TE NE ASM refinement
- - Nov 2014 : PMS-TE NE ASM refinement implementation

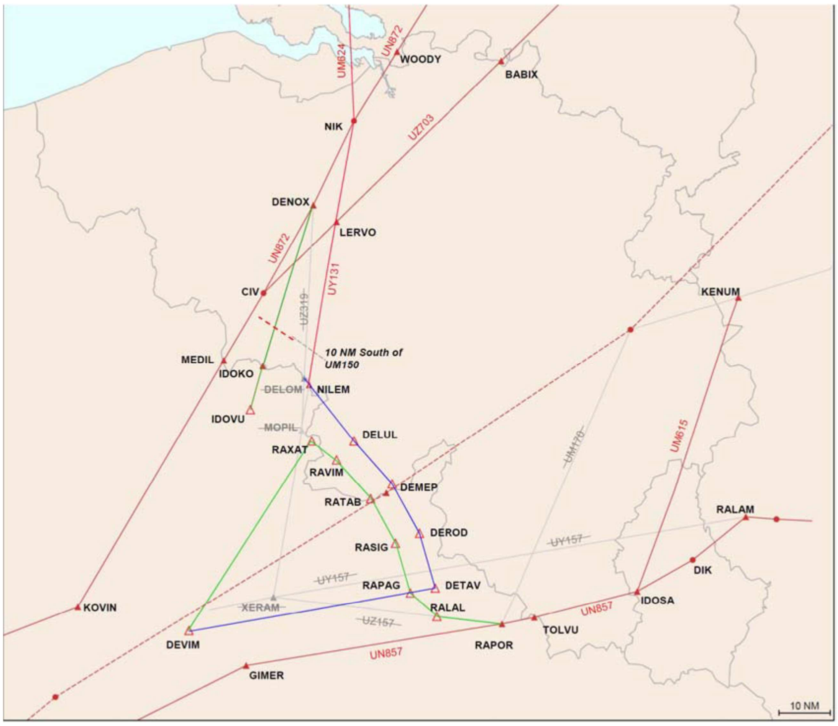


Figure 6.8: Point Merge System Terminal Extended North-East Overview

<u>Expected costs and benefits</u>

Since the project is in a very early stage, implementation cost and benefits cannot be shown.

6.2.6 Free Route Project

On the basis of the so called "Matterhorn Declaration", agreed between the DGCAs of the FABEC states[16] the FABEC ASB endorsed new airspace principles and the related airspace vision and strategy on September 7th, 2011. These set out a three volume airspace concept for all FABEC airspace, split into:

- Free route airspace volume (FRV) over the greatest possible FABEC area based on common concept of operations, providing flexibility and flight efficiency for airspace users;
- Fixed route airspace volume containing multi-hub terminal area (TMAs) serving major airports or a number of adjacent airports in an extended TMA operation, with flexible boundaries and cross border sector groups;
- Transition airspace volume linking the Top 5 TMAs (Paris, Frankfurt, Amsterdam, London and Munich) and fixed routes airspace to free route and to other parts of FABEC, including a harmonised concept of operation for the implementation of arrival and departure management systems, providing capacity and flight efficiency.

The resulting conceptual view of the airspace design is shown in Figure 6.9:

[16] May 23-24 2011

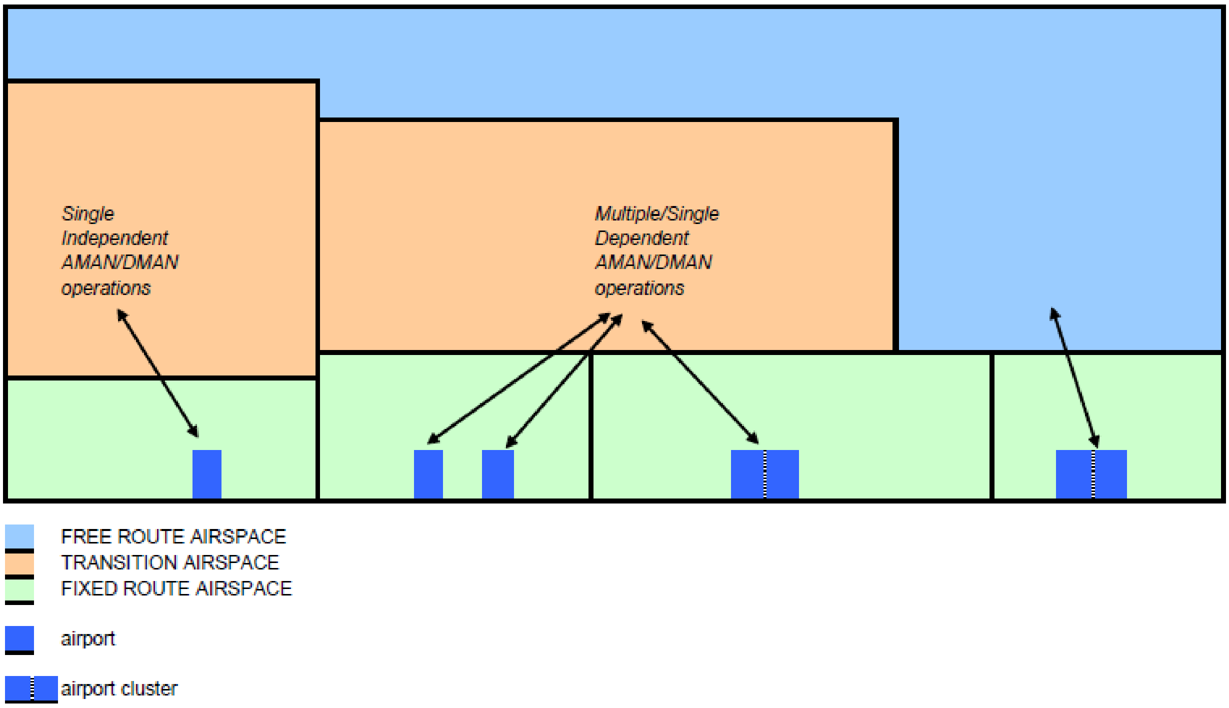


Figure 6.9: Future Airspace Design for FABEC Airspace

A roadmap for the implementation of this concept was decided in Jan 2012. Nevertheless two projects already exist: FRAM in the MUAC airspace and FRAK in the Karlsruhe airspace.

Considering the nature and distribution of traffic within FABEC, the first implementation of free route launched in Maastricht and Karlsruhe, as well as the various technical means available locally, it was considered that different steps of FRA have to be described.

Keeping in mind the objective of a harmonized implementation, its phasing, with regards to each step of FRA, will be optimised even if not simultaneously introduced in each Control Centre.

Step 1: Implementation of direct connections in a defined airspace outside military activity

- Night
  - o Extended night
  - o Extension of current night network and/or creation of new direct connections
- Week-end
- Cross border when possible between ATC units within FABEC or with adjacent FABs
- FABEC wide (direct connections with entry and exit points on the boundary of the area of responsibility of FABEC).

Diverse combinations of above cases can be envisaged.

Step 2: Permanent (H24/7) implementation of direct connections in a defined airspace with active military areas, supported by implementation of advanced FUA

Step 2.a. Within ATC units

Step 2.b. Cross border when possible between ATC units within FABEC or with adjacent FABs

Step 2.c. FABEC wide (direct connections with entry and exit points on the boundary of the area of responsibility of FABEC).

Step 3: Introduction of Business trajectories (using SESAR deliverables).

Final Goal: FABEC wide Full Free Route concept, as defined in the FABEC Free Route Concept of Operations

This should be the achievement of the concept, as it should allow the users to plan their preferred routes, regardless of published points. It takes place in an environment where new technology and new tools are available. A strong collaborative work with SESAR Programme is likely to be fruitful. Several SESAR projects are already working on elaborating tools that will have possible enabling consequences regarding Free Route full concept, such as flight planning without reference to a Route Network.

It has to be noted, that some of the improvements coming from a Free Route Airspace are already shown in the City Pairs or Night Network EIP. Hence the calculation of benefits has to be carefully examined to prevent double counting.

The FABEC FRA roadmap has been elaborated by all civil and military ANSPs, by integrating the existing roadmaps from Maastricht and Karlsruhe and the local roadmaps proposed by the other ATC units.

Table 6.1 below depicts the local view within an ATC Centre. It doesn't describe the further cross-border initiatives.

ANSP	ATC Unit	2012	2013	2014	2015	2016	2017	2018	2019	2020………… 20XX
UPPER AIRSPACE										
DFS	Karlsruhe/East Sectors	1, 2	2	2	2				3	3
DFS	Karlsruhe /Central+West Sectors	1, 2	2	2	2	2	2		3	3
DFS	Karlsruhe/South Sectors	1	2	2	2	2	2	2	3	3
MUAC	MUAC	1, 2	1, 2	1, 2	1, 2	3	3	3	3	3
Skyguide	Geneva	1	1	1	1	1	2	2	2	3
Skyguide	Zürich	1	1	1	1	1	2	2	2	3
DSNA	Reims	1	1	1, 2	1, 2	1, 2	2, 3	2, 3	3	3
DSNA	Paris	1	1	1, 2	1, 2	1, 2	2	2, 3	3	3
DSNA	Aix	1	1	1, 2	1, 2	1, 2	2, 3	2, 3	3	3
DSNA	Bordeaux	1	1	1, 2	1, 2	1, 2	2	2	3	3
DSNA	Brest	1	1	1, 2	1, 2	1, 2	2	2	3	3
LOWER AIRSPACE										
Belgocontrol	Belgocontrol	1	1	1	1	1	1	2	2	Step 3 as of 2024
DFS	Langen	1	1	1	1	2	2	2	2	
DFS	Bremen	1	1	1	1	2	2	2	2	
DFS	München	1	1	1	1	2	2	2	2	
LVNL	FRA not considered for the time being									
ANA	FRA not considered for the time being									

Table 6.1: Roadmap FRA implementation

<u>Expected costs and benefits</u>

The main costs of FRA implementation are incurred by the FABEC ANSPs. The costs include:

- Project management and development;
- Concept validation (real-time simulations);

- ATCO training;
- Non-ATCO training (flight data staff);
- Aeronautical information management;
- Safety cases.

The military ANSPs also incur costs for adapting technical systems. The CFMU will incur costs related to the development of airspace management and flight planning tools, however these tools are already planned and therefore are not additional costs for the CBA. Some airlines may incur costs for new flight planning systems, however these are not included in the CBA. Advanced flexible use of airspace (A-FUA) will be required for enhanced civil-military coordination. We assume no additional costs for the CBA.

The annual costs of FRA implementation for the FABEC ANSPs are shown in Figure 6.10:

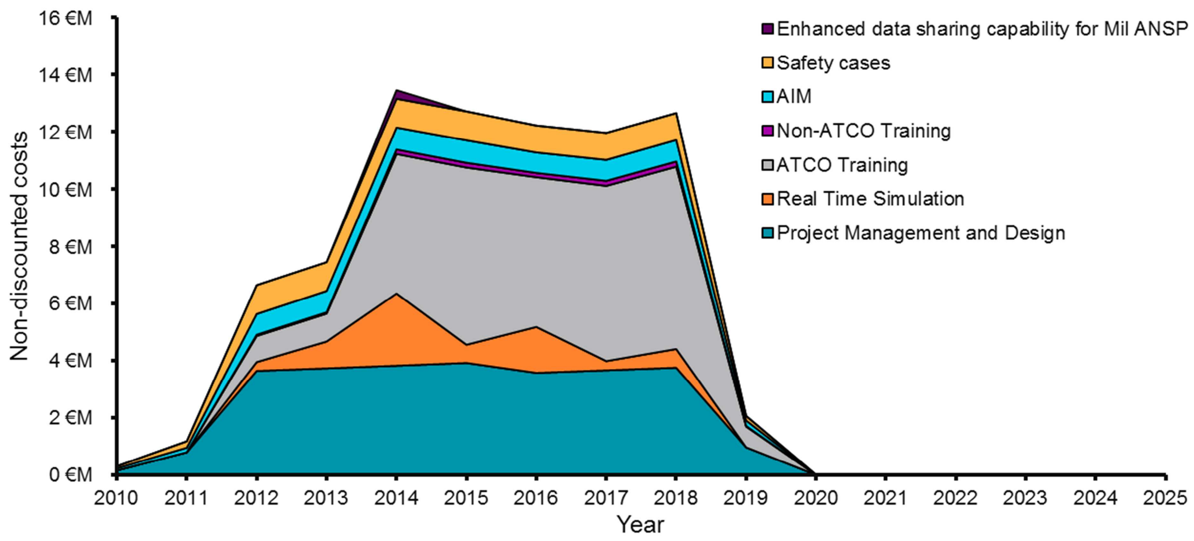


Figure 6.10: FRA project: Costs of implementation

FRA allows airspace users to fly direct routes, thus reducing flight distance flown, with consequent savings in fuel and other direct operating costs. Furthermore, airlines have an added benefit of predictability from direct routes through FRA. Currently, direct routes are offered tactically and therefore airlines plan for sufficient fuel to fly the route as specified in the flight plan. With FRA, the airline has advance information that it will fly on the direct route and therefore it does not need to carry additional fuel for contingency.

Capacity benefits are expected since reduced average transit times should result in an increase in capacity. Capacity benefits may also be due to a reduced number of conflicts, fewer redirects, and the resulting impact on controller tools. The overall impact of FRA on sector capacity cannot be determined without simulations. The SAAM model used to analyse benefits does not currently have the capability to evaluate the impact on capacity, and therefore this has not been quantified for the report.

The quantified benefits from excess route distance saved are presented in Figure 6.11:

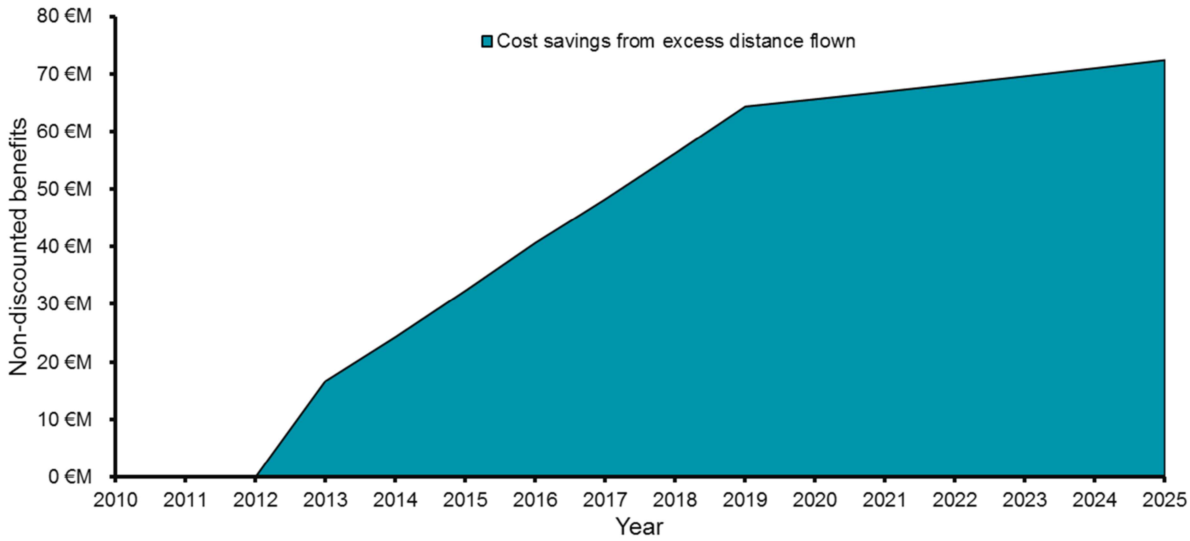


Figure 6.11: FRA project: Benefits

The project has an NPV of €332m over the period 2010 to 2025. It has to be noted, that these benefit estimation is rather conservative, as the underlying SAAM simulation only reflects flight efficiency gains within the AoR of each ACC. Savings stemming from FABEC-wide direct routings are not reflected yet. Detailed information can be found in attachement S.2, the FRA CBA report.

6.2.7 Extended Cross Border Arrival Manager (XMAN)

Description

FABEC provides a unique opportunity to develop a harmonised approach to arrival management in the core area of Europe.

Within the Core Area, DFS (serving Frankfurt and Munich airports), NATS (serving London airports), LVNL (serving Amsterdam airport), DSNA (serving Paris airports) and Belgocontrol (serving Brussels airport), i.e. the ANSP-s serving the major Hubs, have implemented or intend to implement Arrival Management techniques within their Technical Systems and Operational Procedures.

However, these implementations are currently limited to the responsible Approach/ACC Units, except for Munich, where an extension of arrival management operations into the adjacent Vienna En-Route centre has been realised.

The effect of this is that - most of the times - only within Lower Airspace, arrival-sequence related methods are applied, leading to tactical instructions (speed-adjustments, vectoring) at the most difficult stage of the flight, and with the most penalising consequences for the environment (noise, CO_2 emission).

By extending the time-horizon of such Arrival Management techniques into adjacent and/or Upper Airspace, it is envisaged that the effects on the environment will be minimised, and at the same time, that controller workload in lower airspace will be reduced. It seems obvious that by extending the time-horizon of arrival management, the net effect will result in optimising hub operations and meeting airlines needs. Where a Gate-To-Gate concept would be the ultimate goal, this document tackles half of the equation: the En-Route-To-Gate half.

As an en-route centre is managing different traffic-flows (into different airports) which need now not only to be de-conflicted to ensure safety-levels, but also need to be optimised to increase Arrival-Management efficiency, special procedures and tools will have to be put in place. These tools and procedures in the feeding centre should be made as homogeneous as possible for the en-route controller, while still taking into account “local” arrival management techniques and capability levels in the receiving units.

Moving this arrival-management task (partially) into adjacent and/or upper airspace will:

- Require as much as possible system support (e.g. implementation of OLDI AMA message) and/or new operational procedures.
- Introduce additional workload to the Controller in the adjacent and/or upper airspace. This needs to be mitigated by appropriate system support (for example by integration of multiple AMAN feeds into an EMAN and implementation of MTCD).

The environmental and flight-efficiency improvements of applying these techniques in the en-route-phase can only be guaranteed if corresponding operational procedures are applied in the receiving ACCs.

It is very likely that the capability-level of implementing arrival-management techniques in en-route airspace is driven by technical means to support the concept. Important enablers are electronic coordination means both down- and upstream, and data link, which is expected to be the preferred means to pass arrival times etc. to aircraft, especially for en-route sectors.

It is however not excluded that improvements can already be achieved through enhanced operational procedures and techniques which do not depend on technical evolutions of the current ATM Systems.

The necessary extension of arrival management operations is expected to reach out to a horizon of about 200 NM around the major airports. Together, these horizons will cover almost the entire FABEC airspace. Therefore, most of the FABEC control centres will be affected by extended AMAN operations, some of which will need to feed several arrival streams for different airports/TMAs.

The situation is shown in Figure 6.12:

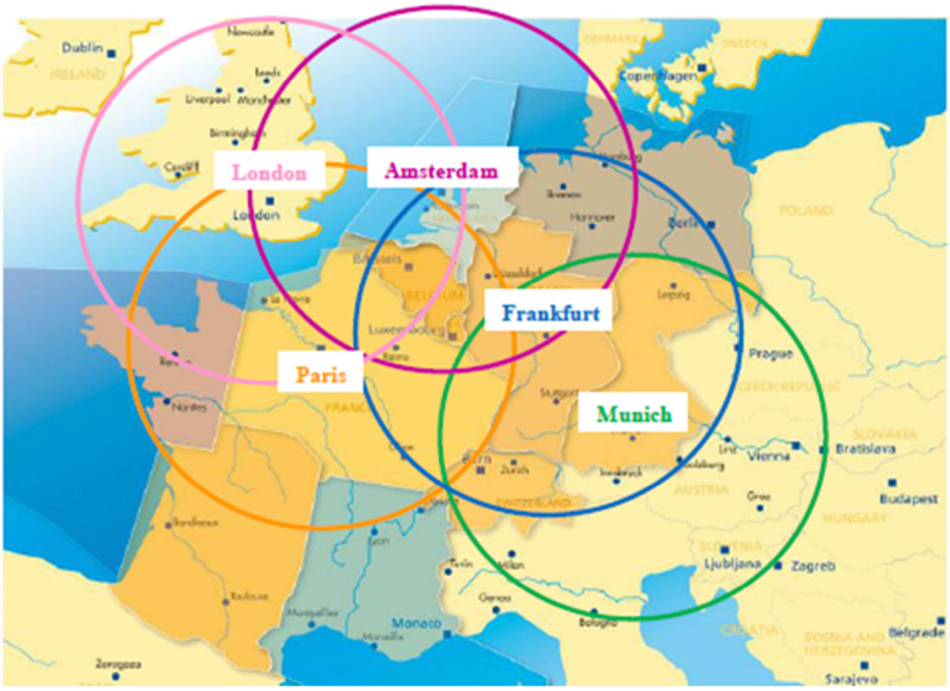


Figure 6.12: Overlapping AMAN operations

As can be seen from Figure 6.9, above described arrival and departure management needs to be implemented as a prerequisite for the future Free Route Airspace strategy. Therefore an accordant FABEC-project was set up in October 2011.

