Network Manager
nominated by
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EUROCONTROL

# Challenges of Growth 2013

## Task 7: European Air Traffic in 2050

# SUMMARY

**When confronted with today's challenges, with short-term financial pressures, or even with the challenges of 2035, 2050 may seem like too far away to need to plan for. However, decisions we make today - for policy, infrastructure, concepts and technology - can strongly improve or reduce our ability to respond as the challenges of 2050 come more sharply into focus.**

**This report presents the first EUROCONTROL forecast of IFR flight movements in Europe up to 2050.** It focuses on developments after 2035; traffic evolution between now and 2035 is discussed in the EUROCONTROL Medium Term and Long-Term Forecasts published in February 2013 and June 2013 respectively (Ref. 1, 2).

Previously STATFOR has met ad-hoc requests for 2050 projections by extrapolating trends from the later years of the existing long term forecast. The 2050 horizon has been specifically requested for Challenges of Growth 2013 (CG13), and we evolve the methodology by specifically considering the drivers between 2035 and 2050.

**The 2050 forecast does not aim at providing the exact future traffic counts, but focuses rather on understanding the factors** that will form the future air traffic and the challenges that lie ahead. The range of likely outcomes presented in the scenarios should contribute to planning and managing risk, and help cope with uncertainty and the potential impact of changes in underlying assumptions.

The development of air transport in Europe is driven by a series of interrelated factors, many of which are external to aviation and indeed external to Europe. Key drivers include demographics (e.g. globally there is high uncertainty about population to 2050) and the global economy (e.g. the European Union is projected to represent 17% of the world economy in 2050, cf. 29% in 2010). Technological advances in particular will have an impact on global aviation markets over the period of 2035 - 2050, and may sharply cut energy consumption, thus reducing environmental impact and dependence on oil products. Many of these advances are likely to come from outside Europe, with Asia moving up traditionally European value chains.

**We use four scenarios to explore European air traffic in 2050**: A – Global Growth; C – Regulated Growth; C': Happy Localism; and D – Fragmenting World. These scenarios are an extension of those in the LTF13. They set the political and economic environment of Europe, providing the context to consider a range of plausible futures for 2050.

The scenarios are differentiated by whether Europe has an 'inward' or an 'outward' perspective at a global level (a primarily political question), and whether Europe adapts (as measured by the economic effect). They do not represent all possible outcomes, and are not necessarily equally probable or exclusive – indeed actual events will probably comprise a combination of factors from different scenarios.

**The scenarios are translated into quantitative terms to serve as input data to the forecast tool.** The scenarios produce different levels and flows of traffic and follow different paths of growth according to their storylines and mix of characteristics factored into the forecast.

- The most 'visionary' scenario, Scenario A (Global Growth), is characterised by strong economic growth in an increasingly globalised World, with technology used successfully to mitigate the effects of sustainability challenges, such as the environment or resource availability. It reflects the highest growth with 26.1 million IFR movements forecast in Europe for 2050 – 2.7 times more than in 2012, although there is significant unaccommodated demand (36% by 2050).

- Scenario C (Regulated Growth) represents an extension to the existing environment we are in today. It is characterised by moderate economic growth, with regulation reconciling the environmental, social and economic demands to address the growing global sustainability concerns. It exhibits a medium level of growth with 18.6 million IFR movements in Europe by 2050 – 2.0 times more than in 2012.

- Scenario C' (Happy Localism) is characterised by the European economies focusing on local exchanges, with nevertheless some adaptation to new technologies but with more environmental consciousness. It exhibits a comparable level of growth to Scenario C, with 17.7 million IFR movements by 2050 – 1.9 times more than in 2012, but exhibits relatively stronger European regional flows.

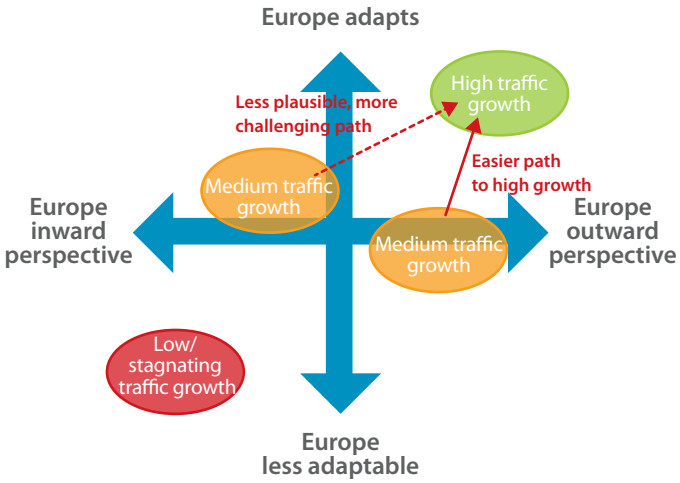
- The forecast for Scenario D (Fragmenting World) exhibits the lowest growth; resulting in 10.5 million IFR movements – only 1.1 times more than in 2012, and it exhibits a 6% decline in traffic between 2035 and 2050. This scenario is characterised by a World of increasing tensions between regions, fragmentation of Europe, with more security threats, reduced trade and transport integration and knock-on effects of weaker economies. Much of the growth in traffic comes from outside of Europe.

**There are a number of key trends that are evident across all scenarios**, to a greater or lesser extent. In all the scenarios, the major growth will come with international arrival/departures, with internal flights declining as a percentage of the total forecast (whilst continuing to be the dominant flow). This is likely a consequence of Europe's declining relative role in the world economy by 2050 in all scenarios, with the major GDP growth and traffic growth being outside of Europe. Even for Happy Localism where there is politically an inward focus in Europe, the expected strong increase in internal traffic is diluted by the fact that by 2050 the majority of global GDP growth is coming from outside Europe.

ESRA NW remains the European region with the highest total IFR movements in 2050, but it will exhibit a decline in the relative proportion of traffic in Europe. ESRA NW – North Atlantic drops out of the Top 10 flows (by number of flights) in all scenarios, with flows from ESRA East and ESRA Mediterranean to Other Europe displacing it. The significant growth (as a fraction of 2012 traffic) comes from ESRA East and (by number of flights) ESRA Mediterranean flows, particularly international flows to North Africa and Asia/Pacific, and to Other Europe.

**The use of scenarios in developing new strategies and assessing existing strategies is particularly aimed at policy makers and business planners**. Scenarios should provoke thought – how could we manage if there was 2.7 times today's air traffic (as for Scenario A which exhibits the highest growth) – and in what economic and technological state would we be to manage with such growth? What would be disruptive to the current assumptions? Should governments support plans for extending capacity? What are the 'early warning signs' that tell us which scenario is beginning to unfold?

We postulate that the 'y axis' in the scenario matrix, economic and technical adaptability, is the most critical for stimulating aviation growth in Europe, even if the growth forecasted is still moderate compared to the second half of the twentieth century. However, the political orientation of Europe should not be discounted if economic adaptability is desirable – in a world where Europe will become a declining player on a global scale, the easiest route to higher traffic growth is for Europe to maintain an outward focus.




**If high growth in Europe is expected, there are some things that policies and business plans can impact**, and others that policy and planning professionals need to keep a watching brief on (for example the global economic and political situation, demographics). The main challenge will be to continue to deliver mobility, when demand growth and technology gains are increasingly outside Europe. As the highest economic and population growth shifts to Africa and Asia, the demand for air transport in these regions could expand substantially over the coming decades and this must be exploited.

Other challenges will be linked to decoupling aviation resource use from economic growth by using less oil fuel products and reducing environmental impact, and yet in an environment where economies continue to grow. Furthermore, in the higher traffic growth scenarios it is clear that airport capacity will continue to substantially limit growth; on our projections here, this will be particularly in ESRA Mediterranean, and it will be necessary for policy planners to decide if, and how, to invest to accommodate demand.

# CONTENT




## Acknowledgements:

We would like to thank the members of the STATFOR User Group and the Working Group 1 (WG1) of the community observatory on airport capacity who contributed to the scenario workshop of this task.

This task of Challenges of Growth has been prepared by Helios and SAMI Consulting for the Network Manager of EUROCONTROL.

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# INTRODUCTION

## 1 Introduction

**This report presents the first EUROCONTROL forecast of IFR flight movements in Europe up to 2050. It focuses on developments after 2035; traffic evolution between now and 2035 is discussed in the EUROCONTROL 7- and 20-year forecasts published in March 2013 and June 2013 respectively (Ref. 1, 2).**

**The 2050 forecast does not aim at providing the exact future traffic counts, but focuses rather on understanding the factors that will form the future air traffic and the challenges that lie ahead. The range of likely outcomes presented in the scenarios should contribute to planning and managing risk, and help cope with uncertainty and the potential impact of changes in underlying assumptions.**

### 1.1 General

EUROCONTROL has completed three studies in the Challenges of Growth series: in 2001, 2004 and 2008. The fourth version is now under way, for completion in mid-2013. The aim of Challenges of Growth 2013 (CG13)[1] is to deliver the best-achievable information to support long-term planning decisions for aviation in Europe. The study overall will address the following question:

*What are the challenges of growth for commercial aviation in Europe between now and both 2035 and 2050?*

The aim of Task 7 of the new study is to develop, for the first time, a forecast of annual numbers of instrument flight rules (IFR) movements in Europe up to 2050. This complements the existing 7- and 20-year forecasts already produced by EUROCONTROL.

Very Long-Term (VLT) forecasts have previously been produced by EUROCONTROL on an ad-hoc basis, looking ahead 40 years, by extrapolating from the later years of the existing long-term forecasts. Now, under CG13, a forecast to the 2050 time horizon has specifically been requested in addition to the 2035 horizon. This reflects the fact that long term strategies for some aspects of aviation need to go well beyond the 20-year horizon - environmental issues for example - and decision makers need the best-achievable set of information to inform longer-term plans.