<u>Expected costs and benefits</u>

Due to the very first stage of the project no concrete performance assessment of this project was made, but various Studies (FAA, Eurocontrol, NATS, etc.) indicate that there is a potential in fuel saving in the order of 50 -100 kg per flight due to speed control in cruise and/or descent combined with arrival management techniques.

If only 10% of the flights[17] to the 5 major FABEC TMAs were eligible for speed control during the arrival phase, about 6 - 12 Million kg fuel per year could be saved. These savings lead to a corresponding monetary saving of about € 8.5m as direct benefit.

Nevertheless these figures were not included in the CBA.

6.2.8 Airport Collaborative Decision Making /Departure Manager (A-CDM/DMAN)

Description

Airport CDM is an operational overall process (concept/procedure) supporting an optimized turn-round process at an airport. It covers the period of time between the estimated off-block time (EOBT) -3hrs and take-off and is a coherent process from flight planning (ATC flight plan) to landing and the subsequent turn-round process on the ground before the next take-off.

Figure 6.13: Definition and partners A-CDM

Airport CDM at an airport is based on the ETSI Community Specification (EN303212).

Airport CDM should also become an operational process at secondary airports and not only at the 5 major TMAs (Paris, Amsterdam, Frankfurt, Munchen, London), as these airports (e.g. Brussels, Zurich, Berlin, Dusseldorf) may have an important impact on such major TMAs.

Within the FABEC region A-CDM is already implemented at the following Airports:

Frankfurt, Munchen, Paris CDG, Brussels

For the other airports A-CDM implementation is planned until 2014.

Expected costs and benefits

Airport CDM produces high returns for relatively low costs. Since each airport is site specific, a local cost benefit analysis (CBA) has to be performed to support the decision to implement Airport CDM.

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[17] 1.2 Million flights per year

Referring to Eurocontrol Airport CDM CBA the Net present value for a midsize Airport (280.000 movements/year 4% traffic growth) is about 90 Mio Euros for all partners for 10 years.

Network benefit is estimated to be about 70 Mio Euros for 10 years if a certain amount of Airports are introducing A-CDM with high quality data. This is proven by a Eurocontrol EEC simulation in 2008.

Due to the early status of the project no costs/benefits are included in this CBA.

6.3 TECH-domain

6.3.1 OLDI Forward!

Description

In the beginning of the FABEC Implementation phase an OLDI Task Force was established to analyse the different sets of OLDI messages in regard to a common implementation within FABEC.

As a result of the OLDI Task Force three sets of beneficial OLDI messages are recommended for implementation:

- Arrival Management Message (AMA) for distribution of Arrival Manager proposals or constraints for inbound traffic from adjacent ACCs; (FORWARD! #1)
- Co-ordination Dialogue Messages (RAP, RRV, CDN, SBY, ACP, REJ) for the co-ordination of non-standard transfer conditions via proposals and counter-proposals; (FORWARD! #2)
- Transfer of Communication Messages (COF, MAS, HOP, ROF) for fully automated transfer of aircraft between ACC; (FORWARD! #3)

The first initiative FORWARD! #1 will be implemented for the airports of Amsterdam and Brussels. A further implementation for Frankfurt is analysed by the Task Force. FORWARD! #1 is an initiative for inter-centre distribution of arrival management-information for traffic inbound to Brussels and Amsterdam to transferring units through the use of the AMA-message. The objective of the initiative is to inform transferring units of speed restrictions that should be placed on aircraft to help smooth the flow of traffic arriving into Brussels and Amsterdam. This traffic smoothing will help to reduce the amount of airborne holding that is encountered by aircraft inbound to these airports.

The Task Force is still working on the initiatives FORWARD! #2 and #3.

Expected costs and benefits

Next to project management costs and system costs (implementation of the AMA message in the relevant systems), which amount to € 100k one time operational costs and € 140k capital costs per year, the benefits of this initiative can be found in the field of flight efficiency:

The flight-efficiency benefits have been identified for Brussels and Amsterdam. The benefits for Amsterdam have been investigated in detail by the OLDI Task Force.

For Amsterdam, the Expected Approach Time (EAT) has a tolerance of ± 120 sec.

The current operating procedures enable approximately 80 seconds to be absorbed after entering Amsterdam ACC, i.e. all flights with > 200 sec. sequencing delay are considered as potentially benefitting from the AMA message. This is approximately 30% of inbound flights that would benefit.

The AMA message will be triggered manually by the controller in the initial implementation. Therefore it will not be possible to use the AMA message for all flights. The TF assumed that a maximum of 40-50% of eligible flights will benefit from the AMA message.

- Standard Paris-Amsterdam flight saving of 110kg based on a B737. Fuel flow figures for narrow and wide-body aircraft have been used to estimate the total fuel savings given the mix of aircraft categories.
- For Amsterdam 36,000 flights out of 200,000 are eligible in the current configuration. Estimated fuel saving of 4.4 Million kg per year (for the observed mix of types of aircraft)
- The average fuel saved per flight is 122kg.

- LVNL estimates that 10-15% of this benefit could be achieved in 2011, increasing to 25-50% in 2018. Therefore, a linear ramp up of benefits reaching a maximum of 13,000 flights in 2018 was assumed.

For Brussels, a slightly lower percentage of inbound flights are actually benefitting was assumed. This is for two reasons: There is less delay in Brussels and the potential savings are also less (route is shorter). Thus the TF assumed benefits of 20% of inbound flights. As Brussels has approximately 125,000 flights inbound per year, it was assumed that 15,000 flights will benefit.

The time frame for benefits is limited to 2018, because from 2018 on the Task force expects advanced interoperability (IOP) mechanisms to be implemented, which would replace the OLDI mechanism and which would also include optimization of Arrival Management.

The above mentioned costs and the described benefits lead to an NPV of € 12m. An extension to Frankfurt and the initiatives #2 and #3 are not yet included in this calculation. At the moment it is analysed if an inclusion of the OLDI project into the new XMAN project is reasonable.

6.3.2 FINE

Description

The FINE TF was triggered by the necessity to define and then implement ground telecommunications means able to perform IP services to support ATM operational and non operational data and voice communications within FABEC area and with FABEC partners (civil and military ANSPs, Airports,…) compliant with SES objectives.

At the beginning of the FINE TF activities three different scenarios were envisaged. But in the mean time, scenario 1 implementation (no cooperation, each ANSP acts individually) has started for IR FMTP implementation. FABEC ANSPs are investing or are planning to invest in the IP upgrade of current networks. This architecture could satisfy FABEC IP communication needs until wide use of air-ground VoIP communication. This need is not foreseen before 2020. According to some ANSPs there is no urgency in this case to take decision on the next step for FABEC network.

So it was decided to postpone all FINE activities to 2018.

Expected costs and benefits

There are no benefits foreseen in the relevant timeframe. TF costs are included in the CBA model.

6.3.3 VCS

Description

The objective of the VCS Task Force was to define a common VCS (sub-)system specification (including interface requirements) for the scope operational systems, tests systems, training systems for ACCs and largest approaches and to identify enablers to allow common maintenance and change management processes.

The initial version of the full VCS specification was produced in July 2010.

After the availability of the specification MUAC and DSNA decided to replace their current VCS systems through a common procurement based on this specification.

The contract was signed in 2011, operational use is planned for 2014 (MUAC) and 2015 (first system DSNA).

Expected costs and benefits

A common procurement shows its benefits in several cost areas: During the procurement phase the system development costs can be reduced. In this case the savings for MUAC are

€ 2.4m and for DSNA € 1.0m. But also for the lifetime of the systems cost savings can be reached: Reductions in maintenance costs but also staff reductions due to the increased redundancy and flexibility of a wider spread system. In this cost area MUAC and DSNA assume cost reductions of € 650k per year.

For the development of a common VCS specification for all FABEC ANSP project costs of € 375k were needed. Due to an intensified coordination between DSNA and MUAC, DSNA assumes additional cost of € 60k per year.

These costs and benefits result in an overall NPV of € 5,1m until 2025.

6.3.4 SUR

Description

ANSPs have planned and implemented SUR sensors infrastructure, largely on the basis of national need, to support operations in their airspace.

Furthermore, some duplication or complementary surveillance means exist between civil and military infrastructure.

The FABEC Feasibility Study states that there is room for optimization of this infrastructure. An example could be collective FABEC needs for radar coverage fulfilled by a more optimised radar network if the coverage approach had been carried out independently of national boundaries.

SUR Infrastructure Optimization is therefore one of the areas of cooperation described in the High Level Roadmap of the Feasibility Study Report. In the context of the roadmap it is the first step to be undertaken in the SUR sensors infrastructure. Further steps may include e.g. a rationalisation of SUR equipment.

The FABEC ANSP therefore established a Task Force. The objective of this TF is to optimize the SUR sensors infrastructure necessary to cover the needs for all phases of flight and corresponding types of ATC unit (ACC, APP, and TWR).

In order to reach this goal the TF will produce a FABEC-wide optimization study independent of inner-FAB national boundaries.

The optimization studies will take account of:

- FABEC operational concepts (cf. FAB CONOPS)
- International and European SUR strategies and regulations (e.g. ATM surveillance strategy for ECAC- V2.2 dated 07/04/2008)
- all phases of flight
- all types of ATC unit (ACC, APP, TWR)
- civil and military needs

European rules or incoming SES rules (e.g. IR MSI or draft IR Surveillance performance and interoperability) should also be considered.

Expected costs and benefits

The costs and benefits of this initiative are included in the overall CNS-Services initiative.

6.3.5 AGDL

Description

Every ANSP will have to provide Air-Ground data link services as from February 2013 in accordance to an EC IR on Data Link Services. The FABEC feasibility study identified potential savings by a joint data link services infrastructure implementation under the umbrella of FABEC for the whole of the FABEC area in the most efficient way. FABEC

ANSPs are today at different levels of data link services infrastructure implementation: MUAC is outsourcing the services, DFS has an operational infrastructure, and others have no service in place.

FABEC ANSPs have to provide VDL2 communication services for ATC communication to airlines which are contracting AOC services with ARINC and SITA. For each of ARINC and SITA, the contractual framework could be:

- A teaming agreement (as currently between DFS and SITA). In this case, FABEC ANSPs are operating part of the communication infrastructure (ground stations and wide area network) for the teaming partner.
- An outsourcing agreement (as currently between MUAC and ARINC and SITA). In this case, FABEC ANSPs are buying VDL2 services for ATC communication.

In the first option, FABEC ANSP could reuse existing infrastructure and share monitoring and control staff to reduce cost.

Based on a business case developed by the AGDL TF, the TECH SC selected the following scenario:

- Teaming agreement with one air communication service provider (ACSP): ARINC or SITA;
- Outsourcing with the other ACSP.

The selected scenario is implemented in three phases:

- in a first phase - FABEC partners interested to procure VDL2/ATN infrastructure organize under the umbrella of FABEC a joint call for tender to choose a partner ACSP for the common procurement of the infrastructure and for the provision to this ACSP of an AOC service;
- in a second phase, and depending on the selected partner in the first phase, other FABEC partners will join an extended cooperation agreement for service provision;
- In a third phase, FABEC partners negotiate an outsourcing agreement with the other ACSP.

For the first phase, the interested ANSPs sealed off their cooperation by means of a Consortium Agreement on AGDL procurement and designated DSNA to act as a leader during the process. Once the tenderer was selected, they jointly concluded a Framework Agreement with the selected tenderer (this Framework Agreement was signed in 2011). For this framework agreement, each party identified a fixed and an optional number of AGDL infrastructures. Under the umbrella of this Framework Agreement, each party agrees with the tenderer on its own Subsequent Contract which sets the principles of execution for the particular situation of the party.

As the selected tender for phase 1 is SITA, the second phase has been implemented.

The third phase is on-going. Contacts have been initiated with ARINC to set up a fair deal for outsourcing.

<u>Expected costs and benefits</u>

Next to the project costs in 2011/2012 there are initial costs of € 0.6m and initial investments of € 2.7m for the chosen scenario. The annual costs for this scenario amount to € 1.3m.

The Task Force calculated initial benefits (cost savings for not choosing the reference scenario for each ANSP) of € 1.0m. Next to these costs savings the participating ANSP can also reduce necessary investments they would have otherwise done in the reference case. Also the reference scenario would have had annual costs, now accounted for benefits of overall € 1.6m.

Additional revenues (cooperation with ACSP) are not valid for all ANSP, as i.e. DFS already cooperates with SITA: For the remaining ANSP these revenues were assumed with an annual value of € 0.1 m.

These costs and benefits lead to a NPV of €2.1m.

6.3.6 CNS-Services

Description

FABEC partners are considering all possible Air Navigation Service areas where de-fragmentation of services is possible to bring additional performance and cost efficiency measures towards airspace users. One of these areas is Communication / Navigation / Surveillance (CNS) Services. Common FABEC CNS Services are considered as a potential FABEC performance improvement. Moreover, the FABEC Feasibility Study identified “CNS Services” as a potential area for FABEC cooperation and expected to find savings in both operating and investment costs for CNS services.

The ASB decided to task a ‘CNS Services Project’ to develop a Business Case for optimising the provision of CNS Services at FABEC level. The goal is to offer at least the same quality of CNS Services for a substantially lower cost.

At the time of writing this study is still ongoing but an outline of the areas being studied is provided below. Additionally, the FABEC CBA includes an initial assessment of the total potential benefit. It should be noted that only a conservative rough estimate is given since the study in still ongoing.

The study explores whether opportunities resulting from an effect of scale exist within the FABEC CNS context. The resulting CNS Services Business Case shall allow ASB to make a well-informed decision as to which of the initiatives the FABEC ANSPs should pursue in common.

The Business Case investigates in particular the following initiatives:

Initiative 1: “Develop a FABEC CNS infrastructure”

Initiative 2: “Jointly operate the FABEC CNS infrastructure”

These two initiatives have been refined by breaking them down into sub-initiatives, each one targeting specific benefits.

This breakdown was done to enable a quantitative estimation of the cooperation benefits, but at the same time it also provides a better understanding of each initiative.

Expected costs and benefits

Common SL3-SL4 for CNS

This sub-initiative has some potential for long-term staff reduction depending on chosen scenario. More importantly, it is an enabler for most of the other sub-initiatives.

Common CNS procurement

FIN SC and TECH SC have proposed to ASB a joint process to support Common Procurement in FABEC. Before taking a firm decision ASB requested both steering committees to assess the financial potential of Common Procurement (see chapter 6.5.3).

The TECH-FIN expert group called FAPTI (FABEC Advisory Process for Technical Investments) has assessed during early 2012 the financial gain to be expected from common procurement of technical systems. Part of that potential can be found in CNS procurement and this is indeed one of the target benefits of the CNS Business Case. In view of this overlap a close FAPTI-CNS coordination has been ensured and the results of the FAPTI assessment will be integrated into the CNS Business Case.

SUR infrastructure optimization

The CNS Business Case includes results of radar coverage simulations to estimate the potential reduction of Surveillance infrastructure.

Best practice in SL2

This is directly enabled by the SL3 cooperation. Its benefit is potentially high but also difficult to estimate. A conservative assessment will be included in the Business Case.

Cross-border maintenance

Cooperation between maintenance teams in cross border areas depends largely on the actual location of infrastructure (e.g. airports). The benefit of this particular sub-initiative will be included but should be expected to be limited.

Centralised SM&C

This sub-initiative is about 24/7 monitoring of CNS systems. The CNS Business Case investigates whether a centralisation of this function would be more efficient than the current solutions.

Joint spare parts holding

The potential benefits of pooling CNS spare parts will be estimated using a high level statistical model.

Common CNS training provision

The benefits in this sub-initiative are taken from the outcomes of the CBA for FABEC Training Services of the Training Task Force.

The estimated costs and benefits of these sub-initiatives lead to an overall NPV for CNS services cooperation of € 71,2m in the timeframe until 2025.

6.3.7 CATS

Description

Today the ATC Centres construct their air situation pictures by merging selected sensor data locally in tracker systems such as ARTAS; to obtain a sufficient degree of redundancy; they often duplicate the number of trackers and optionally constrain sensor feeds to the different trackers.

The FABEC Feasibility Study and High Level Roadmap identified an opportunity to rationalise (centralise) the ARTAS systems in a few centres. The services (air situation picture) generated locally today would then be generated remotely and delivered over a redundant network. At present such facilities largely exist at MUAC (providing a labelled air situation picture to Belgian and Dutch civil and military ACC for fallback purposes, and German and French Air Defence for operational awareness) and in Skyguide (Geneva to Zurich and vice versa).

Expected costs and benefits

In November 2010 ASB decided not to pursue the idea of a common track server any further. The available information (i.e. a Business Case) indicated that under the current circumstances no kind of cooperation would be more cost-effective than the status quo in the tracker domain, despite its high level of standardisation and even current commonality.

This leads to the conclusion that no benefits can be shown for this project. The TF costs (mainly resources) are included in the CBA model.

6.4 HR-domain

6.4.1 Training Services

Description

The objective of the Training services Task Force is to optimize training processes and results by a collaboration approach amongst the training organisations and processes. Moreover the objective is to assess the financial and structural impact on all participating ANSPs.

The vision of the TF is to develop a harmonized and as integrated as possible FABEC training organisation for both civil and military ANSPs' personnel. In that context the training task force aims to achieve performance-oriented solutions for the training in the FABEC context in order to:

- Meet the requirements defined by the ANSPs of the FABEC
- Enable the implementation of new operational concepts
- Achieve the projected performance benefits and
- Create a common FABEC spirit

These performance-oriented solutions shall be achieved by:

- Ensuring adequate recruiting of ATCOs and ATSEPs
- Providing adequately trained people
- Increasing training success rates
- Facilitating personnel mobility and progress for ATCO and ATSEP trainees)
- Developing harmonized top level training products
- Saving cost by a better cooperation or integration of the different resources.

The aim of this TF is a "federation of schools", providing training and education for FABEC ANSPs as much integrated as reasonable by the year 2015. Therefore the FABEC training concept should include the issues of licenses and diploma. Additionally a broad approach including educational and cultural issues should be chosen. But also existing differences shall be respected and the utilization of the existing resources shall be optimised

In order to achieve the objective, an approach in three steps has been developed.

Short term (2010):

- Benchmark the different existing training organisations, identify good practices and possible standardisation or harmonisation
- Evaluate implementation scenarios for ATCO training organisation and present a common proposal to ASB based on best practices and possible cooperation or integration.
- Establish an initial organisation based on cooperation between the existing training providers within FABEC
- Realise early benefits through implementation cases (MUAC training, recruitment and selection, etc.)

Medium term (2013):

- Enhance the efficiency of the initial organisation through improved coordination and integration in domains of shared interests (alliance concept)
- Establish the FABEC training organisation as a brand in the ANS training market
- Deliver common courses to FABEC
- Increase scope of training task force to ATSEP

Long term (2015)

- Increase scope to management training and/or education and diploma issues

- Agree on the launch of a detailed Business Case and plan for the creation of a FABEC training Service Company that could have its own legal structure in order to implement joint solutions between independent training providers and to enable market presence. Proposal shall consider that contribution from the ANSP partners may differ from one another

Expected costs and benefits

The study of the Training TF analyzed and assessed the potential benefits on the following areas of cooperation:

- Recruitment and selection;
- Initial training for ATSEPs;
- Initial training for ATCOs;
- Competence scheme;
- Development training;
- Sales;
- Regulation management.

To provide better granularity, each opportunity was examined at the sub-initiative level[18].

The financial analysis shows that the major type of benefit at the FABEC level is productivity gain benefits (expressed as monetary savings in this report). This is a result of the frequent indication by training organisation representatives that the measures within sub-initiatives can only reduce staff workload, rather than lead to headcount savings. This is evident in that the productivity gain benefits are in strong contrast with the staff reduction benefits which are zero across whole FABEC.

The costs and benefits of all sub-initiatives result in an overall NPV of nearly € 6m for the relevant timeframe until 2025.

6.5 Other contributing elements

Additionally to the projects/initiatives or Task Forces mentioned in the above chapters the CBA has to consider the costs (and possible benefits) of other organisational elements relevant for the project management of such a complex multinational programme.

6.5.1 Programme Management

Description

This initiative contains estimated cost of FABEC groups which are not directly delivering benefits, but are essential to operate FABEC. Therefore only costs and no benefits can be measured.

The following ANSP groups are considered:

- ASB, AFG, AFG/PMG,
- 7 Standing Committees (FIN, IRL, TEC, OPS, ENV, HRT, SAF),
- Com Cell, Social Dialogue,
- 2 Task Forces (Network Management, COM Optimisation) and

[18] A detailed description of all sub-initiative can be found in the report “CAB reviewing the FABEC training Case Services Business Case” prepared by Helios March 2012

- the subgroups of SC OPS and SC TECH: the OPS Working Office (OWO) and the Technical Working Group (TWG).

Moreover, the states driven task forces/initiatives HLIB/ANSCB, FPSG/pFPC and TF Charging with ANSP participation are considered per rate of ANSPs' contribution.

Expected costs and benefits

Due to the nature of the groups summarized in this initiative, no benefits can be expected. Therefore only cost figures were included into the CBA. The cost figures comprise mainly staff costs and necessary mission costs for attending relevant meetings. Regarding the costs spent in the years 2009 and 2010 it was assumed that around € 5.7m per year will be spent for programme management until 2025.

6.5.2 TEN-T Funding

Description

EC Decision C(2011)3258 granted FABEC a maximum amount of almost € 14m TEN-T funding. The actually paid amount depends on the progress of 11 dedicated FABEC Activities in the time frame 2010-2012. However, it is assumed that the full amount will be paid to FABEC.

For this CBA the TEN-T funding is treated as one "initiative" and not shown in each relevant activity as these activities are not always coherent with the initiatives described in the former chapters.

The funding is shown as negative costs although it might also have been treated as a benefit.

In December 2011 it was decided to apply for a second TEN-T funding. The projects FRA, XMAN, A-CDM and Point Merge were chosen as relevant projects for funding. As this application has to be submitted to the European Commission on 13 April 2012, no figure for potential funding can be included in this CBA.

6.5.3 Common Procurement

Description

Common Procurement is one of the most beneficial areas for cooperation between the FABEC ANSP.

The ASB has therefore launched a dedicated FABEC Task Force Common Procurement with clear Terms of Reference.

The purpose/goal is to improve value for money for FABEC ANSPs through the sharing of development cost and/or through economies of scale and through joint bargaining power, as well as to increase efficiency of commercial processes through coordination and harmonization.

The current emphasis is on the establishment of a Portfolio of Potential Common Procurement Candidates (PCPC) (products, equipments, services, goods). The Portfolio shall be supported by Commodity Business Plans (CBP), including a positive CBA per PCPC. The TF Common Procurement will eventually, in a stepwise approach and in accordance with its Terms of Reference define strategies, processes, contractual framework and structural alternatives for FABEC wide common procurement.

FABEC common procurement is supported by the SC Tech through the FAPTI. FAPTI provides advice with regard to mainly ATM and CNS systems procurement and delivers respective contributions to the Shortlist of prospects for potential common procurement candidates (products and services). All procurement- and investment-related actions in other technical workgroups shall be coordinated by the Task Force Procurement / FAPTI. Cross domain support is furthermore assured through representation of FABTI members in the

Task Force Common Procurement and – vice versa – participation of members of the Task Force Procurement in FAPTI.

<u>Expected costs and benefits</u>

The savings target is set at € 7.5m/year based on a common investment portfolio of € 30m/years (with 5% gain) and a common operating portfolio of € 60m/year (with 10% gain). As, however, the current emphasis of the Task Force Procurement (and FAPTI) is on the identification of candidates for eventual common procurement projects and the respective selection process no explicit benefits can be shown in this report at this point in time. (The benefits stemming from actual current or future common procurement projects will be monitored and accounted for in/through the TF Common Procurement.

7 RESULTS OF THE COST-BENEFIT ANALYSIS

In this chapter we present the:

- net benefits of the FABEC initiatives;
- a summary of costs and benefits; and
- discounted cash flow projections.

Since the basis for a cost-benefit analysis is conventionally to express costs and benefits as cash flow, the analysis in the chapter presents all costs and benefits in cash terms. In particular, benefits from capital cost savings are expressed in cash terms.

7.1 Distinction between benefits

In the analysis we have subdivided the benefits according to their nature:

- Indirect to users, through ANSP cost savings; including:
  - Cost savings for ATM systems and related technical support;
  - Cost savings through joint procurement and maintenance technical systems; and
  - Cost savings through common training and qualification of personnel.
- direct to users through quality of service, including:
  - reduction in delay through more capacity;
  - improved flight-efficiency leading to less fuel consumption.

Monetary values of environmental benefits are not included in this analysis.

7.2 Indirect benefits (ANSP cost savings)

Figure 7.1 presents the net benefits that have been estimated by the relevant FABC projects and initiatives. They include both savings in capital expenditure and operating cost savings.

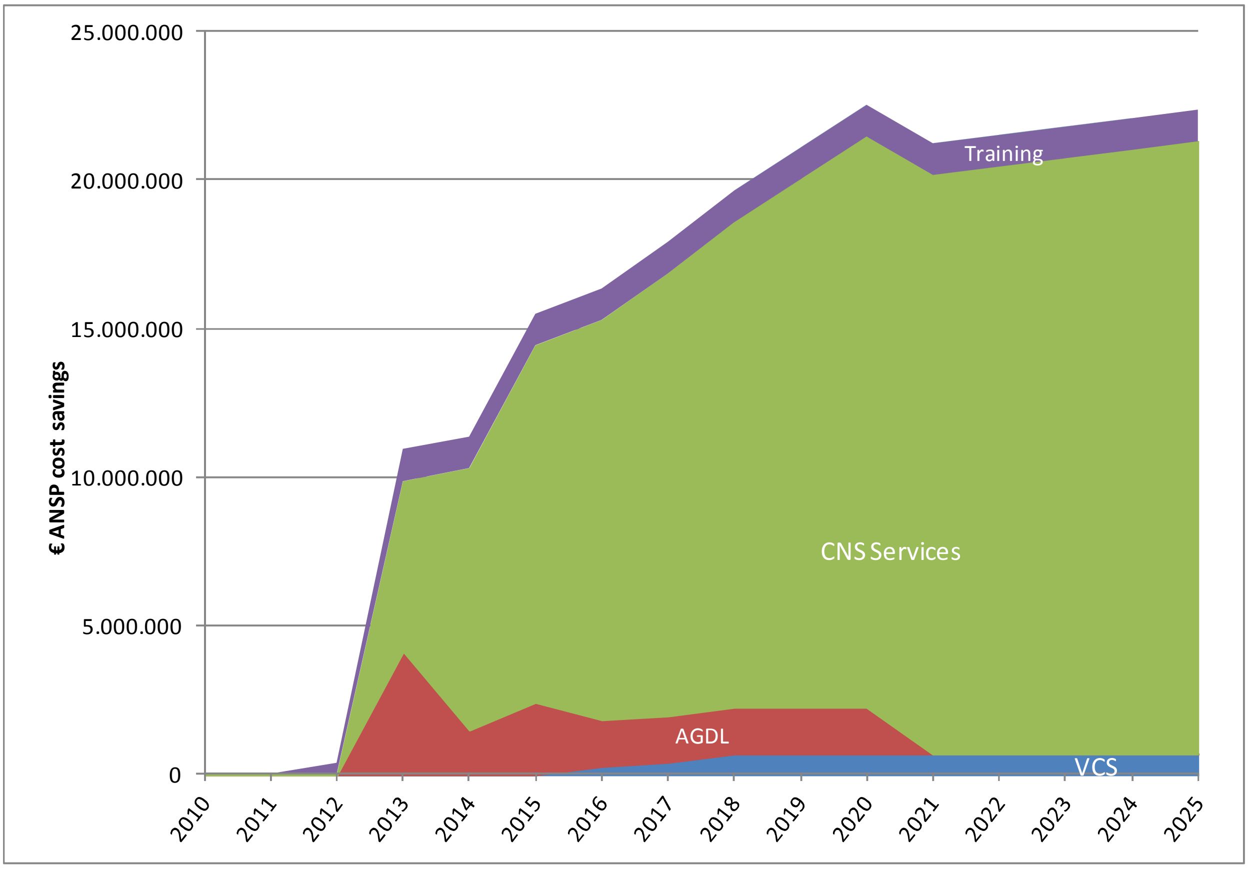

Figure 7.1: Overview of ANSP cost savings

Figure 7.1 shows a cash-flow benefit of € 0.4m in 2012, rising to € 23m in 2020 and a rather stable development thereafter at € 22m per year. This development shows that FABEC ANSP need to find more initiatives especially delivering cost savings in the middle and long term.

7.3 Direct benefits to users

In addition to the indirect benefits to users shown above, AFG/PMG asked the projects for further benefits, having a direct impact on the airlines costs. In this chapter we show the effects of reduced delay and improvements in flight efficiency on the airline costs.

7.3.1 Delay benefits

We have estimated the benefits to airlines of reducing the delay generated by the FABEC region. Figure 7.2 presents the delay per flight both for the reference case and following the implementation of all capacity improvements. It also presents the value of the corresponding reduction of delay and additionally the value of all delay reducing measures other than those increasing capacity or ATCO productivity.

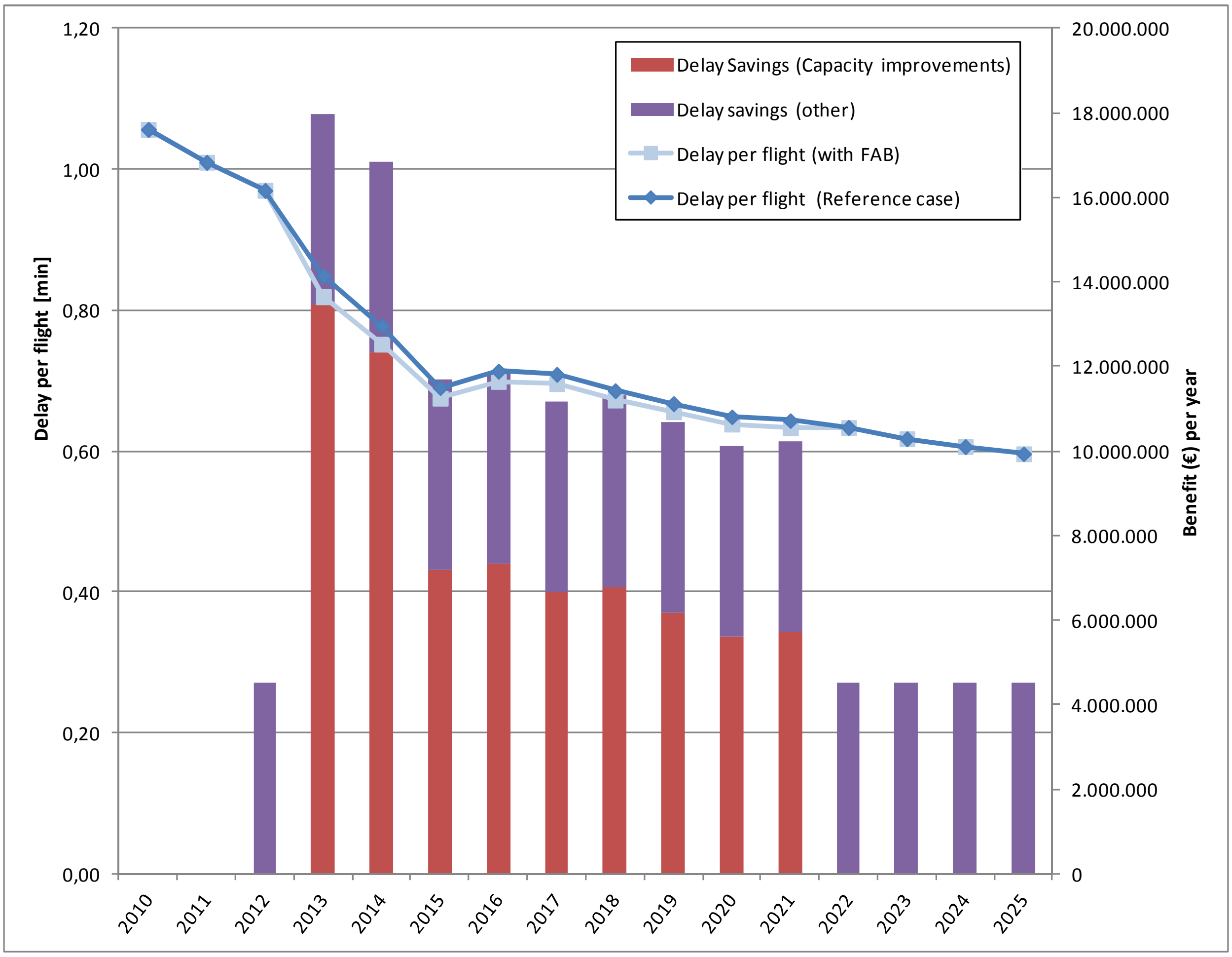

Figure 7.2: Benefits from reduced delay through capacity improvements

At the moment only one project is contributing to a reduction in delay through a capacity improvement. It is the AMRUFRA project, which showed in a real time simulation a capacity increase of in total 0.5% over all concerned ACCs, leading to benefits between € 13.5m and € 6m per year.

The other delay saving presented in Figure 7.2 of about € 4.5m per year comes from the AD West II project. In this project flow restrictions can be lifted leading to delay reductions (see chapter 6.2.2.2).

7.3.2 Flight Efficiency benefits

Flight efficiency benefits can be shown in two different parameters. In this model we used the Percentage of route extension represented in distance flown compared to the great circle distance as the parameter to reflect benefits in the horizontal flight efficiency.

Figure 7.3 presents the monetary value of improved horizontal flight after implementation of all AD projects resp. the free route airspace.

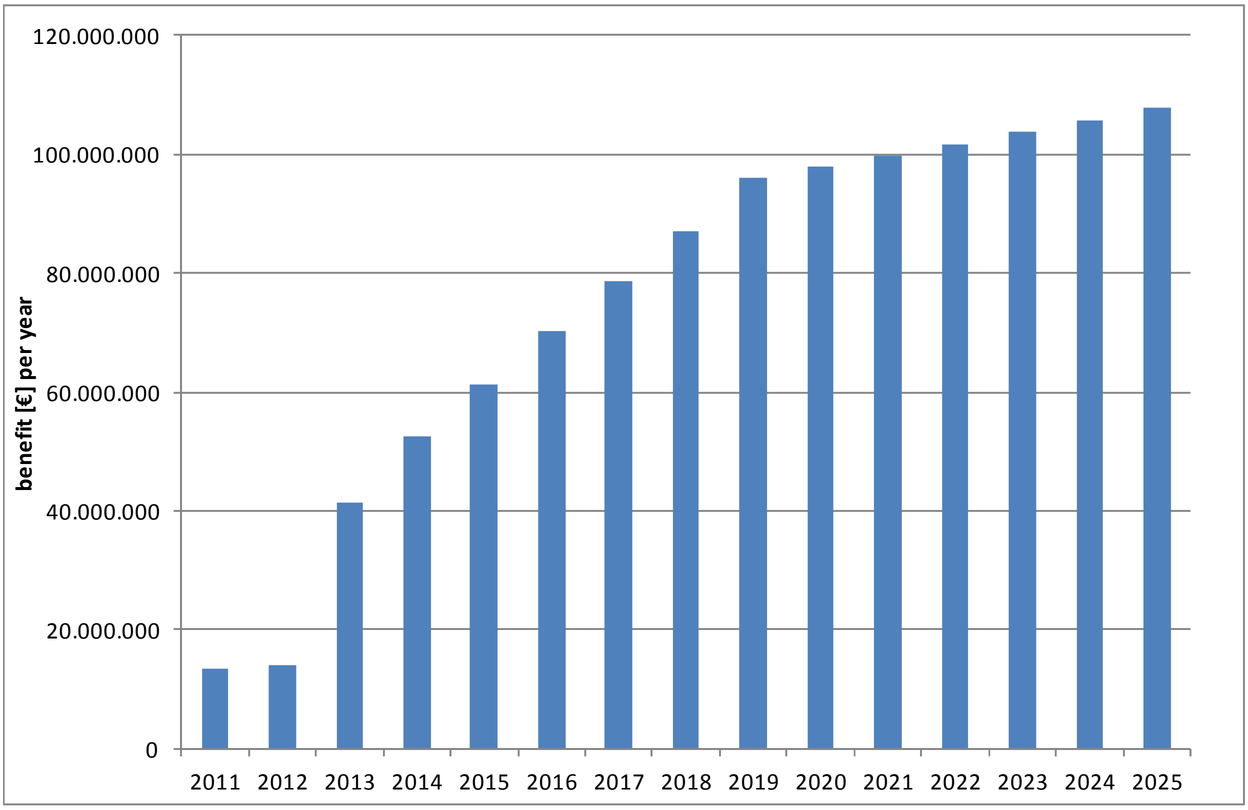

Figure 7.3: Improvements in horizontal flight efficiency

The monetary benefits started already in 2010 (implementation of EIP-projects AMRUFRA; City Pairs and Night Network). After a rather huge step from 2011 to 2012 caused by the implementation of the AD projects for the Hotspots and especially the first steps of FRA, the development after 2014 shows an increase until 2019 with the full implementation of FRA step 2 in the whole FABEC airspace. Improvements in horizontal flight efficiency cause a maximum yearly benefit of around € 147m in 2025.

In order to reflect also improvements in the vertical flight efficiency we also introduced the monetary value of saved fuel into our model. This parameter was for instance used in the calculation of benefits deriving out of the use of the new OLDI message AMA, which is relevant only in the approach phase, which means in a flight phase with vertical movement. Figure 7.4 presents the monetary value of fuel savings because of improved vertical flight profiles. The project team assumed that each year more flights will benefit from the new OLDI message. Hence the benefits start in 2012 with € 800k and increase to € 6.1m in 2018. For the years after 2018 it was assumed, that new IOP mechanisms (SESAR) will be implemented replacing the OLDI mechanism.

Future Improvements caused by the implementation of the XMAN-project would also lead to enhanced vertical flight efficiency.

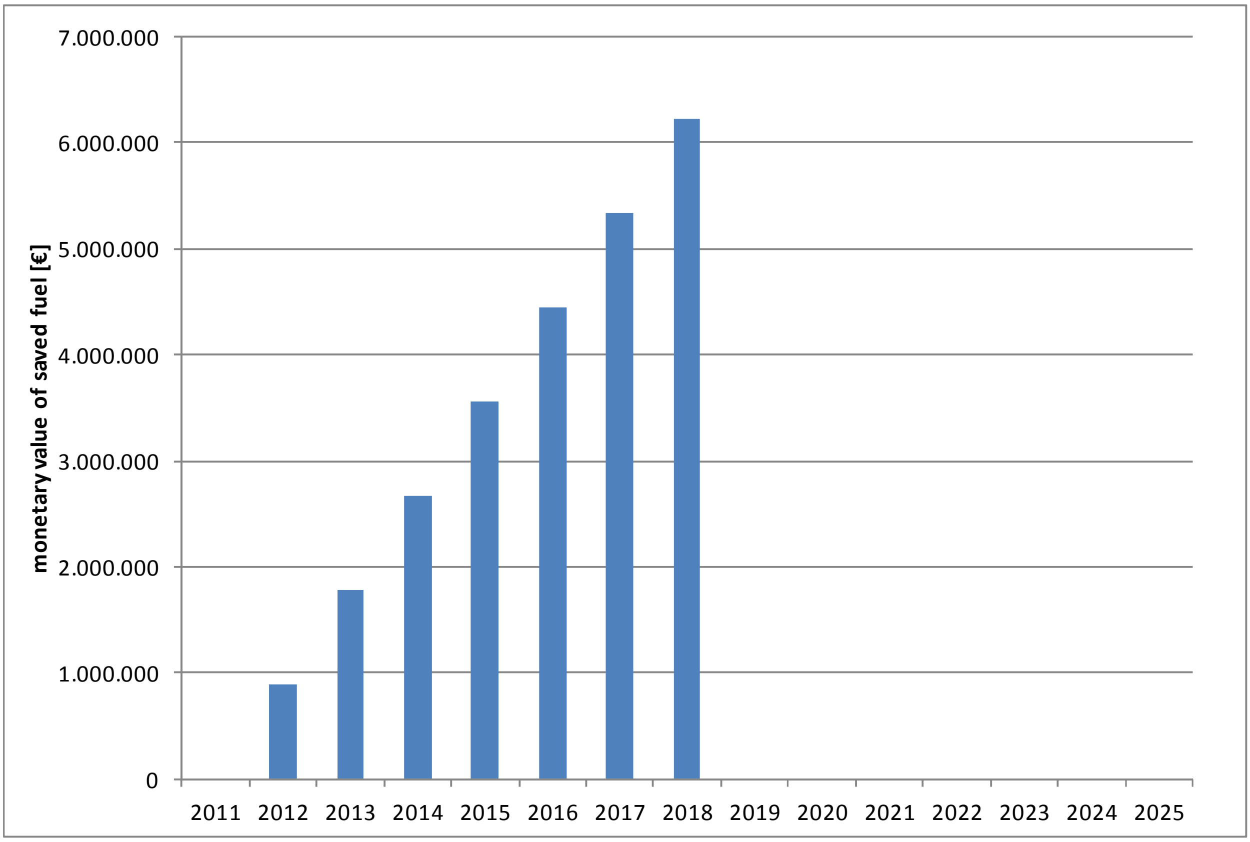

Figure 7.4: Monetary value of saved fuel through improved vertical flight profiles

7.4 Summary of costs and benefits

Table 7.1 gives an overview of the costs and benefits (shown for the years 2014 and 2020) of all relevant FABEC initiatives contributing to the NPV shown in Table 7.2. Certain projects (AD LUX, FINE, CATS,...) are not shown here, because they do not have any costs or benefits (yet). Also not included in this table are the programme management "overhead" and the TEN-T funding.