For this task of CG13, we have built on current best practice and tools to improve on the previous extrapolations and provide high-level forecasts of air traffic in Europe up until 2050.

This report is structured as follows:

- The remainder of Section 1 summarises the challenges of planning for the distant future and the forecast method.
- Section 2 discusses the key trends and issues driving European air traffic to 2050.
- Section 3 presents four scenarios for 2050.
- Section 4 discusses what future demand might be like in 2050.
- Section 5 addresses how to use the 2050 scenarios and related forecasts to plan for the future.

### 1.2 Planning for the distant (20 years +) future

When confronted with today's challenges, with short-term financial pressures, or even with the challenges of 2035, 2050 may seem like too far away to need to plan for. However, decisions we make today - for policy, infrastructure, concepts and technology - can strongly improve or reduce our ability to respond as the challenges of 2050 come more sharply into focus.

Policy makers are heavily reliant on forecasts to shape their judgement, but relying on point forecasts to 2050 is not practical - a point forecast is merely one point in a sea of possibilities. The uncertainties range from the timescale in which events will happen, to what trends and events will have most effect. This is particularly marked for complex landscapes such as aviation, where the range of internal and external drivers of demand and supply is extremely broad.

To "future proof" major investments, such as building runways or airports, the aim is to make a least-regret choice that should be robust to as many of the possible futures as possible, rather than targeting a single 'optimum' outcome.

[1] http://www.eurocontrol.int/articles/challenges-growth

**The 2050 forecast therefore does not aim at providing the exact future traffic counts**, but focuses rather on analysing and explaining the factors that will shape the future air traffic and the risks and challenges that lie ahead. The range of likely outcomes presented in the scenarios should contribute to planning and managing risk, and help deal with uncertainty and consider paradigm shifts.

**This report is not an end in itself**. While developing coherent, imaginative and useful scenarios and forecasts is important, scenarios create a shared language for understanding the environment in which they operate, and for discussing future options for the aviation sector. Scenarios can be used to frame strategic discussions between stakeholders, and can improve decision-making. For example, how would we plan for a desirable future? What are the decision points when action has to be taken for each scenario? Translating the implications of the scenarios into improved decision-making and creating explicit links to the strategic management process is crucial as illustrated in the following diagram adopted by the European Commission's Directorate of Research and Innovation.

**All of the 2050 scenarios should be evaluated** both for policy implications and air traffic volumes.

For policy makers, it is important to have a view of possible futures in order to anticipate potential disruptive trends or factors affecting air traffic.

Business planners (e.g. infrastructure and service providers), on the other hand, are primarily concerned with day-to-day optimisation to deal with today's issues. However, even for these stakeholders, a longer term view is essential in providing a context for optimisation and thinking about limits of the current capacity.

Long term planning is often asked of people who also do short (or immediate) term planning. Both types of readers will find that awareness of early indicators increases the range of external factors that they become aware of, which could affect their organisation, and so are enabled to better anticipate changes. Early indicators of change are provided in Section 5.3.

**This report complements the other reports in the CG13 series** – in particular the LTF13 (Ref. 1), Task 3 which sets out the challenges (Ref. 4), and the mitigation task – what to do about unaccommodated demand (Ref. 5).

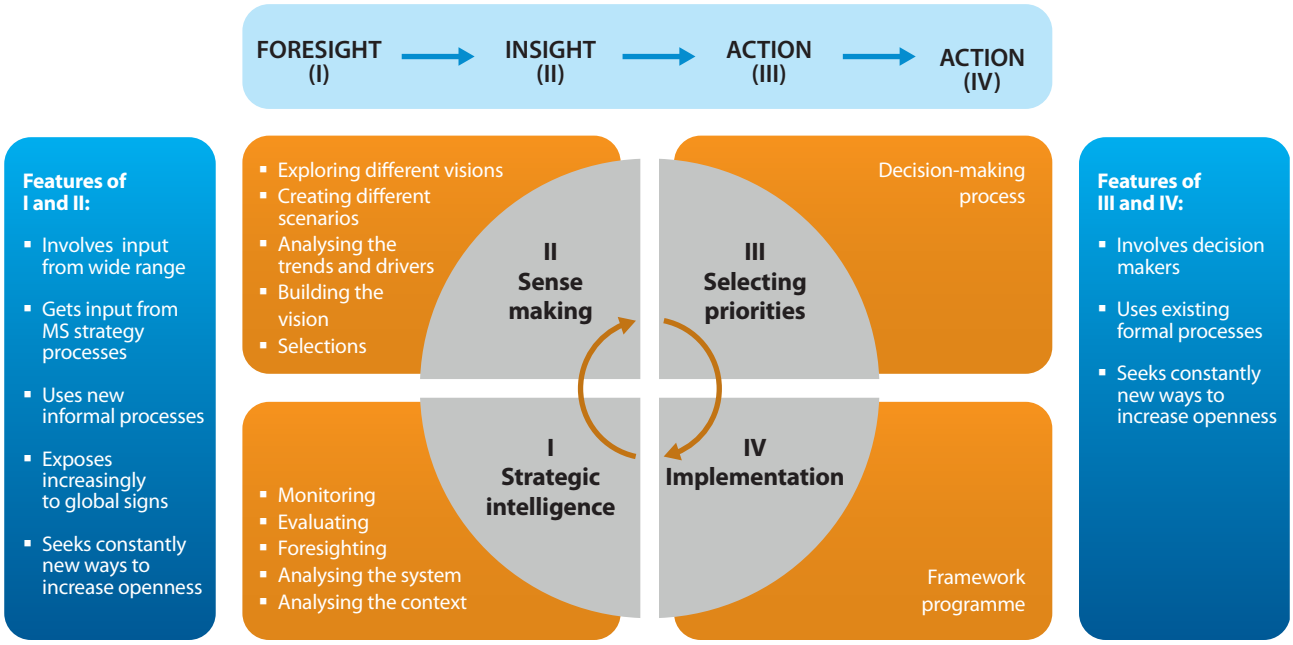



**Figure 1: Elements of the future EU strategic process (Ref. 3)**

### 1.3 Summary of forecast methodology

This 2050 forecast uses the same approach as the LTF – in that it uses qualitative scenarios, to develop quantitative assumptions that in turn drive quantitative forecasts, generated using the long-term forecast tool, in order to consider a range of plausible futures for 2050 and how they might emerge.

The 2050 forecast presents four scenarios which take over from those developed for the LTF13; they are qualitatively-different representations of the many possible (rather than predicted) futures. They were selected using the formal scenario planning technique, guided by views expressed from the STATFOR User Group (SUG) and the WG 1 of the Airport Observatory at a workshop held in EUROCONTROL on 15 and 16 October 2012.

We have used each of these scenarios to set parameters for the accompanying quantitative forecasts. The 2050 forecast method uses a model of economic and industry developments to grow airport-pair traffic forecasts, starting from the last forecast year of each of the scenarios within the LTF13. The model addresses passenger, cargo, military GAT, business aviation and small airport-pairs' traffic by specific sub-models and then combines the results to produce the final traffic forecast per traffic region. Further detail of the methodology is provided at Annex A.

It should be noted that the LTF model was designed to forecast traffic in a world with no discontinuous change, and where traffic is driven by GDP growth. Both of these assumptions could break by 2050, and the scenario forecasts are therefore constrained by this.

## 2 Key trends and issues driving European air traffic to 2050

**The development of air transport in Europe is driven by a series of interrelated factors, many of which are external to aviation and indeed external to Europe. Key drivers include demographics (e.g. globally there is high uncertainty about population to 2050) and the global economy (e.g. the European Union is projected to represent 17% of the world economy in 2050, cf. 29% in 2010). Technology advances in particular will have an impact on global aviation markets over the period of 2035 - 2050, and may sharply cut energy consumption, thus reducing environmental impact and dependence on oil products. Many of these advances are likely to come from outside Europe, with Asia moving up traditionally European value chains.**

**The discussion below is meant to provide a framework for the scenarios, and is built on the references listed. It was not the main purpose of this project to do a full literature review and this list is not intended to be, and is by no means, exhaustive.**

### 2.1 Global and European business environment

#### Demographics

There are two demographic factors which influence passenger demand: the total size of a population and the age composition of the population, with a disproportionate number of air passengers in the 25-54 years age bracket in 2006.

Globally, there is more uncertainty about population to 2050. In 2035 it is reasonable to take a middle view of population, however by 2050 global population is forecast by the UN to be between 7.4 and 10.6 billion (with a mid-range of 8.9) according to the low-growth and high-growth scenarios. Much of the demographic change up to 2050 will take place in the less-developed regions. Collectively, these regions will grow 58% over 50 years, as opposed to 2% for more developed regions (Ref.6).

Population ageing, the shift towards an increased proportion of older persons in the population, is a global phenomenon resulting from rapid declines in fertility rates coupled with reductions in mortality and increased longevity. The age composition of the population is transitioning to an older structure in all regions of the world. In 2050, the age pyramids are projected to have a more rectangular, or older, shape in both the less and more developed regions, a sign of a more advanced stage of ageing (Ref. 7).

In Europe, the population is likely to age and see an overall decline; much of the projected global growth in population in coming decades taking place in the least developed countries. Europe's share of the global population is projected (in the UN medium-variant) to shrink from 11% (today) to 7% by 2050, whilst Africa is projected to have 20% of world population (up from 13% now) (Ref. 6).