Initiative/ project/TF	Total cost incurred		Benefit achieved	Benefit type	2014	2020
AD South-East	Design, simulation and implementation	€ 2.9m	Contribution to flight-efficiency gains	Direct	€ 11.7m	€ 13.0m
AD West	Design, simulation and implementation	€ 2.2m	Contribution to flight-efficiency gains	Direct	€ 1.4m	€ 1.6m
			Reduced delay	Direct	€ 4.5m	€ 4.5m
AD CBA-L/CW	Design, simulation and implementation	€ 6.3m	no benefits assessed yet	Direct		
FRA	Design, simulation and implementation	€ 80.6m	Contribution to flight-efficiency gains	Direct	€ 24.3m	€ 65.6m
VCS	Common specification project coordination	€ 0.7m	Reduced annual operating costs	Indirect		€ 0.7m
CNS Services		€ 19.5m	Different benefits (Synergies, Common procurement,…)	Indirect	€ 4.1m	€ 14.3m
AGDL	Project costs + annual costs	€ 10.1m	Reduced capital expenditure	Indirect	€ 0.9m	

	CAPEX	€ 2.7m	Reduced annual operating costs	Indirect	€ 1.6m	€ 1.6m
OLDI Forward!#1	Project costs	€ 0.2m	Reduced Fuel burn	Direct	€ 2.5m	
AMRUFRA	Design, simulation and implementation	€ 3.8m	Contribution to flight-efficiency gains	Direct	€ 3.2m	€ 3.5m
			Reduced delay	Direct	€ 7.2m	€ 5.6m
Night Network	Design, simulation and implementation	€ 0.6m	Contribution to flight-efficiency gains	Direct	€ 6.4m	€ 7.2m
City Pairs	Design, simulation and implementation	€ 0.8m	Contribution to flight-efficiency gains	Direct	€ 6.2m	€ 6.9m
Training TF	Project costs	€ 4.2m	Reduced costs	Indirect	€ 1.1m	€ 1.1m
	Total	**€ 130.4m**		**Direct**	**€ 67.4m**	**€ 106.1m**
				Indirect	**€ 7.8m**	**€ 17.8m**
				Total	**€ 75.2m**	**€ 123.9m**

Table 7.1: Summary of costs and benefits of FABEC initiatives

7.5 Results of the discounted cash flow analysis

The results of a cost-benefit analysis are conventionally presented as a discounted cash flow. This takes into account the relative value of present and future costs and benefits by using a "discount rate"; the value of equivalent benefits one year later are reduced by the discount rate.

The discounted cash flow calculation sums the net benefits of the project over its history, with costs and benefits in each successive year appropriately discounted.

The Net Present Value (NPV) of the project is the sum of these discounted cash flows for the life of the project.

In

Table 7.2 we present the NPVs of the project cash flows taking into account net benefits to a number of horizons:

- 2014; end of RP1
- 2020; end of RP2 and
- 2025.

For each horizon, we present:

- the net present value (NPV) of the direct user benefits - the savings in delays and flight-efficiency gains;
- the net present value (NPV) of the ANSPs' cash flow; and
- the sum of these - the NPV of the project as a whole.

	Direct benefits (NPV)	NPV of ANSPs' cash flow	Project NPV
2014	€ 109m	€ -9m	€ 100m
2020	€ 439m	€ 10m	€ 449m
2025	€ 696m	€ 35m	€ 732m

Table 7.2: Net Present Value of the "with FABEC-Case"

It has to be noted that the distinction between the NPV of direct benefits and indirect benefits (ANSP cost savings) is not 100% correct, because ANSP costs necessary for implementation of for instance AD projects, are included in the direct benefits NPV above. They would decrease the ANSP cash flow NPV, if put in the ANSP cost category.

7.6 Comparison with the results of the Feasibility Study

These results of the FAEBC Implementation CBA seem to be rather small compared to the results of the Feasibility Study CBA shown in

Table 7.3, and it does not matter in which year (2014, 2020 or 2025) a comparison is made.

	Direct benefits (NPV)	NPV of ANSPs' cash flow	Project NPV
2014	€ 376m	€ 195m	€ 571m
2020	€ 3,147m	€ 685m	€ 3,832m
2025	€ 6,196m	€ 1,099m	€ 7,295m

Table 7.3: Present value of FAB initiatives Feasibility Study CBA

In 2025 the overall project NPV reaches around 10% of the value in the Feasibility Study.

One reason for this huge deviation between the figures lies in the changes in the reference case forecast which happened between 2008 and 2011. Especially the traffic forecast, the capacity development and the evolution in flight efficiency show rather big differences. The traffic forecast is much lower than 3 years ago, and the forecasted capacity results in far better delay figures than in the Feasibility Study anticipated. In regard to the capacity figures, AFG/PMG assumes that in the Feasibility Study all national measures improving the local capacity were neglected. This led together with the high traffic increase to unrealistic delay figures in the reference case. This error does not occur again in this CBA. The capacity figures given by the ANSP show a picture rather the other way round: The forecasted capacity improvements are nearly in line with the increase in demand, so that in regard to capacity FABEC improvements are not really needed. This leads to capacity benefits in this CBA between € 13m and € 6m per year compared to estimated benefits in the Feasibility Study of more than € 1,400m in 2025.

8 RESULTS OF THE PERFORMANCE ANALYSIS

The FAB initiatives have an impact on the following performance areas:

- flight-efficiency (which, of course, also affects the environmental impact);
- delay per flight; and
- financial cost-effectiveness.

Following the method used in the reference case we have encapsulated these three impacts in a single "economic cost-effectiveness" indicator. This includes the cost to users of flight inefficiency and delay.

8.1 Flight efficiency

In this analysis the analysis is focused on horizontal flight-efficiency. Whilst there are benefits from improving vertical flight profiles within the FABEC airspace these are not currently included. This is due to the difficulty of analysing the vertical flight-efficiency and the impact that the FAB may have on it. The above used workaround to show the monetary effects of improvements in vertical flight efficiency by using the value of saved fuel is not used in this analysis.

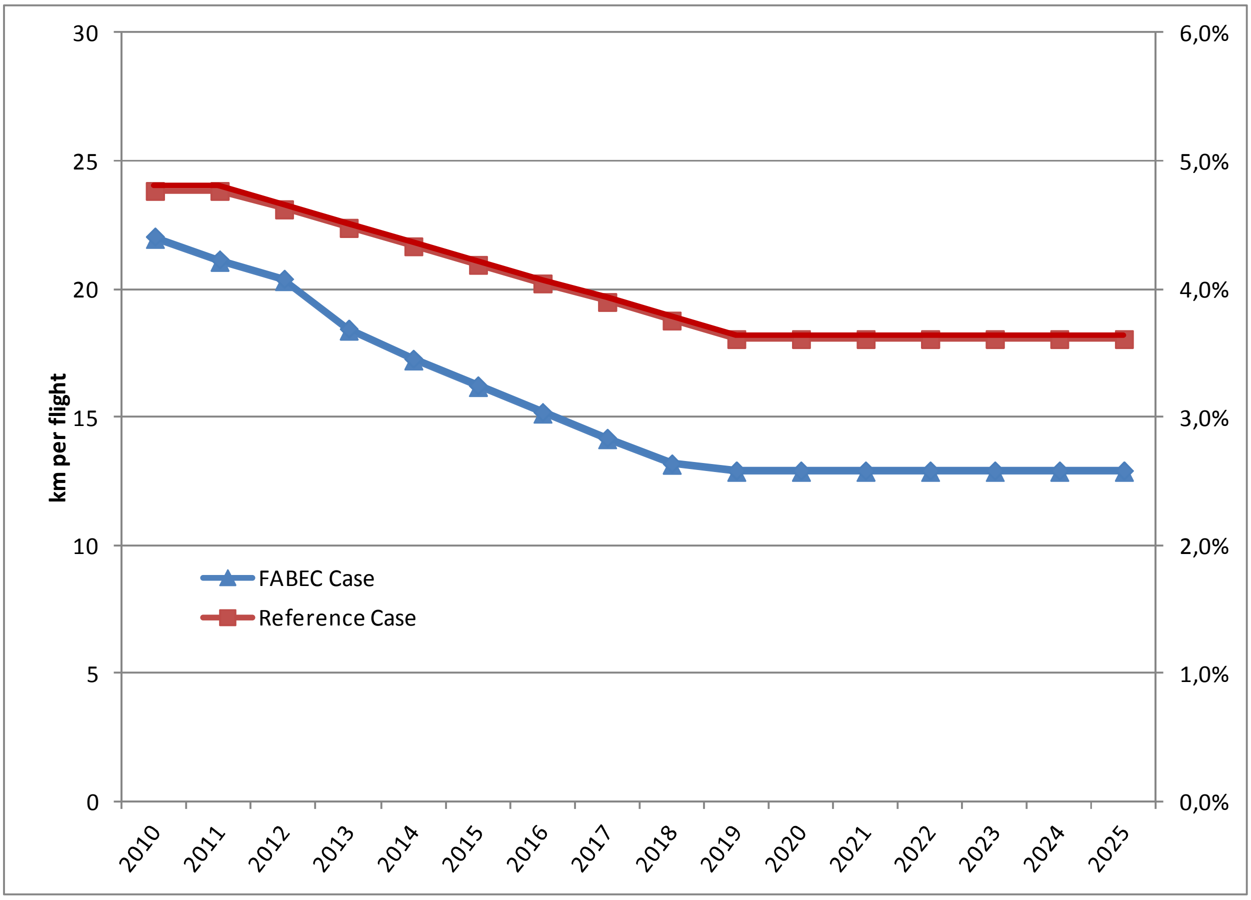

Figure 8.1: Improvements in horizontal flight efficiency

8.2 Delay per flight

The benefits in terms of reduced delay per flight arising from the increase in capacity are presented in chapter 7.3.1.

8.3 Financial cost effectiveness

Figure 5.15 showed how, in the reference case, the performance of FAEBC in terms of financial cost-effectiveness was expected to improve over the period. Figure 8.2 shows the corresponding financial cost-effectiveness performance once all FABEC initiatives, known today have been taken into account. It shows at the moment, that they do not bring any visible contribution in improving the financial cost-effectiveness any further.

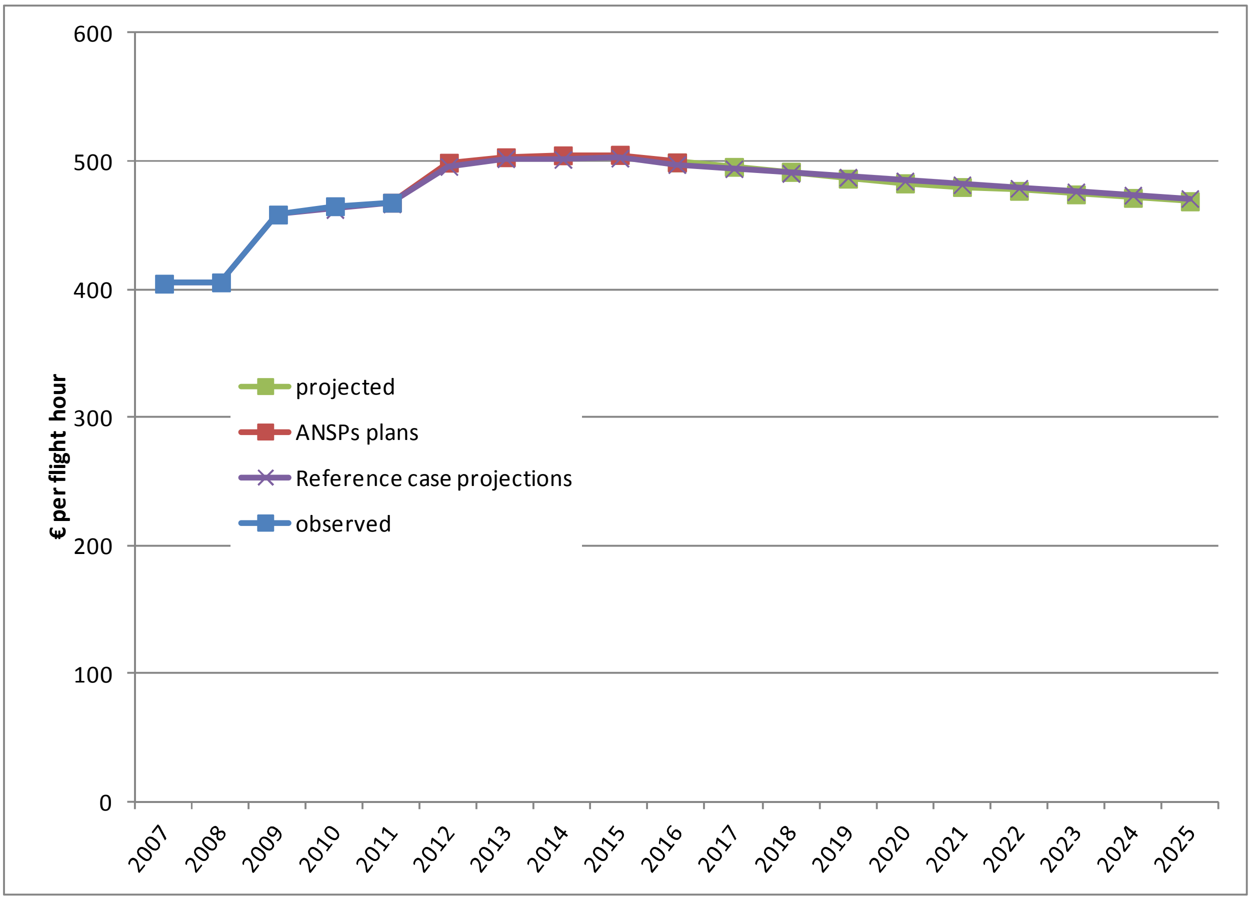

Figure 8.2: Financial cost effectiveness, with and without FABEC

Figure 8.2 shows clearly, that other measures, additionally to the projects/initiatives described in this document are necessary to provide further improvements in the cost effectiveness after 2012 (see chapter 7.2).

8.4 Economic cost effectiveness

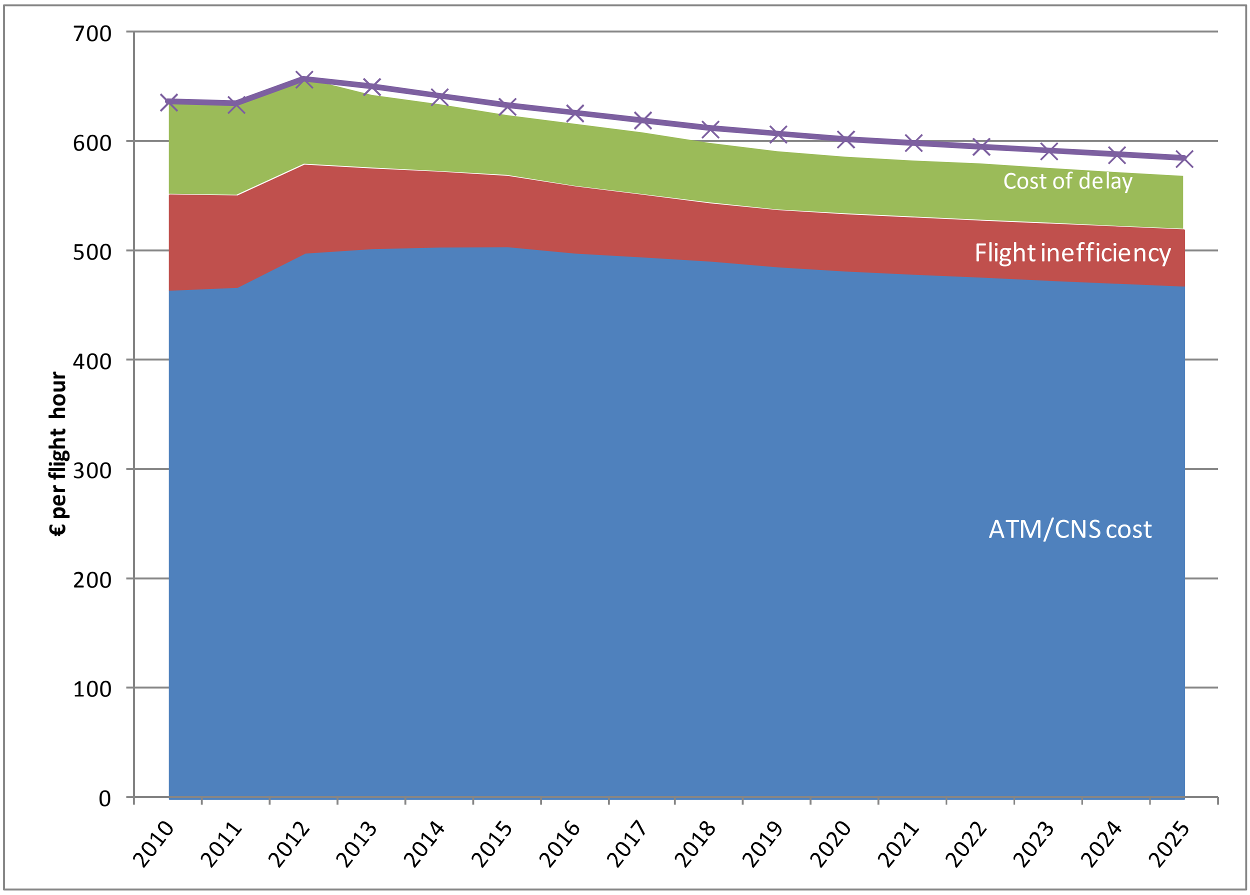

Figure 8.3: Economic cost-effectiveness indicator, with and without FABEC

Due to the relatively low savings especially in the capacity area and the negligible ANSP cost reductions the FABEC economic cost effectiveness is only marginally lower than in the reference case. The delta lies at minus 17€ per flight in 2025 which equals around 3% reduction.

8.5 Comparison with the performance targets

In this chapter an analysis shall be made, if and in what extent the described FABEC initiatives contribute in achieving the different performance targets as they are described in chapter 4.10.

8.5.1 <u>Delay per flight</u>

In the Feasibility Study improvements in capacity were the main drivers to reach the high level for the NPV. Comparing the levels of delay in the reference case in the Feasibility Study and the reference case in this IP CBA, it is obvious that possible capacity improvements reached by ongoing FABEC initiatives can never play that role. The reference case in this IP CBA shows that the future capacity will be sufficient to maintain a high quality of service for the projected growth in traffic, with delays remaining at an acceptable level consistent with the targets laid down in the FABEC Performance Plan. This is at least valid for RP1, but from the forecasts of the ANSP given to calculate delays for the years after 2014 one can assume, that this conclusion will also be valid for future years. In fact at the moment there is no need for FABEC initiatives contributing to an improvement in this domain.

8.5.2 <u>Flight Efficiency</u>

For flight-efficiency the FABEC initiatives are expected to contribute towards meeting the Feasibility Study target of a cumulated reduction of 10km in the average route extension by 2018. The results of the FABEC study show that a reduction of only 3km at that time could be possible. But taking into account, that the reference case already incorporates a reduction in route extension of about 6km, due to national measures, the target is nearly met.

A second fact to consider is the rather conservative approach chosen to calculate the flight efficiency benefits of the FRA project. As the SAAM simulation only reflects route length reductions within the AoR of each ACC and does not show reductions for a FABEC wide direct routing, an assumption may be valid, that flight efficiency gains will be much higher and will indeed help to reach or even exceed the defined targets.

The increased flight-efficiency brought about by the FABEC initiatives will lead directly to lower emissions, hence reducing the impact of each flight on the environment. In regard to the flight efficiency target laid down in the FABEC Performance Plan for RP1 the national improvements in the reference case are already sufficient to reach the target. The gains reached by the FABEC initiative only help to exceed this target and make sure that future targets will also be met.

8.5.3 Financial cost-effectiveness

The FABEC initiatives provide a rather small improvement in financial cost-effectiveness. The reference case, which relies on continuing improvements without the FAB embodies a 2% rise in en-route cost per flight-hour by 2025. The FAB projects, added to the improvements expected without FABEC, achieve to reduce this increase to 1% of the ANSPs' en-route cost per flight hour. It is obvious that the ANSPs need to find more initiatives especially delivering cost savings in the middle and long term. It has to be noted, that the cost figures representing the reference case reflect the ANSPs’ plans from 2010, and therefore do not take in account the impact of the national parts of FABEC Performance Plan on cost efficiency on the future ANSPs’ cost figures in 2011.

9 SENSITIVITY ANALYSIS

In this chapter the impact of the uncertainty of the inputs on the overall results is presented. The input parameters for the calculations are often based on assumptions regarding how ATM will evolve without the FAB, in addition to the expert judgement of the project leaders that has been used to identify the benefits each FAB initiative may bring.

The following sections describe the sensitivity of the results to the following factors:

- traffic demand being lower than anticipated;
- uncertainty in the benefits of the operational and technical initiatives;
- the impact of the discount rate on the NPV;
- higher and lower cost figures in the reference case;
- different capacity figures / delay calculation methods.

9.1 Low traffic growth scenario

The still rising price of crude oil is expected to put furthermore financial pressure on the airline industry and its customers, which will add to that arising from pressure to reduce emissions. Additionally the economic crisis especially in Europe, which impact is still not foreseeable will force the airlines to reduce their flights even farther. In this chapter therefore the impact of growth of traffic demand being lower than has so far been anticipated in the analysis is analysed. As a lower traffic growth scenario the same STATFOR MTF from February 2012 is used but in this case the Low scenario. The years after 2018 have been extrapolated.

This low traffic growth scenario expects traffic to increase by on average 1% per year until 2015, depending on the area observed. After 2015 it expects a traffic growth of 1.5% per year. This is compared with 2% for the higher (Base scenario) traffic demand scenario used so far.

A lower rate of growth in traffic demand is expected to result in reduced delays in the reference case. This, in turn, would enable capacity and ATCO productivity gains to contribute to ANSP cost savings earlier, and it could be expected to shift the benefits from delay reduction to ANSP cost savings. As the FABEC projects do not show significant capacity reductions so far, this effect is not visible in this CBA.