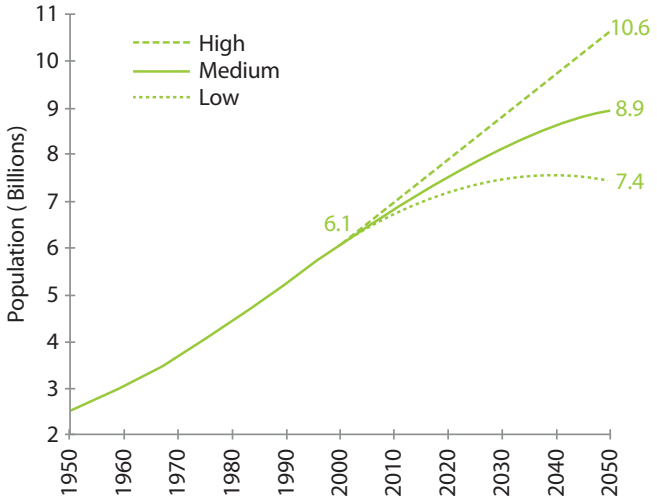



**Figure 2: Estimated world population, 1950-2000, and projections: 2000-2050 (Ref. 6)**

### Global economy and the role of Europe

Global economic growth has historically been a key driver of growth in air traffic demand. The rate and stability of European GDP growth will in part hinge on the future performance and stability of the global economy.

Over the past ten years, Asia has accounted for half of the world's GDP growth. At the end of 2008, Asia's GDP was just under US$14 trillion – roughly the same as the US – and all indications are that its growth will continue to outpace Europe and the US as we head in the next decade. Up to 2025, the highest growth rate is achieved by China, but from 2025 to 2050 it is overtaken by India and Sub-Saharan Africa on average, the latter outperforming the former around year 2040 (Ref. 8).

With the long-term growth in the BRIC economies surpassing that of the highly indebted western economies, the global centre of economic gravity will shift towards Asia (Ref. 9). EU27 is projected to represent 17% of the world economy in 2050 (compared to 29% in 2010), with China (20%) dominating the United States (17%), India (7%), and Japan (5%) (Ref. 8).

## 2.2 Technology and aviation Technology

As the demand for aviation has grown, and with safety as the predominant requirement, the way in which aircraft are designed, operated, and powered has evolved in order to ensure that air transport has remained possible, efficient, comfortable, affordable, and environmentally sustainable (Ref. 10).

Aviation is now marked by the high complexity of its components, products, vehicles, systems and systems-of-systems, all of which are both technology and capital intensive (Ref. 11). Radical new technologies, including blended-wing/body design, new materials, on-board fuel cell systems and previously inconceivable engine architectures may become commercially viable by 2050 (Ref. 12).

Many of these developments could come from outside Europe. By 2050, emerging economies such as Brazil, India and China, which traditionally have played a secondary role in the global innovation landscape, are likely to have caught up in developing their own innovative capabilities and some have emerged as major players in certain technology intensive Key Emerging Technologies sectors. For example, Chinese companies are rapidly moving up strategic industry value chains previously considered as "European" (Ref. 13).

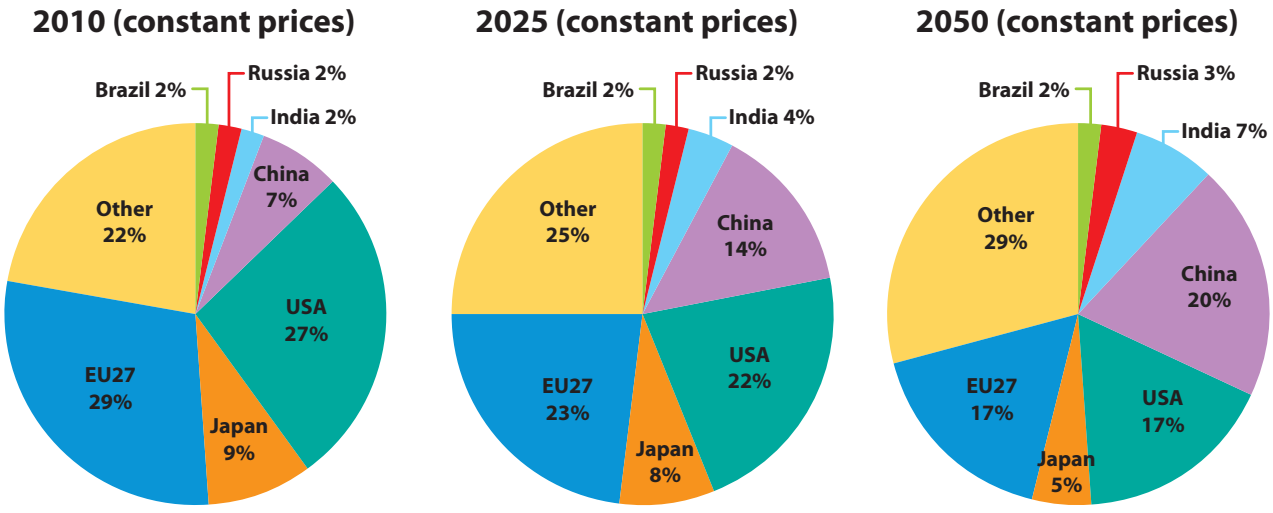



**Figure 3: Shares of the world economy, 2010, 2025 and 2050 (in % of world GDP) (Ref. 8)**

**Environmental impact**

The environmental impacts of aviation are both global (e.g. $CO_2$ emissions from burning fuel) and local (e.g. noise and local air quality impacts) (Ref. 14). Aviation industry stakeholders have long been working to reduce such environmental impacts, with notable results. However, there is significant risk of climate change related impacts affecting the European aviation system – e.g. on tourist locations and demand patterns which affect both the timing and location of traffic peaks and flows, increased extreme weather events affecting airport operations and ATM capacity (Ref. 15). This risk increases over time.

By 2050 technological advances may sharply cut energy consumption in production, operation, distribution and waste processes and are expected to reduce the overall environmental impact of aviation, particularly with regard to reducing $CO_2$ emissions. By 2050 technology of airframes and air traffic management systems will have advanced, with advances anticipated in propulsion, new materials, aerodynamics and avionics/systems. It is suggested that in order to comply with environmental regulations, and to deal with increased oil prices and overcrowded airports, new aircraft configurations will be developed to fly further with lighter frames, increased fuel efficiencies and reduced noise. While the predominant large aircraft types of 2035 are already mostly for sale, the aircraft fleet of 2050 will include significant numbers of aircraft that are still at best in conceptual design. Other advances such as formation flying, and sharing airspace between UAVs and manned planes could also be possible. All of these will change the mix of aircraft, the ratio between flights and passengers and the demand for hub airports.

Moving away from reliance on oil fuel products could increase sustainability. Biofuels and natural gas are the two most promising alternative fuels; by 2050 the Sustainable Aviation Group suggests that an 18% use of alternative fuel may be possible with the right incentives and structures, and the 2011 European Commission Transport White Paper proposes an aspirational target of 40% by 2050 (Ref. 16). The use of biofuels to reduce carbon emissions is based on the premise of sustainability, and the future success of biofuels will depend on two major factors: the expansion of cultivated land, and improvements in agricultural technologies and productivity. By 2050 the next generation of biofuels, such as those based on algae or using cellulose, may be commercially viable and prove to be genuinely sustainable (especially if oil prices climb as forecast). Brazil is expected to remain the leading bioethanol exporter for the coming decades (Ref. 17). Besides the Americas and Europe, countries in Africa and Asia (especially China) have the potential to become major producers and exporters of biofuels. By 2050, the proportion of alternative fuel use will have increased although it is unlikely to be higher than around 10-15%. Even if alternative fuels become more commercially viable, sources of fossil fuels in the Middle East and North Africa will become increasing important particularly for new hub operations.

**Demand for air travel**

The purpose of a journey, be it passenger travel (business, leisure or migration) or air freight, and the relative global patterns of each element in the future is an important aspect of demand for aviation. For example, different types of passengers respond very differently to economic drivers such as changes in fares and income. Factors such as the quality of the passenger experience (influenced by, for example, passenger ticketing and security at airports) will also impact demand differently - affecting the demand for leisure and business travel, but to a lesser extent migration-related travel.

In most developed countries, holiday travel is by far the most important type of travel (Ref. 18). The demand for leisure air travel is income elastic – meaning that an income change will cause a more than proportionate change in demand for leisure air travel (Ref. 19). In more mature markets changing passenger profiles can have a significant impact on demand – for example, growing experience of travel, better education, smaller families later in life, more single travellers. Market maturity is much debated, and is characterised by a declining level of demand response to changes in income levels in society. As discussed in CG13 Task 3 (Ref. 4), European markets are getting more mature, but only national domestic flows are beginning to look to have reached maturity. North America and North West Europe are typically considered to be the most mature markets, but by 2050 other markets are likely to have matured.

The link between migration and air traffic is clear but variable; while the changes in flight counts are in some cases of the same order as the net migration, there are plenty of cases where significant migration brings little in extra flights. Future migrations, as in the past, are likely to be driven by economic reasons (Ref. 4).

For business travel, whilst the generations that have seen the introduction of virtual technologies may not be able to imagine a shift away from face-to-face contact, the generation that has grown up with virtual connectivity may perceive this differently. By 2050 virtual meetings may become the norm for this generation, particularly if advances in technology lead to a better and 'more real' user experience.

Fast, though costly, air freight has in the past decade moved in line or more slowly than overall world trade. This reflects the globalization of business supply chains and increasing international trade (Ref. 10). The continued growth of air freight, in particular long-haul transportation, will likely continue to depend on world trade.

**Advances in ground transport**

The High-Speed Train (HST) is the most important competition to flying short distances, although over the period to 2050 other alternatives such as driverless cars have the potential to disrupt the transport market (Ref. 20). Though unlikely to be a serious challenge to air transport, they may alter the base from which an airport can draw its passengers.

The impact of HSTs on aviation is debated. In 2010 the total distance covered by railway networks was 2.5% of that of the aviation network, and analysis by Boeing shows that passenger traffic on the Chinese HSR network would account for less than 2% of the domestic revenue passenger-kilometers flown by Chinese carriers in 2009 (Ref. 21). However, HST networks are growing across the world and could change the demand pattern inside Europe and eastwards. A number of EU countries are building high speed railways (Ref. 22), and China has ambitions to build a high speed railway line to Europe, with a journey time of 2 days (Ref. 23).