For this analysis it is assumed that, despite the lower rate of traffic demand, ANSPs will still implement the capacity improvements that are anticipated throughout the time horizon of the analysis.

For the low traffic growth scenario the following parameters are presented:

- the delay per flight and unaccommodated demand;
- financial cost-effectiveness;
- economic cost-effectiveness; and
- the project NPV.

The low traffic growth scenario provides an alternative reference case to that of the traffic growth scenario presented in the analysis so far. This, in turn, has an impact on the overall results of the cost-benefit analysis as the improvements of the FAB are assessed from different starting positions.

9.1.1 *Delay per flight and unaccommodated demand*

The lower rate of traffic growth is, in fact, lower than the increases in capacity that are planned for by the ANSPs, both in the LSSIPs and thereafter. Therefore, the reference case delay per flight falls significantly below that which is currently observed, and ends at approximately 0.2 minutes per flight for the time horizon of the analysis. This is due to the large capacity increases that are foreseen in the LSSIPs from 2011-2015 and thereafter.

It was assumed, as previously noted, that ANSPs would continue to implement the capacity enhancing measures foreseen in the LSSIPs and thereafter. Such an assumption may not be realistic, but it has not been possible to identify an alternative capacity improvement profile that would be implemented in the event of lower than anticipated traffic growth.

Because of the ever lower level of ATFM delay in the new reference case there is no direct benefit to the users in terms of delay reduction due to the FAB initiatives.

9.1.2 *Financial cost-effectiveness*

Table 9.1 compares the financial cost-effectiveness (Euros per flight-hour) for the low traffic growth scenario with the results presented in Chapter 8.3. The reference case is also affected by the traffic growth scenario.

	€ per flight-hour 2020	**€ per flight-hour 2025**
Reference case	485€	471€
With FAB	483€	469€
Reference case - low traffic growth	519€	514€
With FAB - low traffic growth	517€	512€

Table 9.1: Financial cost-effectiveness comparison (traffic growth scenarios)

Table 9.1 shows that, in the reference case, the financial cost-effectiveness of ANS provision would be worse if the low traffic scenario is realised, with a cost of 519€ per flight-hour compared with 485€ per flight-hour for the higher traffic growth scenario in 2020.

In 2025, the increase in financial cost-effectiveness resulting from the FAB initiatives is 0.4% for the low traffic growth scenario. This is the same as in the results presented in Chapters 7 and 8 for the higher traffic growth scenario. This shows again, that capacity improvements are not relevant in the current FABEC environment.

9.1.3 *Economic cost-effectiveness*

Table 9.2 compares the economic cost-effectiveness (Euros per flight-hour) for the low traffic growth scenario with the results presented in Chapters 7 and 8. The reference case for the economic cost-effectiveness is dependent on the traffic growth scenario, and hence both the reference case and the “with-FAB” cases are presented for both traffic growth scenarios.

	€ per flight-hour 2020	€ per flight-hour 2025
Reference case	603€	585€
With FAB	585€	568€
Reference case - Low traffic growth	603€	593€
With FAB - Low traffic growth	587€	576€

Table 9.2: Economic cost-effectiveness comparison (traffic growth scenarios)

The low traffic growth scenario results in a lower economic cost per flight-hour in the reference case. This is because of the low level of delay in the reference case for the low traffic growth scenario. However, for the low traffic growth scenario the “with-FAB” case results in a higher economic cost per flight-hour than compared to the higher traffic growth scenario. This is due to the lower level of traffic growth, which results in fewer flight-hours controlled, and hence higher costs per flight-hour.

9.1.4 Project NPV

Table 9.3 presents the NPV for the FABEC project, for both traffic growth scenarios.

	Direct benefits (PV)	NPV of ANSPs' cash flow	Project NPV
With FAB	€ 696m	€ 35m	€ 732m
With FAB - Low traffic growth	€ 616m	€ 34m	€ 650m

Table 9.3: Project NPV for the traffic growth scenarios

The project NPV is sensitive to the traffic demand, and is considerably lower for the low traffic growth scenario. This is mainly because of the low level of delay that is predicted for the reference case. Whilst this does not result in greater cost savings for ANSPs, nothing offsets the reduction in the delay benefits.

9.2 High and low benefit sensitivity tests

We have analysed the impact of the ranges of benefits provided by the different projects/Task Forces. To examine the impact of partly high uncertainty in the input values we have analysed two sensitivity tests:

- one with high benefits; and
- one with low benefits.

High benefits were defined as 10% higher than from the projects/Task Forces delivered. For the low value we reduced the figures received by 10%. This analysis covers for instance the price volatility of the fuel price.

	Direct benefits (PV)	NPV of ANSPs' cash flow	Project NPV
Benefits 10% higher	€ 767m	€ 45m	€ 812m
Benefits as received	€ 696m	€ 36m	€ 732m
Benefits 10% lower	€ 613m	€ 23m	€ 636m

Table 9.4: Impact of benefits variation

This sensitivity analysis shows that the NPV is rather robust to a variation of the level of benefits. Even a reduction of the benefits by 25% result in a NPV of € 504m in 2025. It can be concluded, the the NPV shows a rather low dependency on a variation of the level of benefis, as the highest benefits can be found at the end of the relevant timeframe with a high absolut discount.

9.3 Impact of the Discount Rate on the NPV

The impact of the discount rate on the cost-benefit analysis was also analysed. Table 9.5 presents the results of the CBA in 2025 assuming a discount rate of 4%, 6 % (used in the CBA above) and 8%.

	Direct benefits (PV)	NPV of ANSPs' cash flow	Project NPV
4%	€ 820m	€ 44m	€ 864m
6%	€ 696m	€ 36m	€ 732m
8%	€ 585m	€ 26m	€ 611m

Table 9.5: Impact of discount rate on NPV

The results of this sensitivity analysis show that whilst the results of the cost-benefit analysis are sensitive to the discount rate, the NPV is positive in each case.

9.4 Higher and lower cost figures in the reference case

SC FIN made the proposal to analyse which influence the medium term cost planning of the participating ANSP in the reference case has. The cost figures used in the CBA model represent the ANSP plans from 2010. This means, that the current developments especially in regard to the FABEC Performance Plan which was developed in 2011 are not really reflected in the model.

Changes in the cost planning figures in the CBA-model showed that the NPV does not change as long as any change in the cost figures is valid both for the reference case and for the "with-FABEC"-case. At the moment no influence of the new cost planning shown in the FBAEC Performance Plan on any FABEC initiative can be detected.

9.5 Reflection of different capacity figures/ delay calculation methods

In chapter 5.5.2 is explained, that the delay model used in this CBA does not reflect every development in current capacity/delay figures. As stated this model shows in comparison to the Bottom-Up model used for the FPP target figures rather to high delay values. Therefore PMG proposed to analyse which impact lower delay figures in the reference case have on the NPV.

At the moment only one FABEC initiative has a positive impact on the capacity figures in the "with-FABEC"-case. In the case of lower delay figures in the reference case it has to be analysed if the financial impact of reductions in delay coming from this initiative (AMRUFRA) would be lower than in the current case, calculated in the delay model.

A reduction of the delay in the reference case showed that this has no influence on the NPV, because even with lower delay figures the AMRUFRA initiative benefits are not sufficient to reach the level of overcapacity in the relevant sectors in the Langen ACC. As a consequence the level of financial benefits stays the same.

10 CONCLUSIONS

10.1 Formal requirement from the FAB IR

The FABEC IP CBA clearly shows that the implementation of FABEC has an overall added value. The NPV in the given time frame until 2025 is between around € 500m and € 900m, with the most likely NPV being in the region of € 730m. This leads to the conclusion that

the formal requirement from the FAB Implementing Rule to show an overall added value by delivering a positive NPV is met.

The sensitivity analysis has shown that this conclusion is especially in the case of lower traffic and significantly lower benefits still valid. It has shown that whilst the results are sensitive to the input parameters, the cost-benefit analysis remains positive in all cases.

The results of the FABEC cost-benefit analysis show that there are considerable benefits from the FAB initiatives in comparison to the reference (“without-FAB”) case. The major benefits of the FABEC initiatives arise from the improvements in flight-efficiency. These benefits, especially reached by the introduction of a new free route airspace will also help to reduce the impact of the increase in traffic levels on the environment by reducing the distance flown in excess of the shortest route distance.

FABEC initiatives were not able to reach significant benefits in the field of delay reduction through capacity improvement, as the participating ANSP already put huge effort in coping with the demand on a national basis, leaving no room for extra benefits from FABEC initiatives.

10.2 Development between the FS CBA (2008) and the IP CBA (2011)

10.2.1 Traffic and Capacity forecast

Before assessing the results of this FABEC IP CBA with the results of the Feasibility Study CBA the assumptions of 2008 should be analyzed. Especially the factors chosen for the sensitivity analysis in 2008 give could give an indication, where the main differences between 2006 (last year of observed data in Feasibility Study) and 2010 may lie.

The following factors were analyzed in the Feasibility Study CBA

1. Ability of ANSPs to provide capacity growth after 2012
2. Traffic growth
3. Uncertainty in benefits of OPS & TECH initiatives
4. Impact of ATFM delay target on NPV
5. Impact of discount rate on NPV

In the analysis of the first factor capacity growth together with the second factor traffic growth the authors made the following statement: “The results are most sensitive to the level of delay which is generated in the reference case: lower demand growth will result in lower delays and hence lower net benefits”. The result of the sensitivity analysis for different traffic growth shows this.

In the Feasibility Study CBA the calculation was based on a high growth scenario leading to a NPV of € 7,295m in 2025. This NPV decreased in a low traffic growth scenario to only € 3,590m (2025). Taking into account the undoubtedly lower traffic figures today and the also lower forecast this is one of the main factors leading to the lower NPV in the current IP CBA.

Not only the traffic forecast but also the forecast of the ANSP to deliver sufficient capacity has an impact on the level of delay. By comparing the developments of 2006 with the current figures it is obvious that on national/ANSP level great efforts were made to improve the level of delay. This also decreases the level of benefits which could be reached by delay reductions.

10.2.2 *The FSR Initiatives and their status in the Implementation Phase*

OPS-initiatives

The Airspace Design Projects (in the Feasibility Study also described as Hot Spots) were planned to be implemented by 2013. The current status is as follows:

- The EIPs (CityPairs, NightNetwork and AMRUFRA) were successfully implemented. CP and NN are even extended (see 6.2.1).
- The AD Project South-East plans an implementation in the first quarter 2014. It has a positive NPV, but has still a high risk (see 6.2.2.1).
- The AD project West II shall be implemented in the first quarter 2013. It shows also a positive NPV, but has also a high risk (see 6.2.2.2).
- CBA-L/CW: This project is in the design phase, which means that no performance data is available yet (see 6.2.2.3).
- The AD project LUX is also in the design Phase. For this project performance data are also not available today (see 6.2.2.4).

The second main topic in the Feasibility Study CBA was a new operational concept including a FAB ATFCM/ASM function planned for 2013 until 2018.

- In regard to the FAB ATFCM/ASM function a Life Trial was done. The Life Trail report is expected for the first quarter of 2012. Hence no performance data is available at the moment (see 6.2.3).
- The new airspace strategy started in 2012 with the definition of the FRA and the XMAN projects. These projects include also some common operational concepts. The relevant performance data is available and is included in this CBA (see 6.2.6).

The realization of Common contingency concepts, included in the Feasibility Study, has not been started yet.

Improved cooperation in MET Services and AIS Services are not realized yet. At the moment extended AIS cooperation is only used as a support for the AD projects.

TECH-initiatives

In the Feasibility Study two fields of improvement in the technical domain were identified and filled with certain cooperation projects.

In regard to the necessary ATM infrastructure and the related technical support only one project has been partially realized yet. The use of OLDI message in the approach phase is implemented at the airports of Amsterdam and Brussels. All other envisaged ATM projects very either not be started or stopped at a certain moment. The reasons for this lie mostly in the fact that all ANSP are in different investment cycles. This hampers the introduction of common systems in the relevant timeframe until 2025.

For the CNS infrastructure and the related technical support projects found during the Feasibility Study were either already started in the Implementation phase of FABEC or were included in the overall CNS services Business Case (see 6.3.6).

Training initiatives

In the Feasibility Study benefits in regard to a common training and qualification were envisaged. Some of these benefits were shown in a business case prepared by the Training TF. This business case was the basis of a CBA incorporated in this FABEC IP CBA (see 6.4.1)

The Cooperation model for IP

In the Feasibility Study it was assumed that the implementation of FABEC would be done under a so called “Alliance Model”. This institutional model foresees one or more joint Common Executive Bodies installed to promote the implementation of FABEC projects. A so called “Contractual Model” was considered in the Feasibility Study a as having high risk in terms of implementation cost (high) and timescales (long) because it is based on extensive consultation between the participating ANSPs.

At the moment the Implementation Phase is done with the “Contractual Model”.

A LIST OF GENERAL PARAMETERS USED IN CALCULATION

Parameter	Value
Staff costs per day	700€
Mission costs per meeting	500€
Delay Cost	81.3€ per minute
Fuel Cost	0.71€ per kg
Cost per IFR km flown	3.94€
Cost of unaccommodated flight	700€
Discount rate	6%
Avg. ATCO working hours per year	1,334
Lifetime of assets (depreciation)	12 years
FABEC flight inefficiency 2010	4.5%
Annual improvement of flight efficiency in reference case	0,15%
Delay per flight optimum	0.3 min

B ACRONYMS

ACC	Air Traffic Control Center
ACE	ANSP Cost Efficiency
ACSP	Air Communication Service Provider
AD	Airspace Design
AFG	ANSP FABEC Group
AGDL	Air-Ground Data Link
AIS	Aeronautical Information Services
AMC	Airspace Management Cell
AMRUFRA	AMsterdamRUhrFRAnkfurt
ANA LUX	Administration de la Navigation Aérienne Luxembourg
ANS	Air Navigation Services
ANSP	Air Navigation Service Provider
AOC	Airline Operational Control
APP	Approach Control Service
ARKON	Navigational Point
ASB	ANSP Supervisory Board
ASM	Airspace Management
ANSCB	ANS Consultative Board
ATCO	Air Traffic Controller
ATFCM	Air Traffic Flow and Capacity Management
ATM	Air Traffic Management
ATN	Aeronautical Telecommunication Network
ATSEP	Air Traffic Safety Electronics Personnel
BAF	Belgian Air Force
CATS	Common ARTAS Tracker Services
CBA	Cost Benefit Analysis
CBA	Cross Border Area
CBP	Commodity Business Plan
CDG	Charles-De-Gaule (Airport Paris)
CDM (A-CDM)	(Airport-)Collaborative Decision-Making
CDO	Continuous Descent Operations
CEO	Chief Executive Officer

CFMU	Central Flow Management Unit
CNS	Communications, Navigation and Surveillance
COM	Communication
CONOPS	Concept of Operations
DFS	Deutsche Flugsicherung GmbH
DGCA	Director General Civil Aviation
DIK	Navigational Point Diekirch
DIRCAM	Direction de la Circulation Aérienne Militaire
DMAN	Departure Manager
DNM	Directorate Network Management Eurocontrol
DPE	Navigational Point Dieppe
DSNA	Direction des Services de la Navigation Aérienne
DVR	Navigational Point Dover
EAT	Expected Approach Time
EEC	Eurocontrol Experimental Center (Brétigny)
EGLF	Farnborough Airport
EIP	Early Implementation Package
EMAN	Enroute Manager
ENAC	École Nationale de l'Aviation Civile
EOBT	Estimated Off Block Time
FAA	Federal Aviation Administration
FABF	FAB Function
FAPTI	FABEC Advisory Process for Technical Investments
FINE	FABEC IP NEtwork
FMP	Flow Management Position
FMTP	Flight Message Transfer Protocol
pFPC	(provisional)Financial and Performance Comitee
FPP	FABEC Performance Plan
FPSG	FABEC Project Steering Group
FRA	Free Route Airspace
FRAK	Free Route Airspace Karlsruhe
FRAM	Free Route Airspace Maastricht
FRV	Free Route Airspace Volume
FSR	Feasibility Study Report

GAF	German Air Force
GAT	General Air Traffic
HLIB	High Level Implementation Board
HQ	Headquarter
IFR	Instrument Flight Rules
IOP	Interoperability
IP	Internet Protocoll
IR	Implementation Rule
KOK	Navigational Point Koksijde
KPI	Key Performance Indicator
LSSIP	Local Single Sky ImPlementation
LVNL	Luchtverkeersleiding Nederland
MET	Meteoroloy
MTCD	Medium Term Conflict Detection
MUAC	Maastricht Upper Area Controlcenter
NATS	National Air Traffic Services
NDA	Network Delay Attribution
NM	Nautical Miles
NN WG	Night Network Working Group
NPV	Net Present Value
NSA	National Supervisory Agency
NTM	Navigational Point Nattenheim
OLDI	Online Data Interchange
OWO	Operational Working Office
PCPC	Potential Common Procurement Candidates
PI	Performance Indicator
PMG	Performance Management Group
PMS TE NE	Point Merge System Terminal Extended North-East
PRTS	Prototype Real Time Simulation
PRU	Performance Review Unit
RAT	Risk Analysis Tool
RKN	Navigational Point Rekken
RNLAF	Royal Netherlands Air Force
RP1	First Regulation Period

RTS	Real Time Simulation
SAAM	System for Air Traffic Assignment at Macroscopic level
SAF	Swiss Air Force
SC ENV	Standing Commitee Environment
SC FIN	Standing Commitee Finance
SC HRT	Standing Commitee Human Ressources, Training
SC IRL	Standing Commitee Institutional, Regulatory, Legal
SC OPS	Standing Commitee Operations
SC SAF	Standing Commitee Safety
SC TECH	Technical Standing Commitee
SES	Single European Sky
SESAR	Single European Sky ATM Research
STAM	Short Term ATFCM Measures
STATFOR	Eurocontrol Statistics &Forecasts Service
SUR	Surveillance
SWIM	System Wide Information Management
TEN-T	Trans-European Network - Transport
TF	Task Force
TMA	Terminal Area
ToR	Terms of Reference
TRA	Temporary Restricted Area
TRA	Navigational Point Trasadingen
TSA	Temporary Segregated Airspace
TWG	Technical Working Group
TWR	Tower
VCS	Voice Communication System
VDL2	VHF Digital Mode 2
XMAN	Extended Arrival Manager

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FABEC Implementation Phase

FRA Cost-Benefit Analysis

EC Information

Attachment R.2

Co-financed by the European Union
Trans-European Transport Network (TEN-T)

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FAB Europe Central

Free Route Airspace
Cost-benefit analysis

Draft Report

Document information

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Executive Summary

Free Route Airspace is a specified airspace within which users may freely plan a route between a defined entry point and a defined exit point, with the possibility to route via intermediate (published or unpublished) way points, without reference to the ATS route network, subject to airspace availability. Within this airspace, flights remain subject to air traffic control.

FABEC is developing a roadmap for the implementation of Free Route Airspace in the 2012 – 2020+ timeframe. A stepped implementation is foreseen, where FABEC ACCs will develop and implement Free Route Airspace cross border and FABEC wide.

The aim is to give users opportunities to improve the efficiency of plannable direct routes and preferred trajectories within FABEC airspace and between FABEC and neighbouring FABs.

Free Route Airspace is an important part of the FABEC airspace strategy, and is expected to be a major contributing factor to the overall added value of FABEC. A cost-benefit analysis is therefore required to examine the costs and benefits of FRA implementation within FABEC, in order to show the overall benefits of the project and its impact on performance.

The three steps of FRA aim at a gradual implementation of FRA within FABEC airspace. The idea is that implementation of FRA can progress in parallel in different parts of FABEC, but should be harmonized and defined in such a way that it can be integrated as much and as soon as possible.

The initial focus is FRA implementation in the upper airspace; implementation in the lower airspace is foreseen for certain centres where operationally feasible and beneficial. The three steps are:

- Step 1: Implementation of direct connections in a defined airspace outside military activity.
- Step 2: Permanent (H24/7) implementation of direct connections in a defined airspace with active military areas, supported by implementation of advanced FUA.
- Step 3: Introduction of Business trajectories (using SESAR deliverables).

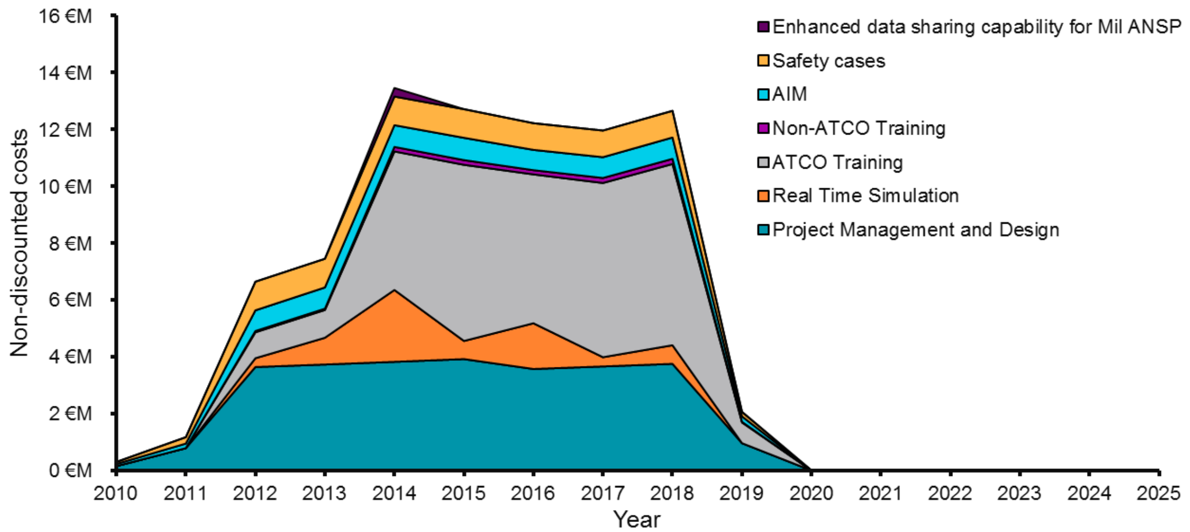
The final goal is a FABEC-wide full Free Route concept, as defined in the FABEC Free Route Concept of Operations.

The main costs of FRA implementation are incurred by the FABEC ANSPs. The costs include:

- Project management and development;
- Concept validation (real-time simulations);
- ATCO training;
- Non-ATCO training (flight data staff);
- Aeronautical information management;
- Safety cases.

The military ANSPs also incur costs for adapting technical systems. The CFMU will incur costs related to the development of airspace management and flight planning tools, however these tools are already planned and therefore are not additional costs for the CBA. Some airlines may incur costs for new flight planning systems, however these are not included in the CBA. Advanced flexible use of airspace (A-FUA) will be required for enhanced civil-military coordination. We assume no additional costs for the CBA.

The annual costs of FRA implementation for the FABEC ANSPs are shown below.

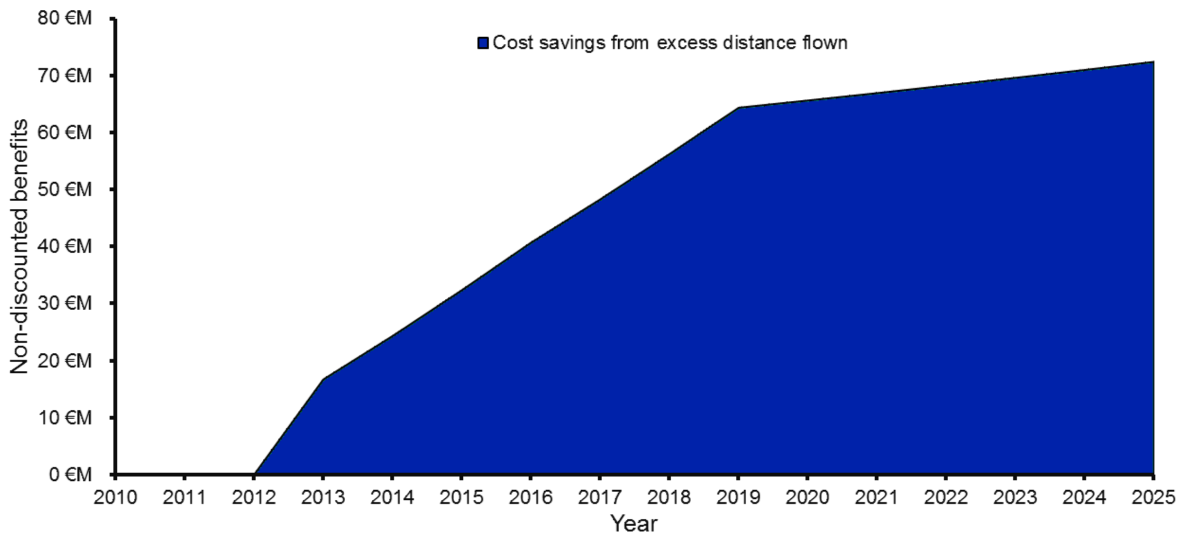


FRA allows airspace users to fly direct routes, thus reducing flight distance flown, with consequent savings in fuel and other direct operating costs. There are environmental benefits from savings in CO_2 emissions.

Furthermore, airlines have an added benefit of predictability from direct routes through FRA. Currently, direct routes are offered tactically and therefore airlines plan for sufficient fuel to fly the route as specified in the flight plan. With FRA, the airline has advance information that it will fly on the direct route and therefore it does not need to carry additional fuel for contingency. For airline operators, having improved predictability for a flight will enable aircraft turnarounds and crew management to be optimised. For air traffic control, improved predictability will result in fewer disruptions to planned traffic flows and fewer aircraft having to hold.

Capacity benefits are expected since reduced average transit times should result in an increase in capacity. Capacity benefits may also be due to a reduced number of conflicts, fewer redirects, and the resulting impact on controller tools. Conversely, conflicts may become more complex and other choke points may emerge. The overall impact of FRA on sector capacity cannot be determined without simulations. The SAAM model used to analyse benefits does not currently have the capability to evaluate the impact on capacity, and therefore this has not been quantified for the report. Simulations to evaluate capacity are however planned for later in 2012.

The quantified benefits from excess route distance saved are presented below.



The resultant environmental benefits are around 56,000 tonnes of CO_2 emissions saved in 2013, increasing to 244,000 tonnes saved in 2025.

The present value of costs, benefits and the project NPV are shown below. The project has an NPV of €332m over the period 2010 to 2025.

	CBA results
Costs (PV)	€59m
Benefits (PV)	€392m
NPV	**€332m**

A number of sensitivity tests were undertaken to show the impact of changes in key parameters on the project NPV. These are summarised below.

Sensitivity test	**Project NPV = €332m**		
		NPV	**∆NPV**
Traffic	Lower traffic scenario	€136m	-€196m
Delay to benefits	Delay of 3 years	€275m	-€57m
	Delay of 5 years	€214m	-€118m
FRA implementation costs	Increase of 50%	€302m	-€30m
	Increase of 100%	€273m	-€59m
Costs of distance flown	Low case (€5.20 per NM)	€219m	-€113m
Airline adoption	Scenario 1 (30%-100%)	€267m	-€65m
	Scenario 2 (15%-50%)	€104m	-€228m

The cost-benefit analysis of the FABEC FRA shows a positive NPV of €332m over the project lifetime. The benefits are largely fuel and other direct operating cost savings to airspace users from the saved route distance from offering direct routes. The sensitivity analyses show that even with the most pessimistic scenarios of low traffic, delayed benefits, higher costs, low airline adoption and a low cost of distance flown, the NPV of the project remains positive.

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1 INTRODUCTION

This document presents the cost-benefit analysis of the FAB Europe Central (FABEC) Free Route Airspace concept.

1.1 Free Route Airspace

Free Route Airspace is a specified airspace within which users may freely plan a route between a defined entry point and a defined exit point, with the possibility to route via intermediate (published or unpublished) way points, without reference to the ATS route network, subject to airspace availability. Within this airspace, flights remain subject to air traffic control.

FABEC is developing a roadmap for the implementation of Free Route Airspace in the 2012 – 2020+ timeframe. A stepped implementation is foreseen, where FABEC ACCs will develop and implement Free Route Airspace cross-border and FABEC-wide.

The aim is to give users opportunities to improve the efficiency of plannable direct routes and preferred trajectories within FABEC airspace and between FABEC and neighbouring FABs.

1.2 Objective

Free Route Airspace is an important part of the FABEC airspace strategy, and is expected to be a major contributing factor to the overall added value of FABEC. A cost-benefit analysis is therefore required to examine the costs and benefits of FRA implementation within FABEC, in order to show the overall benefits of the project and its impact on performance.

1.3 Report structure

The report is organised as follows:

- Section 2 describes the Free Route Airspace concept and roadmap for FABEC.
- Section 3 describes the approach and parameters for this cost-benefit analysis.
- Section 4 presents the costs of FRA implementation;
- Section 5 presents the benefits of FRA implementation;
- Section 6 shows the cost-benefit analysis and performance impact;
- Section 7 presents the sensitivity analysis;
- Section 8 summarises the conclusions.

Two annexes are attached to the report to provide further detail.

2 FABEC FREE ROUTE AIRSPACE IMPLEMENTATION

2.1 Context

Free Route Airspace (FRA) initiatives have been planned and implemented for the last three years in several parts of European airspace. Recent initiatives were launched, within the FABEC area, by Maastricht and Karlsruhe ACC.

Following a workshop held in Paris on 8-9 December 2011, a high level roadmap for the stepwise implementation of Free Route Airspace within FABEC has been elaborated with all civil and military ANSPs. FRA forms a key element of the FABEC airspace strategy.

A phased implementation is foreseen, where FABEC ACCs will develop and implement FRA cross-border and FABEC wide. The roadmap defines three implementation steps, which will provide the framework for the harmonised implementation of FRA in FABEC airspace.

2.2 FABEC airspace

The FABEC airspace strategy centres on the introduction of a three volume airspace organisation for all FABEC airspace, based on a common FABEC concept of operations:

- a Free Route Airspace (FRA) volume over the greatest possible FABEC area;
- a transition airspace volume in which the transition from free route to fixed route airspace, and vice versa, will take place, focusing on the harmonised development of airspace to support traffic flows (e.g. arrival and departure management concept and tools) around the Top 5 TMAs (Paris, Frankfurt, Amsterdam, London and Munich);
- a fixed route airspace volume intended to optimise the use of the lower airspace to improve arrival and departure routes.

The FABEC airspace strategy is intended to ensure a better connection between the FABEC airports and the entire European Route Network by using extended arrival manager/ departure manager and including free route initiatives in the FABs surrounding FABEC.

2.3 FRA implementation steps

The three steps of FRA[19] presented below aim at a gradual implementation of FRA within FABEC airspace. The idea is that implementation of FRA can progress in parallel in different parts of FABEC, but should be harmonized and defined in such a way that it can be integrated as much and as soon as possible.

The initial focus is FRA implementation in the upper airspace; implementation in the lower airspace is foreseen for some centres where operationally feasible and beneficial.

2.3.1 *Step 1: Implementation of direct connections in a defined airspace outside military activity*

- Night
  - Extended night
  - Extension of current night network and/or creation of new direct connections

[19] Source: FABEC Free Route roadmap v1.0, 12 January 2012.

- Week-end
- Cross-border when possible between ATC units within FABEC or with adjacent FABs
- FABEC-wide (direct connections with entry and exit points on the boundary of the area of responsibility of FABEC).

Diverse combinations of the above can be envisaged.

2.3.2 *Step 2: Permanent (H24/7) implementation of direct connections in a defined airspace with active military areas, supported by implementation of advanced FUA*

Step 2a: Within ATC units.

Step 2b: Cross border when possible between ATC units within FABEC or with adjacent FABs.

Step 2c: FABEC wide (direct connections with entry and exit points on the boundary of the area of responsibility of FABEC).

2.3.3 *Step 3: Introduction of business trajectories (using SESAR deliverables)*

Step 3 is not fully defined at this point. The intention is that FRA will allow users to fly business trajectories. The use of business trajectories is determined by the individual strategies of the airlines. Airlines will take into account a number of factors, such as time, route charges, weather, and delay to determine the optimum trajectory for a flight.

2.3.4 *Final Goal: FABEC wide Full Free Route concept, as defined in the FABEC Free Route Concept of Operations*

This should be the achievement of the concept, as it should allow the users to plan their preferred routes, regardless of published points. It takes place in an environment where new technology and new tools are available, with a strong collaboration with the SESAR programme.

2.4 Implementation at ATC units

The figure below shows FRA implementation at individual FABEC ATC units19.

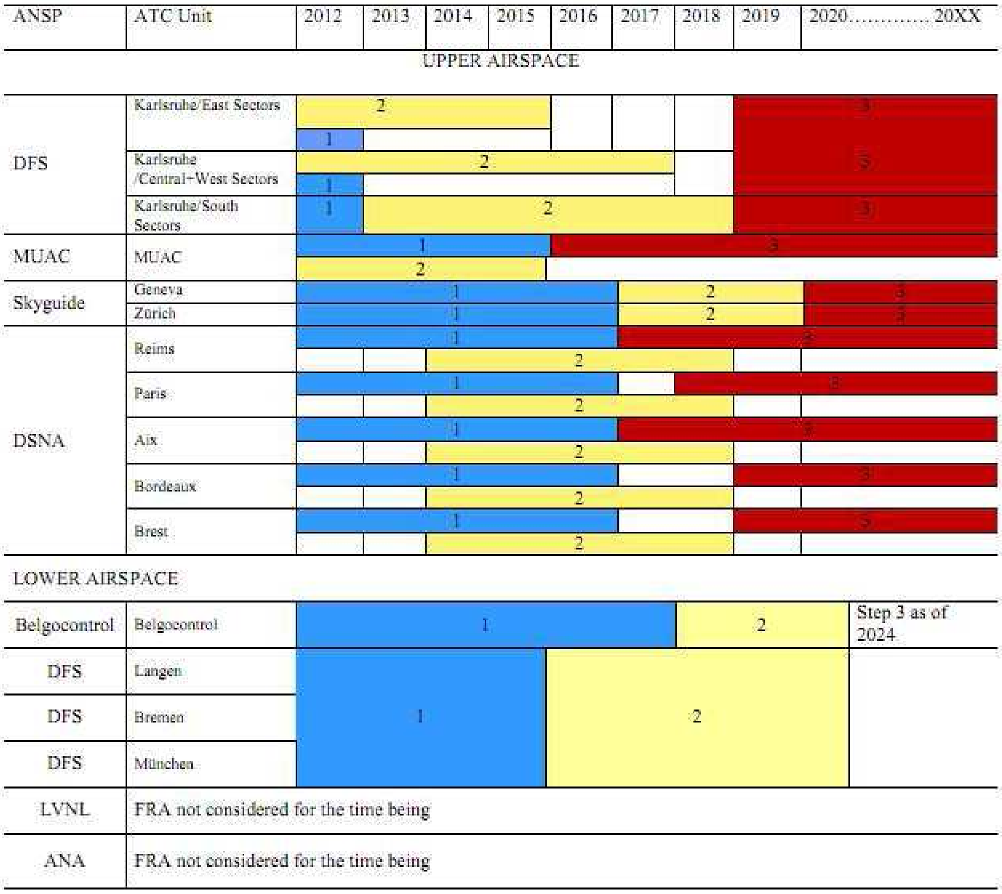

Figure 2-1: FRA implementation at FABEC ATC units

Initially, the roadmap focuses on the implementation of FRA in the upper airspace. FRA implementation in the upper airspace involves Karlsruhe, Maastricht, two centres in Switzerland (Geneva, Zurich), and five centres in DSNA (Reims, Paris, Aix, Bordeaux, Brest). The implementation steps for each centre are described below.

2.4.1 DFS

Karlsruhe: step 1 consists of Night Network development only.

East sectors: step 2 FL 285+ (above Bremen FIR) and FL 315+ (above Munich FIR)

Central + West sectors: step 2 FL 245+

South sectors: step 2 FL 315+

2.4.2 MUAC

Step 1 FL 245+: first initiatives in 2011, towards full implementation in 2015. Main milestones are:

- 2011: MUAC wide application at night and (as of December) weekends with approx. 140 new direct routes;
- 2014: Introducing dynamic sectorisation to optimise capacity with respect to the new flows;
- 2015: full application of direct routing.

Step 2 FL 245+: First initiatives in 2012, towards full implementation in 2015.

Step 3 FL 245+: Depending on deliverables of SESAR.

2.4.3 *Skyguide*

Step 1 FL 245+: Weekend, extended night.

Step 2 FL 365+.

2.4.4 *DSNA*

Step 1: Night network FL 245+ at first, extended night FL 375+ from 2013 and WE FL 375+ at the end of step 1.

Step 2: FL 375+, and above a lower DFL in some parts of the airspace of Marseille, Brest and Bordeaux ACCs, wherever possible. First initiatives of step 2 in 2014, towards full implementation in 2018.

Step 3: planned 2017 in Reims and Marseille, 2018 in Paris and 2019 in Brest and Bordeaux (after the implementation of Coflight).

2.4.5 *Other centres*

Implementation of FRA in the lower airspace is foreseen for other centres and where operationally feasible and beneficial. These include Belgocontrol, DFS's other centres (Langen, Munich, Bremen). LVNL and ANA Luxembourg are not included in the roadmap for now.

3 APPROACH AND PARAMETERS

This section describes the approach in undertaking the cost-benefit analysis and presents the reference case and the key parameters for the cost-benefit analysis. Assumptions regarding the costs and benefits of FRA are presented in later sections of the report.

3.1 Methodology

The approach to the cost-benefit analysis is summarised below:

- **Kick-off workshop with operational, technical and financial experts from FABEC:** The study was initiated with a discussion with FABEC experts on the status of FRA in FABEC, how the implementation of FRA was foreseen across the FABEC ANSPs and the associated timescales. An initial brainstorm was undertaken on the main costs and benefits for the FABEC ANSPs and other stakeholders of introducing FRA in FABEC.

- **Review of existing work related to FRA:** MUAC and Karlsruhe have already started the development of the FRA concept in their ATC units. FABEC has already developed the concept of operations and roadmap for the implementation of FRA. A performance analysis of the FRA in FABEC was carried out by Eurocontrol in January 2012. FABEC provided detailed information through a FRA questionnaire. We reviewed the existing literature on FRA provided by FABEC, which is listed below:

  - FABEC Implementation Phase, FABEC Free Route Airspace, Performance indication;
  - FABEC Implementation Phase, FABEC Free Route Airspace, Roadmap;
  - FABEC Implementation Phase, FABEC Free Route Airspace, Concept of Operations;
  - Response to FRA CBA study questionnaire;
  - Free Route Airspace MUAC (FRAM) Roadmap 2011+;
  - FRAM Cost-benefit analysis;
  - MUAC and KUAC data;
  - SJU WP7 Dynamic Route Structure, Early Project, Final Report;
  - D451C – Part 3 – RTS3 Ground Human Factors in Free Routing (A1) Simulation Trials, Mediterranean Free Flight Programme.

- **CBA assumptions development:** Following our literature review and discussion with FABEC, we elaborated the main assumptions for the CBA. These covered the scope of the CBA, identified the different categories of costs and benefits that would be quantified and the approach used to quantify each; The assumptions were reviewed by FABEC and updated to take account of further input from the ANSPs.

- **Report:** Following analysis by FABEC, the CBA results were reviewed and the draft and final CBA reports were produced.

3.2 Reference case

A key part of any CBA is elaboration of the reference case. The reference case describes the baseline or “do-nothing” case, to which the benefits of the project are compared. In this case it would describe the situation if the FRA project did not go ahead in FABEC.

The reference year is taken as 2010. The performance analysis, undertaken by Eurocontrol, assumes that the reference case includes the current route network, the night network and city pairs. Although the performance analysis appears to indicate that initial benefits of FRAM and FRAK are included in the reference case, we understand from our discussions with FABEC operational experts that the benefits from FRA in 2011 are negligible. We can therefore assume that benefits of FRA do not form part of the reference case.

Traffic for future years is grown using the base scenario of the STATFOR Medium-Term Forecast (October 2011)[20].

3.3 Key parameters for CBA

The key parameters used in the CBA are as follows:

- **Reference year:** The starting year of the analysis is 2010.
- **Time horizon:** The analysis will cover the 2010 - 2025 time horizon. This will allow sufficient time for the benefits of FRA to be realised and is also consistent with the global FABEC CBA.
- **Prices:** All prices in the CBA are expressed in constant Euro 2010 prices.
- **Discount rate:** The rate is 6% and is consistent with that used for the global FABEC CBA.
- **Cost of distance flown:** The benefits of reduced distance flown can be quantified by applying a cost of distance flown. The Standard Inputs for Eurocontrol cost benefit analyses[21] gives an average (strategic) cost of €7.30 per NM in 2010 prices[22]. This equates to a value of €3.94 per km.
- **Scope of CBA:** The FABEC ANSPs and military ANSPs are included in the CBA. Other stakeholders involved in the FRA implementation include the CFMU and airspace users (military and airlines).

[20] EUROCONTROL Medium-Term Forecast of Flights (2011-2017), 21 October 2011
[21] Standard Inputs for Eurocontrol CBAs, Edition 5.0, December 2011.
[22] We assume that the cost of distance flown is in 2010 prices, as the delay costs are in 2010 prices.

4 COSTS

This section presents the main costs for FRA implementation, development and operation. Costs are described for the FABEC civil ANSPs, military ANSPs and other stakeholders (CFMU, aircraft operators and military airspace users).

A summary of cost assumptions are provided in Annex A.

4.1 ANSP costs

FRA implementation could result in the following costs for the FABEC ANSPs:

- Project management and development;
- Concept validation;
- Resectorisation;
- Technical systems and enablers;
- Interfaces with CFMU;
- ATCO training;
- Non-ATCO training;
- Aeronautical information management;
- Safety cases.

Each type of cost is described in the following sections.

4.1.1 Project management and development

The implementation of FRA will require management effort in setting up the project, including airspace design. Following discussions with FABEC experts, it is assumed that each centre will require 2.5 non-ATCO FTEs per year during the development of Steps 1 and 2. The cost for one non-ATCO FTE is assumed to be €154 000 in 2010, based on an average FABEC man-day rate of €700[23]. The cost per non-ATCO FTE is assumed to increase by 2.5% per year from 2010 onwards.

The annual cost for project management and development is applied over the following periods for each centre:

- MUAC: 2010-2015
- KUAC: 2010-2018
- Skyguide (2 centres): 2012-2019
- DSNA (5 centres): 2012-2018.