Maglevs may become more economically viable by 2050, including over a longer range, and form a significant substitute for air traffic in Europe, and to the East. The superconducting Maglev has the potential to cut $CO_2$ emissions by two-thirds and reduce transport times by half compared to conventional rail, speeds up to 500km/h (Ref. 17). For example, a Maglev line with a cruising speed of 500 km/h is proposed between Berlin and Moscow, cutting the travel time to under 4 hours (Ref. 24).

[2] *For the LTF13, airport capacity data is based on EUROCONTROL survey data which extends to 2035, but no data exists beyond this; 0.8% is a continuation of the reported rate of addition.*

[3] *In the sense of no longer growing as the economy grows.*

# 3 Scenarios for European aviation in 2050

**We use four scenarios to explore European air traffic in 2050: A – Global Growth; C – Regulated Growth; C': Happy Localism; and, D – Fragmenting World. These scenarios are extension of those in the LTF13. They set the political and economic environment of Europe, providing the context to consider a range of plausible futures for 2050.**

**The scenarios are differentiated by whether Europe has an 'inward' or an 'outward' perspective at a global level (a primarily political question), and whether Europe adapts (as measured by the economic effect). They do not represent all possible outcomes, and are not necessarily equally probable or exclusive – indeed actual events will probably comprise a combination of factors from different scenarios.**

## 3.1 Scenario development

### The context

The scenarios were developed as outlined in Section 1.3 and Annex A. The focus of this project was not to create an original set of macro-economic and political scenarios, but to build on and refresh the wealth of existing studies. Therefore, to 'flesh out' the scenarios and drivers in the following sub sections we have been guided by the extant material available which is referenced throughout this report.

The scenarios for Europe are framed within the context of two key variables which emerged from the workshop on 15th/16th October 2012. The questions – the directions of which are uncertain, yet likely to have a major impact on shaping the future course of events – leading to axes are:

- whether Europe has an 'inward' or an 'outward' perspective at a global level - a primarily political question;
- whether Europe adapts well to the prevailing situation (politically, technically, environmentally etc) –measured principally by the economic effect.

Whilst these two axes are related, they are separately uncertain. These axes are used to define the societal attitudes in Europe in each scenario, and subsequently to think about the adoption of technology. We have made the following underlying assumptions across all scenarios, although with different size of impact and emphasis under each scenario:

- Global business environment:
  - **Demographics**
    Global population will increase. Europe's population will age, and Europe's share of the global population will decrease.
  - **Economy**
    however prosperous the European economy, it will become a smaller proportion of global GDP by 2050.
- Technology and aviation environment:
  - **Effect of technology**
    Technology will reduce the environmental impact of aviation and make air travel more flexible. Most relevant technology will be developed outside Europe by 2050 – this enables us in Section 5 to identify technology differences for 2050 which are scenario independent.
  - **Airport capacity**
    Incremental improvements will be made in capacity at an annual rate of 0.8% per annum from 2035 capacities, across the network.[3]
  - **Market maturity**
    Aviation markets will be increasingly mature, led by NW Europe and North America. But in Europe domestic markets remain the ones most likely to reach full maturity. [3]

**The scenarios**

Combining the two axes described above results in quadrants of different futures to explore, to describe what Europe could look like in 2050. The goal was to end up with four contrasting environments, but not all of the scenario spaces are as interesting as others, and some are not necessarily plausible.

The following diagram (Figure 4) shows the positions of the four scenarios on the combined axes, named here as Global Growth, Regulated Growth, Happy Localism and Fragmented World. Scenario C (Regulated Growth) represents a consensus view of an extension to the existing environment we are in today. Scenario A (Global Growth) represents a 'visionary' future of sustainable aviation.

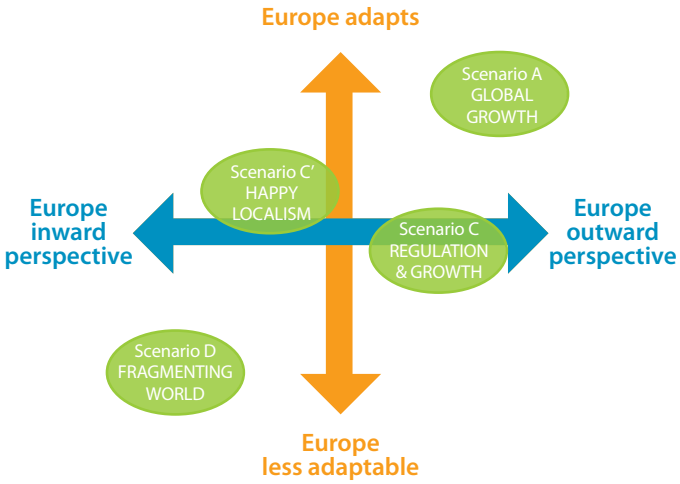



**Figure 4: The four scenarios for 2050**

### 3.2 Scenario A (Global Growth)

This scenario is characterised by strong economic growth in an increasingly globalised World, with technology used successfully to mitigate the effects of sustainability challenges, such as the environment or resource availability.

Global growth represents the visionary future, where the EU remains an important player in the prosperous global market. Despite having a smaller share of global GDP; Europe has remained buoyant by embracing this global change and adapting economically. Europe has politically become stronger and more integrated and has embraced technological developments outside of the EU, to drive a more sustainable and low carbon aviation sector. Turkey joined shortly before 2035, bringing Europe's most populous State into this dynamic Union.

By 2035, incremental technology-efficiency improvements had been fully realised. Commercial production of second-generation biofuels became important after 2040 and, combined with other radical new technologies which are commercially viable by 2045, competitively reduced the price of kerosene and made air travel less reliant on more expensive emissions trading to offset emissions, thereby keeping the real cost of air travel stable. The clear move towards sustainable aviation affected societal attitudes to aviation, and it remains socially acceptable to fly.

This scenario aligns with the European Renaissance scenario from Global Europe 2050 (Ref. 25): "The EU continues to enlarge and become stronger. It consolidates its political, fiscal and military integration. Innovation systems become more efficient with an increased role given to users. Investment in technological and services innovations will have a direct impact on economic and social development. Member States will work together to make the European Research Area fully functional with research agendas being decided in common across Europe. EU GDP almost double by 2050."

Building on this, Flightpath 2050 (Ref. 11) describes a visionary world where "even with the advent of high-speed rail, the distance involved means that air transport remains the only viable direct way of connecting Europe's regions. Even for shorter distances in some geographical areas, aviation sometimes offers the most efficient means of transport. Air transport is the principal way of conveniently satisfying the growing demand for diffused, flexible point-to-point connections."

### 3.3 Scenario C (Regulated Growth)

This scenario is characterised by moderate economic growth, with regulation reconciling the environmental, social and economic demands to address the growing global sustainability concerns.

Regulated growth represents a common view of an extension to the existing environment we are in today. Europe tried to embrace its changing position in the global environment, but progress was thwarted well into the 2020s by political and economic issues within Europe as they tried to grapple with rising national debt. By 2035 the gap widened between Europe and the rest of the world, and Europe's economic growth remains slow (in relation to Scenario A) to 2050. The European Union continues to play a role in the global governance, but its position is relatively weak.

The aviation sector achieved some progress from the 'business as usual' baseline up to 2035, but Europe has not been willing to embrace key technological developments in the East which is limiting progress towards a sustainable aviation sector. Biofuels have become commercially viable, but aviation is competing with other sectors for access to supplies which are limited by concerns about their real sustainability.

It roughly aligns with the 'Nobody cares: standstill in European integration' Global Europe 2050 (Ref. 25) scenario where Europe is seen in a process of prolonged 'muddling through' in the absence of guiding and visionary actors and the lack of a redesigned policy framework. Thus, economic growth remains low in Europe. The divergence between the EU and the leading world economies – USA in the short-medium term, but also China in the longer term – widens, as the latter keep a strong developmental pace (the implicit assumption is therefore a better future trajectory for the rest of the world). The challenges posed by the ageing phenomenon in Europe are not decisively addressed, leading to economic instability. The completion of the European market remains unachieved. There is limited public support to address climate change and other global challenges, leading among others to an increased dependence on the foreign supply of energy."

### 3.4 Scenario C' (Regulated Growth)

This scenario is characterised by the European economies focusing on local exchanges, but nevertheless some adaptation to new technologies but with more environmental consciousness.

Happy localism is a variant of Scenario C, above, and also shares some characteristics of the 'Nobody cares: standstill in European integration' Global Europe 2050 (Ref. 25) scenario. However, Happy Localism has a much more inward focused view of Europe, although with slightly more economic adaptation than in Scenario C.

The political and economic challenges within Europe to 2035 have led to Europe having a much more politically inward view – Europe and its voters have accepted its declining importance on a global scale and have realised that they need to work together to face the challenges over the coming decades. European policy promotes small scale regionally-based economic activity and self-sufficiency. Europeans see merit in dealing with other Europeans and travelling within Europe. There is however willingness to look outside of Europe for key technological developments to improve local issues.

### 3.5 Scenario D (Fragmenting World)

This scenario is characterised by a World of increasing tensions between regions, with more security threats, reduced trade and transport integration and knock-on effects of weaker economies.

Fragmenting world is one of increased global tensions, reduced trade and a continuing trend of global fossil fuels-based energy resulting in carbon constraints. The EU27's share of global GDP is, by 2050, down to around 17% with China and India exhibiting the most growth.

While the EU is ageing rapidly, the number of young people in prime migration age continues to increase in the EU's greater neighbourhood, but migratory flows are hindered by restricting EU Member States immigration policies, aimed to protect the national workforce.

The EU imposed barriers on international trade, and investment restrictions were introduced to focus development and improvements of existing infrastructures. The UK and Denmark, after much debate, finally left the EU in 2043 after becoming disillusioned with the restrictions imposed.

The failure of technology to bring about the promised improvements in reducing the environmental impact of aviation has resulted in more constraints on the sector, including night curfews to limit aircraft noise impact.