4.1.2 Concept validation

The development of FRA within FABEC will need validation of the concept as each step proceeds and progressive changes are foreseen. The validation will require real-time (RTS) and fast-time simulations (FTS).

The ANSPs assume that RTSs will be required for each centre that implements FRA and that at least one RTS per major step will be required.

[23] Source: FABEC average daily rate for non-ATCO staff.

RTS costs include preparation, overhead (pilot and others' participation) and the cost of ATCO participation. The preparation and overhead costs are estimated to be €200 000. Each RTS will be of one week's duration with around 30 ATCOs participating. Each RTS will therefore require around 150 ATCO man-days. The cost for an ATCO man-day is assumed to be €700[24] in 2010 (the same rate as a non-ATCO FTE). The cost of an ATCO man-day is assumed to increase by 2.5% per year from 2010. The ATCO participation cost in 2010 is €105 000. The total cost per RTS in 2010 is €305 000.

Some ANSPs will need additional RTS for further development (R&D).

We assume that the RTS will take place towards the end of each step. The table below summarises the assumptions on RTS for each ANSP or centre.

Centre	Assumptions
MUAC	1 RTS in 2012 Since MUAC started development of FRA in 2008, only one RTS is needed from 2011.
DSNA	1 RTS per step per centre + 4 R&D RTS For each centre: 1 RTS in 2014 (step 1: 2012-2016), 1 RTS in 2016 (step 2: 2014-2018). For the ANSP: 4 R&D RTS in total - 2 R&D RTS in 2013 and 2 in 2015. The assumption is that the R&D RTS precede the RTS for each step.
Skyguide	1 RTS per step per centre + 2 R&D RTS For each centre: 1 RTS in 2014 (step 1: 2012-2016), 1 RTS in 2018 (step 2: 2017-2019). For the ANSP: 1 R&D RTS in 2013 and 1 in 2017.
KUAC	1 RTS in 2014

These costs only relate to the costs of RTS for concept validation of FRA within each ATC unit. If FRA is implemented FABEC-wide, costs relating to additional simulations would need to be considered. We assume that an additional RTS per centre will be required in the preceding year of FABEC-wide FRA implementation.

For FABEC-wide concept validation, we would expect fewer RTS than for the earlier steps, although they would be of larger scale. We have therefore taken the above assumption as a first indication of the costs.

Although FTS will be undertaken, they are not assumed to have additional costs.

4.1.3 Resectorisation

As free routes are implemented, sectors may need to change to fit new traffic patterns and flows and to minimise the number of sectors crossed. Some ANSPs may need the ability to resectorise dynamically to meet the changing requirements.

The cost is difficult to estimate since the extent of resectorisation is not yet known and ANSPs are in the early stages of identifying the effect of FRA on traffic flows. Resectorisation costs have not been included in the CBA.

[24] Source: FABEC average daily rate.

4.1.4 *Technical systems and enablers*

A number of systems and tools will be required for FRA. These include Medium Term Conflict Detection (MTCD) and Flight Data Processing (FDP) systems.

We understand from FABEC ANSPs that the FRA implementation roadmap is aligned with the technical roadmap to ensure that all required technical systems are implemented in time for FRA Steps 1 and 2.

MTCD: In MUAC, there is currently no obvious need for MTCD, as FRA is operational during nights and periods of low traffic. Even in Step 2, the functionality exists to cope with 24/7 operations. MTCD is in use in Karlsruhe and the capability will be enhanced by CORA (Conflict Resolution Assistant) in 2017. Skyguide has planned MTCD for 2013. DSNA has no specific technical need for MTCD during Step 1, although as traffic grows, the need will grow. For Step 2, MTCD will be required to display predicted trajectory and potential conflicts.

FDP: The current FDP capability is assumed to be sufficient to address FRA requirements for Step 1. As the number of direct routes offered increases, the FDP capability should allow for the increase in entry/exit points. For Step 2, additional FDP functionality is needed and these are currently being installed.

Step 3 will require three-dimensional sectorisation and business trajectories which are closely linked to SESAR initiatives. Specific interfaces will be needed between FABEC FDP systems to enable flexible sectorisation between ACCs. Step 3 will require further validation and lead to updated requirements within the context of SESAR. The detailed technical requirements for Step 3 are therefore unclear at present.

Since the systems required for Steps 1 and 2 are already planned by the ANSPs, we assume that there are no additional costs related to these.

4.1.5 *Interfaces with CFMU*

The ANSPs will require system adaptations to interface with CFMU tools and database for FRA Step 2. We assume that these interfaces are already being developed and therefore no additional costs apply.

4.1.6 *ATCO training*

ATCOs will require training to familiarise them with the new FRA routes and procedures. MUAC estimates that around 1.5 days of training will be required for MUAC ATCOs in 2015, with an estimated cost of €1.17m. MUAC has had a few years of experience with direct routes and the tools required for FRA and therefore we would expect more training for the ATCOs in other ANSPs.

Following discussions with FABEC experts, it is assumed that around two days' training per ATCO per year will be required for each centre during Step 2. In practice, the training will take place in certain years and will depend on the changes in each step; however, we can assume a uniform spread of costs over Step 2 as a starting assumption.

The cost of training includes ATCO time, instructor time and simulation preparation costs. The cost of two days' training per ATCO is €1400 in 2010. The cost will apply to all ATCOs using FRA. Training simulation costs and instructor costs can be represented as an "overhead" cost. We assume the overhead is 75% of the ATCO training cost.

The annual training cost per centre will therefore be (two days' ATCO training* 1.75 * number of ATCOs to be trained in that year) and will apply over the following periods:

- KUAC: 2012-2018

- Skyguide (2 centres): 2017-2019
- DSNA (5 centres): 2014-2018.

4.1.7 *Non-ATCO training*

Flight data staff in the ANSPs will require some training to be familiar with new flight data processes for FRA.

Following discussions with FABEC experts, it is assumed that around one day's training per flight data staff will be required every year throughout Step 2. The cost of one day's training per flight data staff is €700 in 2010. The number of flight data staff at each centre is approximated by assuming that it is equivalent to 10% of the number of ATCOs (FABEC assumption).

The annual cost of training per centre is applied over the following years:

- MUAC: 2011-2015
- KUAC: 2012-2018
- Skyguide (2 centres): 2017-2019
- DSNA (5 centres): 2014-2018.

4.1.8 *Aeronautical information management (AIM)*

There are costs related to the publication of new routes in aeronautical information publications (AIPs), circulars (AIC) and the route availability document (RAD). Each centre will need around 0.5 FTE per year during Steps 1 and 2 to publish new routes.

The cost per centre for AIM is therefore €77 000 in 2010, and is assumed to increase by 2.5% per year. The cost applies per centre over the following periods:

- MUAC: 2010-2015
- KUAC: 2010-2018
- Skyguide (2 centres): 2012-2019
- DSNA (5 centres): 2012-2018.

4.1.9 *Safety cases*

Safety cases will be required for any operational and technical changes from FRA implementation. The human factors impact is assumed to be included in the cost of safety cases. Following discussions with FABEC experts, it is assumed that the costs for safety cases are around 10% of the total project costs (project management, concept validation, training and AIM). The costs are spread over Step 1 and Step 2 for each centre.

4.2 *Military ANSP costs*

4.2.1 *Technical systems and enablers*

MUAC can implement Step 2 without significant costs to the military ANSPs. However this may not be the same for other ANSPs. FABEC military ANSPs will require changes to their technical systems to enable enhanced data sharing. Level 2 (pre-tactical coordination) requirements will not result in significant additional costs. Level 3 (tactical coordination) requirements for radar display availability could incur additional costs.

Tools such as STANLY will need to be adapted to meet these requirements. FABEC estimates that the cost of developing STANLY to meet the requirements of Step 2 FRA is around €100 000 per ANSP. The cost will apply to the military ANSPs in Belgium, the Netherlands and France.

4.3 Other stakeholders

FRA costs for the CFMU, aircraft operators and military users are described below.

4.3.1 CFMU

Airspace management (ASM) tools: All partners will need to share the updated information with respect to the availability of airspace and therefore new tools will be required. We assume that the development of future functionality in ASM required for Steps 2 and 3 is already planned and therefore no additional costs are assumed here.

IFPS tools: The IFPS can handle the current FRA requirements for Step 1. Improved sharing of information for Steps 2 and 3 was feasible during live trials. However improved information exchange may be required for Step 3, for example merging information from XMAN/DMAN and CDM and applying this for the business trajectory.

Since we are only considering Steps 1 and 2 in the CBA, we assume no additional costs are incurred.

4.3.2 Aircraft operators

Flight planning procedures: Airlines will need to file flight plans according to up-to-date information before flight. The use of repetitive flight plans will be adapted. Some airlines (for example, low cost airlines) may need to invest in flight planning systems in order to benefit from FRA. The costs are not known and are not included in the CBA.

Pilot training: New routes will be published in the AIC, AIPs and a harmonised publication at FABEC level. This is deemed sufficient for the pilots to use the direct routes. No pilot training is required.

Avionics: No changes are expected in on-board systems.

4.3.3 Military airspace users

FRA Steps 2 and 3 require advanced FUA (A-FUA), which will enable enhanced coordination between civil and military airspace users. This will require greater harmonisation of civil-military procedures on a FABEC wide basis.

Since A-FUA is a concept that is not specific to FRA and will be implemented anyway, it is assumed that there are no additional costs related to A-FUA implementation.

5 BENEFITS

The benefits of FRA are described in this section.

5.1 Quantitative benefits

FRA allows airspace users to fly direct routes, thus reducing flight distance flown, with consequent savings in fuel and time. Furthermore, airlines have an added benefit of predictability from direct routes through FRA. Currently, direct routes are offered tactically and therefore airlines plan for sufficient fuel to fly the route as specified in the flight plan. With FRA, the airline has advance information that it will fly on the direct route and therefore it does not need to carry additional fuel for contingency. These benefits are described below.

5.1.1 Performance indication

An initial analysis of the benefits of FRA implementation in FABEC has been undertaken by Eurocontrol[25] (performance indication), using the SAAM tool. The benefits calculated in the analysis are used for the cost-benefit analysis.

The performance indication quantified the route distance savings from FRA in the upper airspace of FABEC. Lower airspace was excluded. The benefits of Steps 1 and 2 were evaluated.

A traffic sample of one week over the period 27 June 2011 to 3 July 2011 (week 26) was used. The traffic was based on filed flight plans. The SAAM tool compared the distance flown on the current route network (see reference case description in section 3.2) with distance flown on the FRA routes, given by the FRA roadmap. The comparison was made for three years: 2013, 2016 and 2019. A variation of scenarios 2016 and 2019, for which the minimum flight levels for DSNA and Skyguide were lowered, was also evaluated.

The STATFOR MTF forecast (October 2011) was used to estimate traffic for 2013 and 2016, whilst the STATFOR LTF forecast[26] was used to estimate the traffic for 2019. The base growth scenario was used for both forecasts.

The scenarios are taken from the performance indication paper and are summarised in the table below. We understand that FABEC-wide or ANSP-wide direct routes were not modelled.

The effect of military airspace use was taken into account in the benefits for Step 2. On average, military airspace was found to be activated between 25–30% of the time. The number of flights in the evaluation was adjusted so that any flights through activated military airspace would be excluded.

[25] FABEC Free Route Performance indication v1.0, 12 January 2012.
[26] EUROCONTROL Long-Term Forecast - Flight movements 2010-2030, 17 December 2010.

	Scenario
2013	**MUAC:** As planned and based on the FRAM roadmap; **Karlsruhe:** As planned and based on the FRAK roadmap; Munich UAC weekend routes similar to Karlsruhe SE sectors; **DSNA:** based on current night network; **Skyguide:** weekend routes FL245+.
2016a	**MUAC:** Step 2 FL245+ and based on the FRAM roadmap; **Karlsruhe:** -Step 2 FL 315+ and based on FRAK roadmap; -Night Network FL 245+; -Cross-border within ANSP; **DSNA Step 1:** -Weekend routes FL 375+; -Extended Night Network: FL 375+; -Night Network FL 245+; -Cross border within ANSP; **Skyguide step 1:** -FRA FL 245+; -Cross border within ANSP.
2016b	As for 2016a, except DSNA weekend route and extended NN FL 315+
2019a	Cross border FABEC (not actually modelled) **MUAC** step 2 FL 245+ and based on FRAM roadmap **Karlsruhe:** -As planned (step 2) and based on FRAK Roadmap FL 315+ -Night Network FL 245+ **DSNA:** -Step 1: Weekend routes FL 375+ -Step 1: Extended Night Network FL 375+ -Step1: Night Network FL 245+ -Step 2 FL 375+ **Skyguide:** -Step 1 FL 245+ -Step 2 FL 365+
2019b	As 2019a, except: **DSNA** Step 1: weekend and extended NN FL 315+, Step 2 FL 315+ **Skyguide** Step 2: FL 315+

Table 5-1: FRA benefits scenarios

5.1.2 Reduced route distance and flight time

The SAAM model calculated the potential savings in route distance by comparing the current route network with FRA routes in each of the scenarios.

Benefits were extrapolated from the sample week to an average week in the year by applying a weighting of 0.874. This is to take account of the fact that the sample week was during the peak period for traffic and an average week's traffic and therefore benefits would be lower.

The flight efficiency improvement in percentage terms was derived from the performance analysis and applied to the latest traffic forecast from Eurocontrol[27].

The benefits were quantified by applying a cost per IFR km. The cost is based on the direct operating costs to airlines and includes fuel costs, maintenance costs, fleet costs and crew costs. The Standard Inputs document gives an average (strategic) cost of distance flown of €7.30 per NM. This equates to €3.94 per km.

The estimated benefits25 for each scenario are shown below:

	km saved (annual)	Annual cost savings
2010	0	-
2011	0	-
2012	0	-
2013	4,240,910	€ 16.7m
2014	6,171,222	€ 24.3m
2015	8,207,837	€ 32.3m
2016	10,326,110	€ 40.7m
2017	12,251,935	€ 48.3m
2018	14,264,675	€ 56.2m
2019	16,331,674	€ 64.3m
2020	16,652,924	€ 65.6m
2021	16,983,106	€ 66.9m
2022	17,319,967	€ 68.2m
2023	17,663,646	€ 69.6m
2024	18,014,284	€ 71.0m
2025	18,372,024	€ 72.4m

Table 5-2: FRA benefits

We assume that the benefits of FRA begin in 2013. Benefits are extrapolated for intermediate years, and grown with traffic after 2019.

5.1.3 Fuel carriage penalty

In addition to the reduced fuel burn due to reduced distance flown, there will be an additional fuel saving. This is related to the cost of carrying additional fuel on board the aircraft, as an aircraft must take on board the fuel necessary according to the filed flight plan.

Additional fuel is estimated (Standard Inputs for EUROCONTROL Cost Benefit Analyses, October 2009) to be 40kg per tonne of fuel, that is, a fuel carriage penalty of 4%. The average fuel consumption of a typical aircraft in cruise was assumed to be 7.8 kg per NM[28]. The corresponding fuel saved is shown in the table below. The fuel carriage benefit is 4% of the fuel savings.

[27] Eurocontrol Medium-Term Forecast, February 2012, Flight Movements, 2012-2018.
[28] FABEC Free Route Performance indication v1.0, 12 January 2012.

	km saved (annual)	Fuel saved (tonnes)	Fuel penalty saving (tonnes)
2010	0	0	0
2011	0	0	0
2012	0	0	0
2013	4,240,910	17,851	714
2014	6,171,222	25,977	1,039
2015	8,207,837	34,549	1,382
2016	10,326,110	43,466	1,738
2017	12,251,935	51,573	2,062
2018	14,264,675	60,045	2,401
2019	16,331,674	68,746	2,749
2020	16,652,924	70,098	2,803
2021	16,983,106	71,488	2,859
2022	17,319,967	72,906	2,916
2023	17,663,646	74,353	2,974
2024	18,014,284	75,829	3,033
2025	18,372,024	77,335	3,093

Table 5-3: Fuel carriage benefits

The benefits of fuel carriage cost savings have not been quantified in the CBA.

5.1.4 Environmental impact

The consequent reduction in CO_2 emissions was also quantified. The average fuel consumption in cruise was assumed to be 7.8 kg per NM. The amount of CO_2 emissions resulting from the combustion of one kg of fuel is 3.149 kg[29].

The CO_2 emission savings are not financially quantified here. The CO_2 emissions saved for each year are shown in the table below.

[29] Standard Inputs for Eurocontrol CBAs, Edition 5.0, December 2011.

	km saved (annual)	Fuel saved (tonnes)	CO_2 emissions saved (tonnes)
2010	0	0	0
2011	0	0	0
2012	0	0	0
2013	4,240,910	17,851	56,215
2014	6,171,222	25,977	81,802
2015	8,207,837	34,549	108,798
2016	10,326,110	43,466	136,876
2017	12,251,935	51,573	162,404
2018	14,264,675	60,045	189,084
2019	16,331,674	68,746	216,482
2020	16,652,924	70,098	220,741
2021	16,983,106	71,488	225,117
2022	17,319,967	72,906	229,583
2023	17,663,646	74,353	234,138
2024	18,014,284	75,829	238,786
2025	18,372,024	77,335	243,528

Table 5-4: Environmental benefits

5.2 Qualitative benefits

The qualitative benefits of FRA are described below.

5.2.1 Sector capacity

Capacity benefits are expected since reduced average transit times should result in an increase in capacity. Capacity benefits may also be due to a reduced number of conflicts, fewer redirects, and the resulting impact on controller tools. However conversely, conflicts may become more complex and other choke points may emerge. Therefore the overall impact of FRA on sector capacity cannot be determined without simulations. The SAAM model used to analyse benefits does not currently have the capability to evaluate the impact on capacity, and therefore this has not been quantified for the report. Simulations to evaluate capacity are however planned for later in 2012.

5.2.2 Predictability

FRA will mean that direct routing, which is currently offered on a tactical basis, can be planned for by airlines. For airline operators, having improved predictability for a flight will enable aircraft turnarounds and crew management to be optimised. For air traffic control, improved predictability will result in fewer disruptions to planned traffic flows and fewer aircraft having to hold.

5.2.3 Flight plan flexibility

FRA will provide a greater flexibility to the airline operators in filing flight plans, allowing them to choose routes optimised for their operations.

6 COST-BENEFIT ANALYSIS

The results of the cost-benefit analysis are presented in this section.

6.1 Costs

The annual (non-discounted) costs of FRA implementation are shown in Figure 6-1.

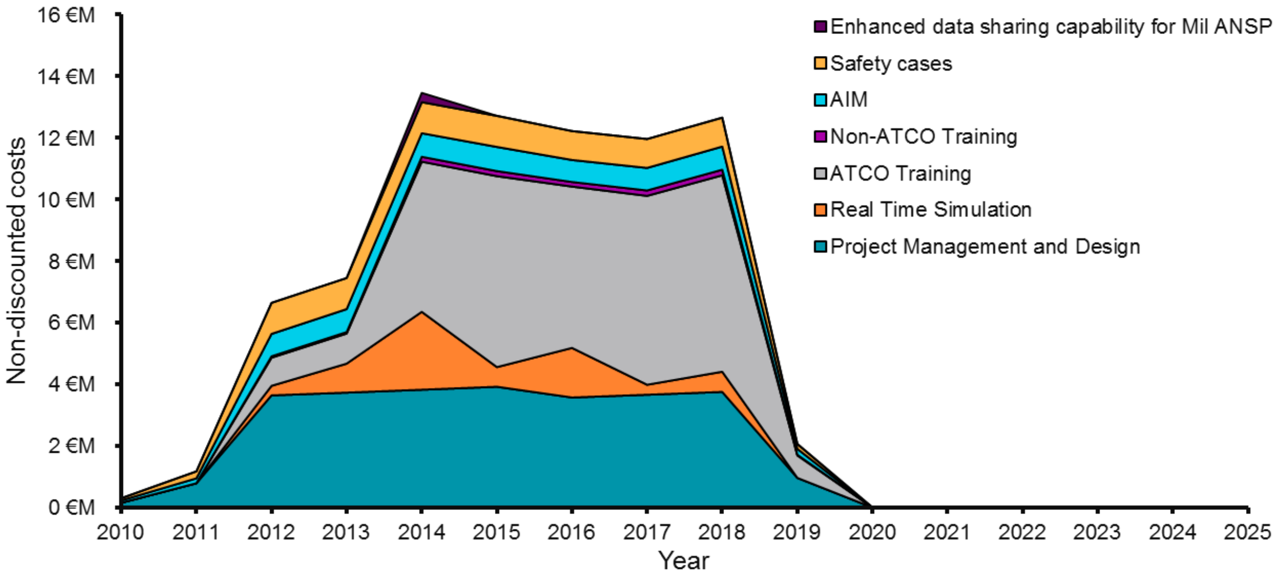

Figure 6-1: Annual costs (non-discounted)

6.2 Benefits (PV)

The annual benefits (non-discounted) are shown in Figure 6-2.