This scenario is similar to 'EU under threat: a fragmented Europe' from the Global Europe 2050 (Ref. 25) scenarios which "envisages a global economic decline, with protectionist reactions, the subsequent increase in transaction costs and increasingly congested infrastructures. A range of serious geopolitical risks emerge including possible low-intensity conflicts – civil wars, nuclear conflicts and the radicalization of governments in advanced democracies. The EU heads towards disintegration, triggered by the possible withdrawal of one or more leading Member States and the emergence of two or more speeds of development and integration within the Union. Climate change and its implications are not addressed. Food and oil shocks materialize. Major energy supply disruptions and failures of the different European grid(s) system(s) are becoming more probable due to heavy underinvestment in the renovation of these. The failure of Europe to implement sound research policies leads to a reduction in the pace of innovation. Productivity gains diminish progressively until 2050 within the EU, also compared to the Nobody cares scenario. Unlike Europe, the rest of the world and especially the emerging markets reap their potentials to economic growth, so that the rest of the world continues to keep a relatively strong developmental pace."

Parallels can also be drawn with the Fallen Angel scenario within 'Scenarios for Long-Haul Tourism in the Evolving Global Climate Change Regime' (Ref. 11) where, in 2050, the tourism sector is often compared to a 'fallen angel': due to its historical contribution to GDP and employment, it had so much .

### 3.6 Arriving at quantitative differences between the scenarios

The general scenario storylines in Section 3.1, in conjunction with the major driving factors in Section 2, can be translated into quantitative terms to serve as input data to the scenario forecast tools which are the basis of Section 3.

A summary of the main characteristics for each scenario is shown in Figure 5, and in more detail in Annex A. The characteristics are presented around the factors within the forecast model - passengers, economic conditions, price of travel, network and market structure.

The majority of the inputs are derived from scenario storylines and related assumptions, and necessarily jump off the values for 2035 for each scenario in the LTF13 – this is a feature of how the model works, and how the forecast is reported.

| | A<br>**Global Growth** | C<br>**Regulated Growth** | C'<br>**Happy Localism** | D<br>**Fragmenting World** |
|---|---|---|---|---|
| Scenario conditions | High adaptability Europe outward perspective | Not very adaptable Europe outward perspective | Some adaptability Europe inward perspective | Very resistant to change Europe inward perspective |
| 2035 traffic growth | High ↗ | Medium → | Medium → | Low ↘ |
| **Passenger** Demographics (Population) | UN High-fertility variant for all regions apart from Southern and Eastern Europe (Medium – fertility) | UN Medium-fertility variant for all regions | UN Medium-fertility variant for all regions apart from Eastern and Southern Europe (low – fertility variant) | UN Medium-fertility variant for all regions apart from Europe (zero migration variant) |
| Routes and Destinations (tourism) | Europe →<br>External ↗ | Europe →<br>External ↘ | Europe ↗<br>External ↘↘ | Europe ↗<br>External ↘↘ |
| Sensitivity to ticket price | Less sensitive, particularly outside Europe ↘↘ | Base → | Base for Europe →<br>Less sensitive outside Europe ↘ | More sensitive, particularly inside Europe ↗↗ |
| High-speed rail | 54 city-pairs | 54 city-pairs | 54 city-pairs | 42 city-pairs |
| **Economic conditions** GDP growth | Stronger ↗ | Moderate → | Moderate → | Weaker ↘ |
| | Downward elasticity trends for all as markets mature.<br>ESRA NW and North Atlantic most mature for all scenarios – lowest elasticity | | | |
| GDP elasticity | Higher elasticity ↗ | Medium elasticity →<br>but higher outside Europe (E - RoW) | Medium elasticity →<br>but higher inside Europe (E - E) | Lower elasticity ↘<br>particularly E-E and E-RoW |
| EU Membership GDP boosts | Stronger political union ↗ | Stable → | Stable → | Some fragmentation ↘ |
| Free Trade | More, global | Limited | Limited | None |
| **Price of travel** Operating cost | Decreasing ↘↘ | Decreasing ↘ | Decreasing ↘ | Increasing ↗ |
| Fuel as % of operating cost | Decreasing ↘ | Stable → | Stable → | Increasing ↗ |
| Price of kerosene/barrel | Low ↘ | Medium → | High ↗ | High ↗ |
| Ticket price trend | Short haul ↘↘<br>long haul ↗ | Short haul ↘<br>long haul ↗ | Short haul ↘<br>long haul ↗↗ | Short haul ↗↗<br>long haul ↗↗↗ |
| **Structure** Network | Middle-East hubs ↗↗<br>Europe ↘ Turkey ↗ | Middle-East hubs ↗↗<br>Europe & Turkey ↗ | Middle-East hubs ↗↗<br>Europe & Turkey ↗ | No change → |
| Market Structure | Medium ↗↗<br>Large - Very Large ↗ | Medium<br>to Very Large ↗ | Large ↗<br>Very Large ↗ | Large ↗<br>Very Large ↗ |
| Load factors | Low ↘ | Medium → | High ↗ | High ↗ |
| Business aviation | Highest growth | Medium growth | Lowest growth | Lowest growth |

**Figure 5: Scenario summary characteristics**

## 4 What might be the future demand for air traffic?

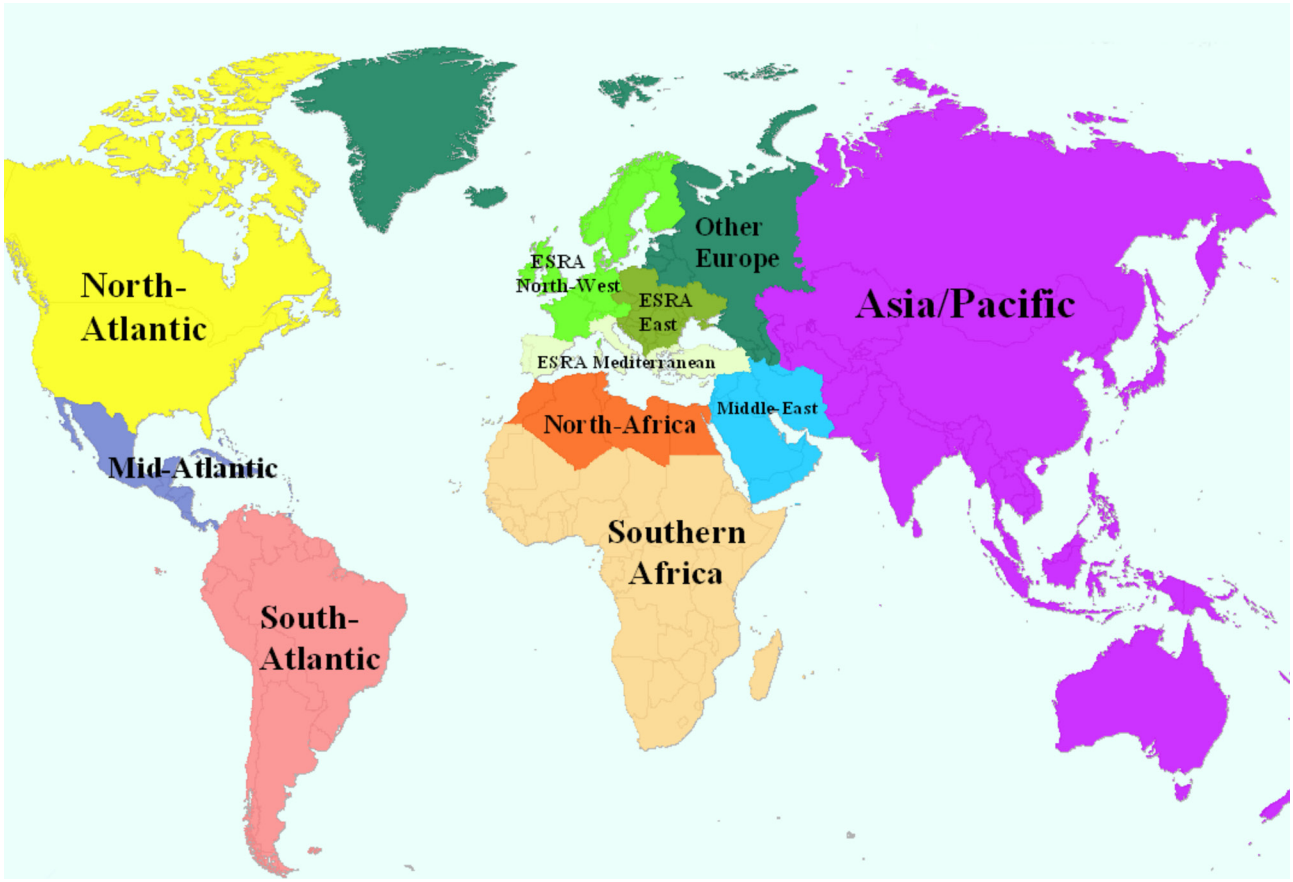
**The scenarios are translated into quantitative terms to serve as input data to the forecast tool. The scenarios produce different levels and flows of traffic and follow different paths of growth according to their storylines and mix of characteristics factored into the forecast.**

**There are a number of important trends that are evident across all scenarios, to a greater or lesser extent. In all the scenarios, the major growth will come with international arrival/departures, with internal flights declining as a percentage of the total forecast. This is likely a consequence of Europe's declining relative role in the world economy by 2050 in all scenarios. The significant growth (as a fraction of 2012 traffic) comes from ESRA East and ESRA Mediterranean flows, particularly international flows to North Africa and Asia/Pacific, and to Other Europe.**

### 4.1 Quantitative scenario forecasts

The forecast for the ESRA08 region for 2035-2050 is presented in Figure 7, on a combined plot with the LTF13 and the most recent MTF[4]. This forecast is limited by the projected available capacity at the airports. It is reported at an ESRA level only, with data for ESRA08, ESRA North West (NW), ESRA Mediterranean and ESRA East as shown in the figure below. Due to the nature of the assumptions made within the 2050 forecast, in particular adopting a region-wide trend for growth of airport capacity (see Section 3.2), it is not appropriate to report results at State level.