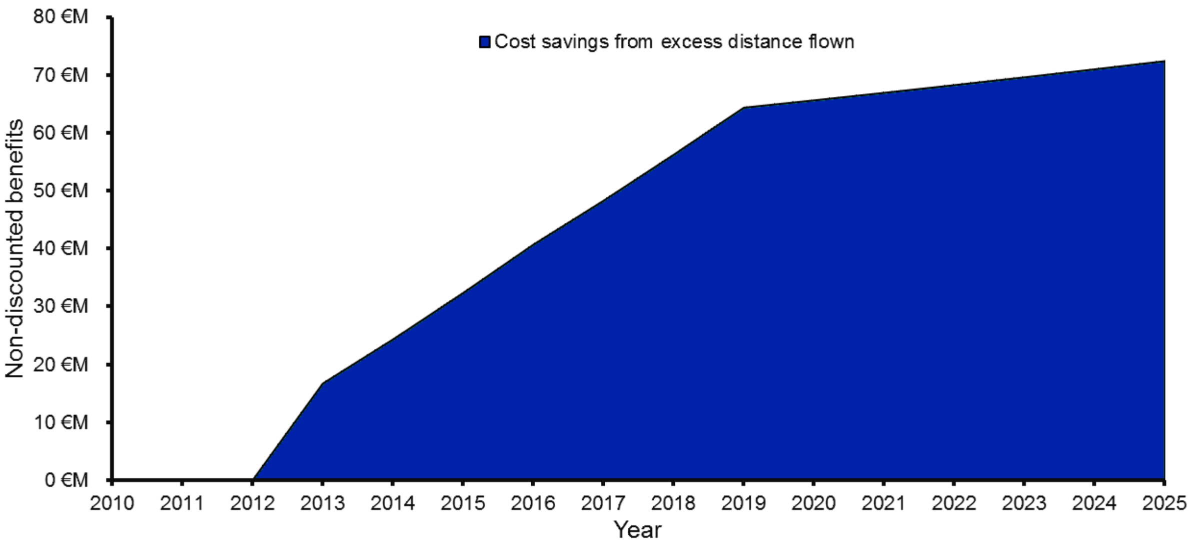

Figure 6-2: Annual benefits (non-discounted)

6.3 Net Present Value

The present values of costs and benefits and the project NPV is summarised in the table below.

	CBA results
Costs (PV)	€59m
Benefits (PV)	€392m
NPV	**€332m**

Table 6-1: CBA results

7 SENSITIVITY ANALYSIS

Sensitivity analysis assesses the impact of modifications in key parameters on the NPV of the project, assuming that the remaining parameters remain unchanged.

In this section, we examine the impact of the uncertainty in many of the assumptions made on the overall results.

We consider:

- sensitivity to lower traffic growth;
- sensitivity to delaying all benefits by three and five years;
- sensitivity to an increase in costs by 50% and 100%;
- sensitivity to lower costs for distance flown; and
- sensitivity to changes in airline adoption of FRA.

7.1 Traffic

Traffic growth depends on many macroeconomic variables and is difficult to estimate. Traffic forecasts are characterised by a high level of uncertainty and it is important to prepare analyses to show the impact of alternative traffic growth rates.

For the purpose of the sensitivity analysis, a lower traffic growth scenario is assumed. The latest Eurocontrol MTF forecast gives an average annual growth rate for European traffic from 2011 to 2018 of 2.1% for the base scenario and 1.1% for the low scenario. In the absence of modelling the performance analysis using the low forecast from Eurocontrol, we have used a simplified scenario of reducing the benefits by a factor of 50% to represent the decrease in traffic.

A lower traffic scenario reduces the NPV by around two-thirds, although the NPV remains positive.

Traffic	NPV	∆NPV
Base forecast	€332m	-
Lower traffic scenario	€136m	-€196m

Table 7-1: NPV for lower traffic

7.2 Delay to FRA implementation

FRA implementation in FABEC is in its initial stages and involves the participation of many centres and ANSPs. It is therefore important to consider the impact of a delay to FRA implementation and achievement of the benefits in line with the roadmap.

In order to analyse the impact on performance, we have considered two scenarios in which we assumed that all benefits are delayed by three years and five years, respectively. In these scenarios we assume only a delay of benefits. All costs are assumed unchanged.

A delay of three years reduces the NPV by €57m, whilst a delay of five years reduces the NPV by €118m. However, even in the worst case, with a delay of benefits of five years, the project is still positive, with an NPV of €214m.

Delay to benefits	NPV	∆NPV
No delay	€332m	-
Delay of 3 years	€275m	-€57m
Delay of 5 years	€214m	-€118m

Table 7-2: NPV for delay to benefits

7.3 Higher costs

FRA implementation in FABEC is in its initial stages and therefore the costs estimated to implement FRA, which are based on experts' judgement and experience, include an element of uncertainty. It is therefore important to consider the impact of increased costs of FRA implementation on the CBA results.

In order to analyse the impact on performance, we have considered two scenarios in which we assume that all costs are increased by 50% and by 100%, respectively. In these scenarios we assume that benefits remain unchanged.

An increase of FRA implementation costs of 50% and 100% reduces the NPV by €30m and €59m respectively. A doubling of costs still results in a positive NPV of €273m.

Higher costs	NPV	∆NPV
No change in costs	€332m	-
Increase of 50%	€302m	-€30m
Increase of 100%	€273m	-€59m

Table 7-3: NPV for higher FRA implementation cost

7.4 Lower costs for distance flown

The benefits of FRA are largely fuel savings and savings in other direct operating costs for airlines. It is therefore important to consider the impact of lower direct operating costs for airlines on the CBA results.

The CBA assumes the base figure for the average strategic cost of distance flown which is €7.30 per NM[30]. In order to analyse the impact on performance, we consider the low value for strategic cost of distance flown of €5.20 per NM[30].

The low figure for cost of distance flown reduces the NPV by a third but is still positive at €219m.

Cost of distance flown	NPV	∆NPV
Base case (€7.30 per NM)	€332m	-
Low case (€5.20 per NM)	€219m	-€113m

Table 7-4: NPV for lower cost of distance flown

7.5 Airline adoption

The benefits of FRA are dependent on airlines planning and flying direct routes. The CBA assumes that airlines will fly a direct route if available (that is, 100% adoption). It is therefore important to consider the impact of airline take-up of FRA routes on the results of the CBA.

In order to analyse the impact on performance, we have considered two scenarios in which we assume that:

[30] Standard Inputs for Eurocontrol CBAs, Edition 5.0, December 2011.

- Scenario 1: airline take-up of benefits is around 30% in the first year of benefits, and increases by 10% per year until 2019 when it is 90%; We assume a 100% take-up from 2020 to 2025;
- Scenario 2: airline take-up of benefits is around 15% in the first year of benefits, and increases by 5% per year until 2019 when it is 45%; We assume a 50% take-up from 2020 to 2025.

The resulting NPVs are shown in the table. The effect of airline adoption is to reduce the NPV for both scenarios. In particular, assuming a pessimistic airline adoption in scenario 2 significantly reduces the NPV, although the NPV is still positive.

Airline take-up	NPV	∆NPV
100% take up	€332m	-
Scenario 1 (30%-100%)	€267m	-€65m
Scenario 2 (15%-50%)	€104m	-€228m

Table 7-5: NPV for low airline adoption

8 CONCLUSIONS

The cost-benefit analysis of the FABEC FRA shows a positive NPV of €332m over the project lifetime. The benefits are largely fuel and other direct operating cost savings to airspace users from the saved route distance from offering direct routes.

The sensitivity analyses show that even with the most pessimistic scenarios of low traffic, delayed benefits, higher costs, low airline adoption and a low cost of distance flown, the NPV of the project remains positive.

A Summary of assumptions

A.1 The assumptions used in the cost-benefit analysis are summarised in this section.

	Assumptions used
Stakeholders involved	Stakeholders: Those who are involved in the FRA project and for whom costs and benefits are included. **FABEC UACs:** Karlsuhe, MUAC, Geneva, Zurich, Reims, Paris, Marseille, Bordeaux, Brest. FRA below FL 245 and connection procedures with: Belgocontrol, Langen, Bremen, Munchen and LVNL (connected procedures only). **FABEC military organisations:** Belgian AF, Royal Netherlands AF, Swiss AF (Skyguide), German AF (DFS), French AF. **Other stakeholders:** Assume Eurocontrol (NMF and RNDSG) costs are not in scope of CBA. States and Air Defence not in scope of CBA.
Reference case	Performance indication used the current route network during reference period 27 June - 3 July 2011, including the route network, Night Network, City Pairs. **CBA assumption:** Costs and benefits from 2010 are included in CBA. Costs earlier than 2010 (eg for MUAC and KUAC) are not included.
FRA concept	Three steps: **S1: Directs in defined airspace outside of military activity**. • Night (EN or extension of current NN and creation of new DCT); • Weekend • Cross-border between ATC units within FABEC or with adjacent FABs • FABEC wide **S2: Directs in defined airspace with active military areas (24/7), with A-FUA** • S2a: within ATC units • S2b: Cross-border between ATC units within FABEC or with adjacent FABs • S2c: FABEC wide. **S3: Business trajectories** Concept not finalised and SESAR developments need to be accounted for. **Final goal: FABEC wide Full Free Route concept, defined in FRA Conops.** The FRA starts with the Night Network and City Pairs and more routes are gradually added to the current NN and CPs. There is a significant step change towards the end of Step 1, when the FRA is 24/7 and one could expect that the benefits will increase accordingly.
Civil/military cooperation	Improved information sharing between civil/military with respect to Advanced-FUA. AMC should anticipate likely increase in workload and plan for extension of pre-tactical phase.
CBA parameters	**Scope:** Only costs and benefits up to the end of Step 2 will be included. Step 3 benefits have not been evaluated in the performance indication. The business trajectory concept for FRA is still being developed and therefore there are a number of unknowns regarding costs and benefits. **Time horizon:** 2010-2025 to be consistent with the global FABEC CBA. **Discount rate:** 6% to be consistent with the global FABEC CBA. **Prices:** In constant 2010 prices and in real terms.
Costs for ANSPs	
Project management	**CBA assumption:** Project management costs include set-up and management costs of the project and airspace design costs.

costs	Assume 2.5 non-ATCO FTE per year for each centre for Step 1 and Step 2 over the following periods: Karlsuhe: 2010-2018 MUAC: 2010-2015 Skyguide (2 centres): 2012-2019 DSNA (5 centres): 2012-2018 The cost of 1 non-ATCO FTE is 154k€ in 2010, based on a daily cost of 700€ and assuming 220 working days (increased by 2.5% per year).
Concept validation	The FRA concept will be validated with real-time simulations (RTS). **<u>CBA assumption:</u>** The cost per RTS comprises preparation and overhead costs plus staff costs. Preparation and overhead cost is around 200k€. There are around 30 ATCOs per RTS, each RTS of duration 1 week, resulting in a total of 150 ATCO man-days. Assuming a 700€ cost per day per ATCO, the cost is 105k€. The total cost per RTS is therefore 305k€ in 2010 with man-day rate increasing by 2.5% per year. The FRA Step 1 starts with the night network and city pairs and therefore the RTS are not necessarily required until there are significant changes to the routes and concept. Therefore we could expect that the RTS are done toward the middle to end of each step. The assumptions on RTS for each ANSP are as follows: MUAC: 1 RTS in 2012. DSNA: 1 RTS per step per centre + 4 R&D RTS. For DSNA centres, Step 1 is 2012-2016 and Step 2 is 2014-2018. Therefore assume 1 RTS in 2014 and 1 in 2016. 4 R&D RTS are also required, two in 2013, two in 2015. Skyguide: 1 RTS per step per centre + 2 R&D RTS. For Skyguide centres, Step 1 is 2012-2016 and Step 2 is 2017-2019. Therefore assume 1 RTS in 2014 and 1 in 2018. 2 R&D RTS are also required, one each in 2013 and 2017. KUAC: Assume 1 RTS in 2014. <u>FABEC-wide FRA:</u> If the benefits include direct routes across FABEC airspace, then the costs should reflect the step change to FABEC-wide FRA. We assume that at least one additional RTS will be required for each centre in 2018, if FABEC-wide benefits are included. Fast-time simulations (FTS) are undertaken but no additional costs are assumed for these.
Resectorisation	Step 2 could require resectorisation for some ANSPs. The costs will depend on the changes required. These are unknown at this point. The capability already exists to resectorise but increased manpower may be required. Step 3 will require resectorisation to minimise number of sectors crossed and enable flexibility. Resectorisation costs will not be included in the CBA.
ATC system changes	Technical systems are assumed to be implemented in time for FRA for all ANSPs since the technical roadmap is aligned with the FRA roadmap Steps 1 and 2. Step 3 will require further validation and lead to updated requirements within the context of SESAR. **ASM:** airspace users will need to know whether airspace is available or not; All partners need to share the updated information with respect to airspace reservations. New support tools should be developed.

	Cost for NMC (CFMU) – outside scope of the CBA. **IFPS:** New support tools should be developed. Cost for NMC (CFMU) – outside scope of the CBA. **MTCD:** MUAC - Currently need for MTCD not obvious as used during nights and periods of low traffic. Karlsruhe – in use and enhanced with CORA in 2017. Skyguide – MTCD planned 2013. DSNA – MTCD in FR West (2014), then FR East (2018). S1: No specific technical needs, but as traffic grows, there is a need for MTCD functionality S2: Display predicted trajectory and potential conflicts – need MTCD. **FDP:** S1: FDP capability needs to be checked for increase in number of DCTs with entry/exit points. S2: FDP systems currently being installed. S3: 3-D sectorisation and business trajectory, SESAR programmes. Specific interfaces needed between FABEC FDP systems for flexible sectorisation between ACCs. **CBA assumption:** No additional costs for technical enablers
ATCO training	MUAC: ATCO familiarisation 1.5 day training per ATCO in 2015, with an estimated cost of 1.17M€. Take into account that MUAC has long experience with DCTs and tools required for FRA. **CBA assumption:** Assume at least 2 days per ATCO per year during Step 2 for each centre. Recognise that training will not be uniformly distributed and will depend on steps but can assume as a starting point. The training will apply every year over the following periods: KUAC: 2012-2018 Skyguide: 2017-2019 DSNA: 2014-2018 Training simulation costs and instructor costs can be represented as an "overhead" cost. We assume the overhead is 75% of the training cost.
Non-ATCO training	Flight data (FD) staff will require some training to familiarise with new flight data processes for FRA. **CBA assumption:** Assume 1 day per FD staff per year throughout Step 2. The cost is 700€ per FD staff day. The number of FD staff is approximated as 10% of ATCO numbers. The period over which these costs are applied are as follows: MUAC: 2012-2015 KUAC: 2012-2018 Skyguide: 2017-2019 DSNA: 2014-2018
Interface to tactical database	Applicable for S2. Interfaces with CFMU will need to be enhanced. Already evolving. **CBA assumption:** No additional cost assumed.
Military	FRA may require changes at the military ANSP level and from military users. **Military ANSPs:** Military ANSP technical enablers may be required for enhanced data sharing. Level 2 (pre-tactical coordination) – no significant additional cost foreseen. Level 3 (tactical coordination) implies additional cost regarding radar display availability. MUAC can implement Step 2 without significant costs to the military ANSPs. However this may not be the same for other ANSPs. Tools such as STANLY will need to be adapted to meet these requirements. STANLY as

	an example would cost 100k€ per ANSP. This figure is used for mil ANSP in F, BE, NL (2014) **Military users:** Advanced-FUA applies to military users as they will need the advanced capability for FRA Step 2 and 3. Since A-FUA is a concept that is not specific to FRA and will be implemented anyway, there are no additional costs included in the CBA~~.~~
AIM	**MUAC:** AIC; Publication in RAD and AIP **KUAC:** AIC for S3; Publication in RAD and AIP; 100 man-days in 2012/2013 for publication of transition route. **CBA assumption:** The direct routes will need to be published in the RAD, AIC and AIP. Assume 0.5 FTE per year per centre will be required throughout Step 1 and Step 2. The period over which the costs apply are as follows: Karlsuhe: 2010-2018 MUAC: 2010-2015 Skyguide: 2012-2019 DSNA: 2012-2018
Safety cases	Safety cases will be required for the FRA project. A safety case will be required for operational and technical changes and includes the HF impact. **CBA assumption:** We assume that costs for safety cases are around 10% of total project costs (project management, training, simulations, AIM etc). The costs are uniformly distributed over Step 1 and Step 2.
Costs to CFMU	
Airspace DB	The IFPS can handle the current FRA therefore no costs assumed for S1. Assumptions for Steps 2 and 3: Improved sharing of information was shown to be possible in live trials. For S3, better information data exchange is needed. Merge information from XMAN/DMAN and CDM to apply business trajectory. **CBA assumption:** No additional costs assumed
IFPO support tool	CFMU already has this and it meets FRA requirements so no additional costs. **CBA assumption:** No additional costs assumed
Costs to AOs	
Flight planning	Airlines will need to file Flight Plans according to up to date information before flight. The use of RPL will be adapted. Some airlines (eg low cost airlines) may need to invest in flight planning systems in order to benefit from FRA. The costs are not included in the CBA.
Training for pilots	Not required. Published in AIC and AIPs and harmonised publication at FABEC level.
Avionics	No changes are expected.
Quantitative Benefits	
Direct Operating Costs (fuel and time)	Performance indication undertaken by CEF Eurocontrol. Upper airspace; FRA Steps 1 and 2 were modelled. Traffic sample: June-July 2011 Traffic grown for future years using STATFOR MTF and LTF forecasts. Military activity accounted for through a reduction of 30% in benefits. Only the direct routes within an ATC unit were modelled. This excludes the benefits of “within ANSP” and “FABEC-wide” directs for both Steps 1 and 2. Route distance savings converted to time savings and quantified through strategic costs, fuel costs, maintenance costs, fleet costs and crew costs, using €7.30 per NM, this is

	around €3.94 per km. CO_2 emission savings quantified but not financially. No evaluation of impact on sector capacity. The fuel carriage penalty cost savings have not been quantified. Benefits of FRA are assumed to begin in 2013. Benefits are extrapolated in intermediate years. CEF Performance modelling: An earlier analysis on benefits was carried out in December 2011 which looked at a similar scenario but also included FABEC-wide directs. This analysis shows the potential for the benefits that may be possible. A request for an additional analysis from CEF, based on the latest MTF forecast (Feb 2012) and as described below has been made: 1. Steps 1 and 2 of the FRA roadmap to show benefits of direct routes within ATC units, as already modelled, but now with the latest traffic forecasts. 2. An extension of scenario 1, to also include the benefits of FABEC-wide direct routes. 3. Scenarios 1 and 2 evaluated using the "low" traffic forecast, as a sensitivity test.
Sensitivity analysis	**Traffic:** A lower traffic growth scenario is assumed. In the absence of modelling the performance analysis using the low forecast from Eurocontrol, use a simplified scenario of reducing benefits by a factor of 50% to represent a decrease in traffic; **Delay to roadmap and benefits:** Two scenarios assuming that all benefits are delayed by 3 years and 5 years, respectively. All costs are assumed unchanged; **Higher costs of implementation:** Two scenarios, assuming that all costs are increased by 50% and by 100%, respectively. Assume that benefits remain unchanged ; **Adjust airline adoption:** Two scenarios: 1: Airline take-up of benefits is 30% in the first year of benefits, and increases by 10% per year until 2019 when it is 90%; Assume 100% take-up from 2020 to 2025; 2: Airline take-up of benefits is 15% in the first year of benefits, and increases by 5% per year until 2019 when it is 45%; Assume 50% take-up from 2020 to 2025; **Lower fuel costs:** Scenario to use the low value for strategic cost of distance flown of €5.20 per NM.
Qualitative benefits	
Capacity and ATCO workload	SAAM model cannot evaluate capacity benefits currently. Simulations on capacity are expected in 2012. No capacity benefits are currently assumed – it is not clear what the overall impact of FRA on capacity is. Fewer conflicts; fewer re-directs; impact of ATCO tools. Conversely, conflicts may be more complex, other choke points emerge, impact of HMI.
Adjustment factors	
Effect of TSAs	TSAs activated 30% of the time. The performance benefits are net benefits and have taken account of this effect.

B Abbreviations and acronyms

AF	Air Force
ACC	Area Control Centre
A-FUA	Advanced-Flexible Use of Airspace
AIC	Aeronautical Information Circular
AIM	Aeronautical Information Management
AIP	Aeronautical Information Publication
ANSP	Air Navigation Service Provider
AO	Aircraft Operator
ASM	Airspace Management
ATC	Air Traffic Control
CBA	Cost-benefit analysis
CDM	Collaborative Decision Making
CEF	Capacity Enhancement Function (Eurocontrol)
CFMU	Central Flow Management Unit
CO_2	Carbon Dioxide
DFL	Division Flight Level
DMAN	Departure Management
FABEC	FAB Europe Central
FDP	Flight Data Processing
FIR	Flight Information Region
FL	Flight Level
FRA	Free Route Airspace
FRAK	Free Route Airspace Karlsruhe
FRAM	Free Route Airspace MUAC
FTS	Fast-time Simulations
FUA	Flexible Use of Airspace
KPIs	Key Performance Indicators
MTCD	Medium Term Conflict Detection
NPV	Net Present Value
PV	Present Value
R&D	Research & Development
RAD	Route Availability Document
RTS	Real-time Simulations
SESAR	Single European Sky ATM Research
TMA	Terminal Area
UAC	Upper Area Control
XMAN	Cross-Border Arrival Management

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FABEC

FABEC Implementation Phase

CBA Stakeholder Consultation

EC Information

Attachment R.3

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