**Figure 6: STATFOR Traffic Regions and ESRA sub-regions**




[4] *Please note that population forecasts globally differ by +/- 20% for 2050 and so this sets the maximum possible accuracy of these forecasts.*

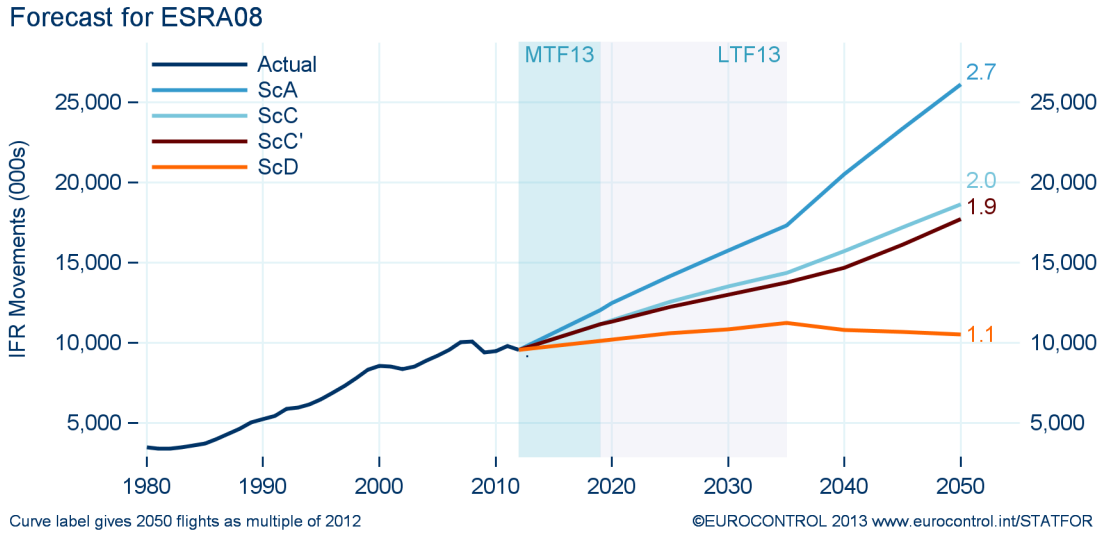



**Figure 7: Constrained forecast for 2050 (combined with the MTF and LTF)**

The different scenarios exhibit different growth rates; this is summarised in the following table. The differences in the scenario forecasts are discussed in the following sections, and presented in more detail in Annex B.

Unlike for the 20-year forecast, there is no 'most likely' scenario identified. Whilst Scenario C represents a common view of an extension to the existing environment we are in today, it is not appropriate to identify a 'most likely' scenario over this extended time horizon when there is such scope for uncertainty.

| | IFR Movements (million) | | | Annual Growth | | | AAGR 2050/ 2012 | Traffic Multiple 2050/ 2012 |
|---|---|---|---|---|---|---|---|---|
| | 2012 | 2035 | 2050 | 2012 | 2035/ 2012 | 2050/ 2035 | | |
| **A:** Global Growth | 9.5 | 17.3 | 26.1 | -2.4% | 2.6% | 2.8% | 2.7% | 2.7 |
| **C:** Regulated Growth | - | 14.4 | 18.6 | - | 1.8% | 1.8% | 1.8% | 2.0 |
| **C':** Happy Localism | - | 13.8 | 17.7 | - | 1.6% | 1.7% | 1.6% | 1.9 |
| **D:** Fragmenting World | - | 11.2 | 10.5 | - | 0.7% | -0.4% | 0.3% | 1.1 |

**Figure 8: Summary of scenario forecasts for ESRA08**

However, there are a number of trends that are evident across all scenarios, to a greater or lesser extent:

- **The major growth will be in flights into/out of the region**, and also overflights, with internal flights declining as a percentage of the total forecast (whilst continuing to be the dominant flow). This is likely a consequence of Europe's declining relative role in the world economy by 2050 in all scenarios.
- **ESRA NW will remain the region with the highest total IFR movements** in all scenarios, but will exhibit a decline in the relative proportion of traffic for all scenarios.
- **Overall ESRA East will see the highest growth in flights by 2050** (as a fraction of 2012), whilst ESRA Mediterranean will see the highest number of additional flights in all scenarios - these markets are relatively less mature, and their economies are developing faster.
- **ESRA NW – ESRA NW remains the top flow for all scenarios** (by number of flights), as for 2012.
- **'ESRA NW – North Atlantic' drops out of the Top 10 flows** (by number of flights) in all scenarios, with flows from ESRA East and ESRA Mediterranean to Other Europe displacing it.
- **The most significant growth comes from ESRA Mediterranean and ESRA East flows**, (as a fraction of 2012 movements) particularly international flows to North Africa and Asia/Pacific. The most significant growth in Europe - Europe flows (as a fraction of 2012 movements) is from ESRA East and ESRA Mediterranean to Other Europe, and ESRA East – ESRA Mediterranean.
- **There is a trend to an increasing proportion of medium- to long-haul flights.**
- **There is unaccommodated demand** in all scenarios by 2050, with the majority of this demand in ESRA Mediterranean.

## 4.2 Scenario A (Global Growth)

This scenario is characterised by strong economic growth in an increasingly globalised World, with technology used successfully to mitigate the effects of sustainability challenges, such as the environment or resource availability.

The Global Growth scenario, driven by high global GDP and decreasing operating costs due to the advent of more sustainable aviation, exhibits the highest growth of the four scenarios with the European aviation market 2.7 times larger by 2050, than in 2012 with 26 million IFR movements. Growth increases after 2035 when major technological advances are introduced which drive a more sustainable and low carbon aviation sector and keep costs stable.

Whilst this scenario exhibits a decrease in the percentage of internal European flights, it remains characterised by strong European flows in 2050, with more flows to 'Other Europe' (mostly Russia) entering the Top 10 regional flows. 'ESRA NW - North Africa' is the only non-European flow in the Top 10. The major growth in routes comes from ESRA East and ESRA Mediterranean, with 'ESRA East – North-Africa' and 'ESRA East – Asia/Pacific' reflecting the shift in global economy. The strong performance of Europe, however, reflects its economic and political adaptability.

There is significant unaccommodated demand in this scenario, with the 18% unaccommodated demand by 2035 rising to 36% by 2050. The majority (51%) of the unaccommodated demand is in ESRA Mediterranean.

### 4.3 Scenario C (Regulated Growth)

This scenario is characterised by moderate economic growth, with regulation reconciling the environmental, social and economic demands to address the growing global sustainability concerns.

Scenario C (Regulated Growth) exhibits a moderate level of growth, which picks up pace slightly after 2035 as Europe moves on from its political and economic issues that thwarted the previous decades, as they tried to grapple with rising national debt. Traffic is forecast to be twice that of 2012 by 2050, with 18.6 million IFR movements. By 2050 there is 19% unaccommodated demand in Europe in this scenario, largely in ESRA Mediterranean.

Scenario C is, like Scenario A, characterised by strong European flows but non-European movements have a stronger presence with 'ESRA NW - North Africa' and 'ESRA NW – Asia/Pacific' remaining in the Top 10 flows. This reflects Europe's unwillingness to embrace key technological developments in the East which is limiting progress towards a sustainable aviation sector. As for Scenario A, the highest growth (as a fraction of 2012 movements) in regional flows is to outside of Europe, including 'ESRA East – Asia/Pacific' and 'ESRA East – North-Africa'.

### 4.4 Scenario C' (Happy Localism)

This scenario is characterised by the European economies focusing on local exchanges, but nevertheless some adaptation to new technologies but with more environmental consciousness.

Scenario C' (Happy Localism) exhibits a comparable moderate level of growth to Scenario C (Regulated Growth), with 17.7 million IFR movements by 2050 – 1.9 times the traffic in 2012. By 2050 there is 15% unaccommodated demand in Europe in this scenario, largely in ESRA Mediterranean.

Scenario C' is characterised by strong European flows, with more flows to 'Other Europe' entering the Top 10 flows (based on traffic movements) than for other scenarios. The strong inward focus of Europe within this scenario is, however, diluted to some extent by the majority of global GDP growth coming from outside Europe. For example, the main growth in regional flows is still dominated by international flights (e.g. 'ESRA East – Asia/Pacific') although routes to Other Europe exhibit stronger growth than in other scenarios.

### 4.5 Scenario D (Fragmenting World)

This scenario is characterised by a World of increasing tensions between regions, with more security threats, reduced trade and transport integration and knock- on effects of weaker economies.

The forecast for Scenario D (Fragmenting World) exhibits the slowest growth; with on average only 0.3% AAGR to 2050, resulting in 10.5 million IFR movements – only 1.1 times more than in 2012.

This stagnation in traffic results from the lack of political or economic adaptability, resulting in low GDP growth in Europe and higher operating costs for airlines. A 6% decline in traffic is seen between 2035 and 2050, reflecting the turmoil in the EU over this period, the continued increase in the cost of flying, and flying becoming less socially acceptable due to the environmental impacts.

This scenario exhibits the biggest decrease in internal ESRA flights, falling from 73% (2035) to 67% of total flights by 2050. The highest 'growth' in regional flows comes from 'ESRA East – Asia/Pacific' and 'ESRA Med – Asia/Pacific', with only two Europe flows in the Top 10 growth. This reflects Europe's declining presence in the global economy, which is particularly marked within this scenario.

# 5 Planning for 2050

**The use of scenarios in developing new strategies and assessing existing strategies is particularly aimed at policy makers and business planners. Scenarios should provoke thought – how could we manage if there was 2.7x today's air traffic (as for Scenario A which exhibits the highest growth) – and in what economic and technological state would we be to manage with such growth? What would be disruptive to the current assumptions? Should governments support plans for extending capacity? What are the 'early warning signs' that tell us which scenario is beginning to unfold?**

**If high growth in Europe is expected, there are some things that policies and business plans can impact, and others that policy and planning professionals need to keep a watching brief on (for example the global economic and political situation, demographics).**

## 5.1 How to use the 2050 scenarios for strategic planning

As discussed in Section 1, the 2050 scenarios and forecasts are for use by two types of stakeholder – policy makers and those in business planners related to aviation.

The role of scenarios in the standard cycle from intelligence to implementation, shown in Figure 1, is to gain insight into what the future might hold. Scenarios should provoke thought – how could we manage if there was 2.7 times today's air traffic (as for Scenario A which exhibits the highest growth)? And as Eisenhower famously said "plans are worthless but planning is everything" – a long term plan for air traffic in Europe will need to be kept under review – the question is – what would be disruptive to the current assumptions? Should governments support plans for extending capacity? Should businesses invest in particular routes?

We discuss some of the potential challenges – sources of disruption – below, and we then consider the early indicators relating to these. Early indicators are potential newspaper headlines of events which would signal the development of one scenario rather than another. The awareness of a set of early indicators among operational managers and policy makers reduces the likelihood of the "boiling frog" syndrome, in which gradual, slow change conceals an unexpected future.

## 5.2 Challenges for Europe to 2050

It can be seen from the scenario forecasts that the world envisaged in Scenario A (Global Growth) will result in the highest traffic growth in Europe. This is a world where Europe has remained buoyant by embracing global change and adapting economically. Europe has also become politically stronger and more integrated, and has embraced technological developments outside of the EU, to drive a more sustainable and low carbon aviation sector.

The opposite of this, Scenario D (Fragmenting World), results in eventual decline: a 6% decline in traffic 2050 compared to 2035. Scenario C and C' result in medium, comparable levels, of growth despite being oriented differently politically. It can therefore be postulated that the 'y axis' in the scenario matrix, economic adaptability, is the more critical for stimulating aviation growth in Europe.

However, the political orientation of Europe should not be discounted as unimportant. When developing the scenarios, stakeholders found it difficult to imagine a scenario where Europe has an inward focus, and is very economically adaptable (i.e. a scenario in the top left of the matrix) – this was not considered a very plausible future, particularly with Europe becoming a declining player in the global economy by 2050. Therefore, if economic adaptability is desirable, it is probably a result of an outward focus within Europe. This is illustrated in the following figure.

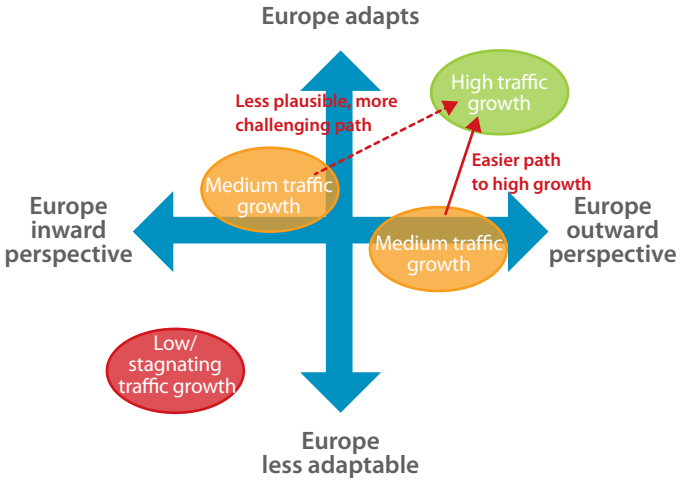



**Figure 9: The challenge of stimulating high traffic growth in Europe**

The challenges will be different for each scenario. If high growth in Europe is expected, there are some things that air travel policies can impact, and others that policy and planning professionals need to keep a watching brief on (for example the global economic and political situation, demographics).

The main challenge will be to continue to deliver mobility, when demand growth and technology gains are increasingly outside Europe. As the highest growth in economy and population shifts to Africa and Asia, the demand for air transport in these regions could expand substantially over the coming decades and this must be exploited in order for European aviation to grow.

Another big challenge going forwards will be to decouple aviation resource use from economic growth by using less oil fuel products and reducing environmental impact, and yet maintain an environment where economies continue to grow, where necessary mobility is still available. It will be important to concentrate research effort to produce both technological, social and public sector innovation and embrace technological advances outside of Europe.

Furthermore, in the higher growth scenarios it is clear that airport capacity will severely limit growth and it will be necessary for policy makers and business planners to decide if, and how, to invest in order to reduce unaccommodated demand. The CG13 mitigation report (Ref.5) analyses the impact of generic mitigation measures on unaccomodated demand (note that they will not mitigate 100% of unaccomodated demand), considering the impacts of:

- accelerating the increase of larger aircraft on congested airport pairs;
- additional HST network;
- use of local alternative airports;
- increasing the capacity of smaller single-runway airports;
- implementing airport and TMA capacity improvements identified by SESAR;
- schedule smoothing.

Success or failure in addressing capacity constraints could affect which of these scenarios evolves. It is clear that links to countries with high economic growth between now and 2050 (e.g. in Asia and Africa) will become increasingly important for the growth of air traffic in Europe. If this demand cannot be accommodated due to existing capacity constraints at airports, this may limit traffic growth in Europe. For example, if the inward stance of Europe in Scenario C' (Happy Localism) results in prioritisation of internal flights, this may limit the potential for growth in air traffic over a longer term.

Policy makers should therefore also carefully consider the implications of route prioritisation at constrained airports on future growth.

### 5.3 Early indicators

Some of the decisions we make today will make sense across all of the future scenarios; others may not. Likewise, the way in which the global environment evolves may rule out some scenarios.

For these we want to know the early warning signs that tell us those scenarios are beginning to unfold. Sometimes, the leading indicators for a given scenario are obvious, but often they are subtle. It may be some legislation, or technical breakthrough, or gradual social trend. Then, of course, it is important to monitor these critical signs closely.

The general trends to watch out for are provided below, followed by a table of specific indicators presented as hypothetical "headlines" that might be found in a newspaper during the early years of the scenario which might lead to each scenario.

- **Demographics**
  Watching overall birth rates, age composition of populations and overall migration rates.

- **Global economy and the role of Europe**
  Monitor rate and stability of European GDP growth, particularly as a share of global GDP. What is the growth of important global economies (e.g. China, India, sub-Saharan Africa and the USA)? How do trade flows evolve (strengthening or weakening links with Africa, India, SE Asia, china, Latin America)? Evolution of the European Union in terms of membership, EC budgets, trade flows (e.g. links with Africa, India, SE Asia, China, Latin America) and politics. In particular watch for developments in Turkey and its association with Europe.

- **Technology**
  What are the levels of investment in aviation-related R&D and technology in the EU and globally? Are new manufacturers entering the airframe market at disruptive prices? Are there any new developments in airframes which give new price/performance mix? How does the Single European Sky progress? Are drones sharing airspace or airports with manned flights?

- **Environmental impact**
  Monitor the commercial viability and uptake of biofuels; the introduction of radical new technologies to reduce $CO_2$ emissions and stringent environmental legislation. Are new routes, and new hubs being used by European airspace users to the East, driven by cheaper fuel (e.g. Middle East, Russia, North Africa, Turkey)?

- **Demand for air travel**
  How do leisure habits change? What is the impact on the link between GDP and aviation – look for trends that markets are maturing and whether the link is breaking. How does migration-related travel evolve, where are the key migration hotspots? Watch how business travel habits evolve, and the use of virtual meetings by younger generations.

- **Advances in ground transport**
  Look for announcements of European HST network expansions, and Maglev lines to the East, e.g. Russia and China. Evolution of driverless cars.

| Indicator | **Sc A** Global Growth | **Sc C** Regulated Growth | **Sc C'** Happy Localism | **Sc D** Fragmenting World |
|---|---|---|---|---|
| **Demographics** | "European population boosted by families of immigrants" | "European population static since 2010" | "European population - stable, well educated, well fed…static since 2010" | "European population has shrunk by 20 million since 2030" |
| **Global economy** | "India and Sub-Saharan Africa forecast to outstrip China growth rates in next 10 years" | "Government and consumers struggle to reduce their debt levels" | "Government and consumers struggle to reduce their debt levels" | "More divergence between the EU and the leading world economies" |
| **Role of Europe** | "Europe hosting global summit on feeding the next 1 billion" | "Europe strives to maintain role in G8" | "Europe increases customs walls against goods from outside EU"<br><br>"Manufacturing and agriculture outstrip services" | "EU on verge of disintegrating with departure of UK and Denmark" |
| **Technology** | "Lufthansa buys low emissions fleet from China"<br><br>"Air traffic moves to connect growth cities in Asia from many locations" | "Insufficient funds for SESAR deployment - airspace users in uproar as deployments delayed by 5 years" | "Insufficient funds for SESAR deployment - airspace users in uproar as deployments delayed by 5 years" | "Ageing fleets of European airlines rejected by passengers" |
| **Environmental impact** | "US hails success in developing low carbon industries"<br>"Massive investment in second-generation biofuels production creates new job opportunities" | "Slow international progress made in curbing carbon emissions" | "Slow international progress made in curbing carbon emissions" | "Demonstrations in London: no to biofuels, land required for food"<br>"Heavy taxation on energy consumption and carbon emissions imposed by EC" |
| **Demand for air travel** | "Leisure travel from Asia dominates European flights" | "Explore the Orient – if you can afford it" | "Top 20 holidays for Europeans are inside the EU – happy to stay local" | "Leisure travellers holiday at home to avoid airport hassle" |
| **Advances in ground transport** | "TGVs cut journey time to Russia, Asia" | "HST connection with Russia approved in small phases" | "TGVs stop at Berlin" | "European HST plans cut after EC budget reduction" |

**Figure 10: Early indicators for each scenario written as hypothetical newspaper headlines**

# METHODOLOGY

## A Methodology

### A.1 Introduction

This annex provides a more detailed description of the methodology that we have used to explore what European air traffic might be like in the period of 2035 – 2050.

### A.2 Overall methodology

This 2050 forecast uses the same approach as the LTF – in that it uses qualitative scenarios to drive quantitative forecasts, generated using the long-term forecast tool set to consider a range of plausible futures for 2050 and how they might emerge:

- We developed four scenarios to explore European air traffic in 2050. The scenarios set the political and economic environment of Europe, and provide the context set to consider a range of plausible futures for 2050 and how they might emerge.
- The scenarios were then translated into quantitative terms to serve as input data to the scenario forecasts, which were produced using the LTF forecasting software.
- The scenarios produce different levels and flows of traffic and follow different paths of growth according to their storylines and mix of characteristics factored into the forecast.

The decision to use the LTF13 forecast model to generate the traffic forecasts was made for the following reasons:

- developing and testing a new model would have been unfeasible within the project constraints;
- to give consistency (as far as possible) between the LTF and 2050 forecast;
- to provide a more robust forecast with explicitly documented assumptions which STATFOR can build upon.

It should be noted that the LTF13 forecast model was designed to forecast traffic in a world with no discontinuous change, and where traffic is driven by GDP growth. Both of these assumptions could break by 2050, and the scenario forecasts are therefore constrained by this.

### A.3 Scenario development

The 2050 forecast presents four scenarios which take over from those developed for the LTF13; they are qualitatively-different representations of the many possible (rather than predicted) futures. They were selected using the formal scenario planning technique (Ref. 26), guided by views expressed from the STATFOR User Group (SUG) and the WG 1 of the Airport Observatory at a workshop held in EUROCONTROL on 15 and 16 October 2012.

The axes chosen, and the scenarios developed are outlined in Section 3. The focus of this project was not to create an original set of macro-economic and political scenarios; therefore, to 'flesh out' the scenarios and drivers in the following sub sections we have been guided by the wealth of extant material available which is referenced throughout this report:

- Political, economic and legal factors: we have drawn on a set of scenarios developed for the European Commission, "Global Europe 2050" (Ref. 25) and CEPII data from 'The Great Shift: Macroeconomic projections for the world economy at the 2050 horizon' (Ref. 8).
- Societal factors: we have drawn on the projections and variants from the United Nations Population Division (Ref. 6) and in Global Europe 2050 (Ref. 25).
- Energy, technology and environmental factors: we have drawn on numerous references including the following – The World Energy Council's 'Global Transport Scenarios 2050' (Ref. 17), academic research on '2050 Scenarios for Long-Haul Tourism in the Evolving Global Climate Change Regime' (Ref. 12) and 'Flying into the Future: Aviation Emissions Scenarios to 2050' (Ref. 27) and ICAO's Aviation Outlook: 2010 – 2050 (Ref. 28).

[5] http://data.un.org/Resources/Methodology/PopDiv.htm#_A._Fertility_assumptions

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This 2050 forecast uses the same approach as the LTF – in that it uses qualitative scenarios to drive quantitative forecasts, generated using the long-term forecast tool set to consider a range of plausible futures for 2050 and how they might emerge:

- We developed four scenarios to explore European air traffic in 2050. The scenarios set the political and economic environment of Europe, and provide the context set to consider a range of plausible futures for 2050 and how they might emerge.
- The scenarios were then translated into quantitative terms to serve as input data to the scenario forecasts, which were produced using the LTF forecasting software.
- The scenarios produce different levels and flows of traffic and follow different paths of growth according to their storylines and mix of characteristics factored into the forecast.

The decision to use the LTF13 forecast model to generate the traffic forecasts was made for the following reasons:

- developing and testing a new model would have been unfeasible within the project constraints;
- to give consistency (as far as possible) between the LTF and 2050 forecast;
- to provide a more robust forecast with explicitly documented assumptions which STATFOR can build upon.

It should be noted that the LTF13 forecast model was designed to forecast traffic in a world with no discontinuous change, and where traffic is driven by GDP growth. Both of these assumptions could break by 2050, and the scenario forecasts are therefore constrained by this.

## A.3 Scenario development

The 2050 forecast presents four scenarios which take over from those developed for the LTF13; they are qualitatively-different representations of the many possible (rather than predicted) futures. They were selected using the formal scenario planning technique (Ref. 26), guided by views expressed from the STATFOR User Group (SUG) and the WG 1 of the Airport Observatory at a workshop held in EUROCONTROL on 15 and 16 October 2012.

The axes chosen, and the scenarios developed are outlined in Section 3. The focus of this project was not to create an original set of macro-economic and political scenarios; therefore, to 'flesh out' the scenarios and drivers in the following sub sections we have been guided by the wealth of extant material available which is referenced throughout this report:

- Political, economic and legal factors: we have drawn on a set of scenarios developed for the European Commission, "Global Europe 2050" (Ref. 25) and CEPII data from 'The Great Shift: Macroeconomic projections for the world economy at the 2050 horizon' (Ref. 8).
- Societal factors: we have drawn on the projections and variants from the United Nations Population Division (Ref. 6) and in Global Europe 2050 (Ref. 25).
- Energy, technology and environmental factors: we have drawn on numerous references including the following – The World Energy Council's 'Global Transport Scenarios 2050' (Ref. 17), academic research on '2050 Scenarios for Long-Haul Tourism in the Evolving Global Climate Change Regime' (Ref. 12) and 'Flying into the Future: Aviation Emissions Scenarios to 2050' (Ref. 27) and ICAO's Aviation Outlook: 2010 – 2050 (Ref. 28).

- Developments in commercial aviation: We have drawn on various manufacturers' forecasts, e.g. Boeing (Ref. 21) and Airbus (Ref. 29), Flightpath 2050 – Europe's vision for aviation (Ref. 11), IATA Vision 2050 (Ref. 10) and the CG13 Task 3 Report (Ref. 4).

A summary of the main characteristics for each scenario is shown in Figure 5.

## A.4 Quantitative scenario forecasts

The 2050 forecast method uses a model of economic and industry developments to grow airport-pair traffic forecasts, starting from the last forecast year of each of the scenarios within the LTF13, 2035. The model is described in detail in the LTF13 (Ref.1).

We have used the scenarios (Section 3) to set parameters for the quantitative forecasts. The method uses a model of economic and industry developments to grow airport-pair traffic forecasts, starting from the last forecast year of each of the scenarios within the LTF13. The model addresses passenger, cargo, military GAT, business aviation and small airport-pairs' traffic by specific sub-models and then combines the results to produce the final traffic forecast per traffic region.

The scenario forecasts are detailed in Section 4, and in Annex B.

## A.5 Forecast inputs

The majority of the inputs have been derived from scenario storylines and related assumptions, and necessarily jump off the values for 2035 for each scenario in the LTF13 – this is a feature of how the model works, and how the forecast is reported. Furthermore, to impose consistency between the two forecasts we have staggered input trends that we have applied for the period 2035 – 2050 from those at the end of the LTF13. Therefore, the 2050 forecasts are naturally constrained by the forecasts from the last year of the LTF13.

A summary of the main characteristics of the forecast inputs for each scenario is shown in Figure 5. This section expands on this to discuss some of the more important ones.

### Demographics

There are two demographic factors which influence passenger demand: the total size of a population and the age composition of the population. Changes in the population size are captured through the GDP growth assumptions where a strong link between the total GDP and the total population is expected.

For the age composition of the population for the 2050 forecast, we used different variants of UN population data[5] depending on the assumptions made for each scenario. The low, medium and high fertility UN variants differ among themselves exclusively in the assumptions made regarding the future path of fertility. The "zero-migration" variant differs from the medium variant only with regard to the path followed by future international migration.

### GDP growth

The GDP data for the LTF13 is supplied by Oxford Economics, and did not extend beyond 2035. For the 2050 forecast we used data from CEPII, a French research centre in international economics (Ref. 8). Unlike the LTF13 which uses different GDP forecasts depending on the scenario, we only used the one available GDP forecast for all scenarios. We applied the GDP growth difference between scenarios using the GDP elasticities.

### The elasticity of demand for air travel with respect to GDP

Traditionally in air traffic forecasting, an elasticity of 1.5-2.5 is expected. Values of 1.0-1.5 would be considered rather low, though only a value near zero would really mean maturity: demand for flights does not grow any more as the economy grows. Because we used only one GDP value for all scenarios, we used the GDP elasticities to model the maturity and the difference in GDP. For this we applied an uplift on the GDP to Scenario A, and a downshift to Scenario D. We kept Scenario C and C' at the base GDP elasticity.

We modelled all elasticities to decrease over time, and modelled ESRA NW and North Atlantic as the most mature in all scenarios (e.g. for Scenario C, North Atlantic – North Atlantic is 0.83 by 2050, and ESRA NW to North Atlantic is 1.04). We also varied the elasticities to reflect the different stance of Europe (e.g. outward vs inward looking) in the scenarios.

# B Quantitative scenario forecast analysis

## B.1 Introduction

This annex presents a more detailed analysis of the total and regional forecasts for European aviation for 2035 – 2050. This analysis complements the analysis presented in Section 4. The scenario forecasts were developed in line with the descriptions summarised in Table 2.1.

## B.2 Main flows

For ESRA08, IFR movements can be split into internal flights, departures and arrivals (e.g. respectively going to or departing from a non-ESRA country) and overflights (e.g. flights for which both departure and arrival aerodromes are outside the region).

Within ESRA08, internal flights currently constitute the majority of IFR movements (79% for 2012). For all scenarios this percentage is forecast to decline, with international arrival/departures and overflights becoming an increasing proportion of total movements. The extent of this trend varies between scenarios, with Scenario A (Global Growth) exhibiting the largest decrease in the percentage internal flights although this scenario exhibits the largest absolute number of internal movements.

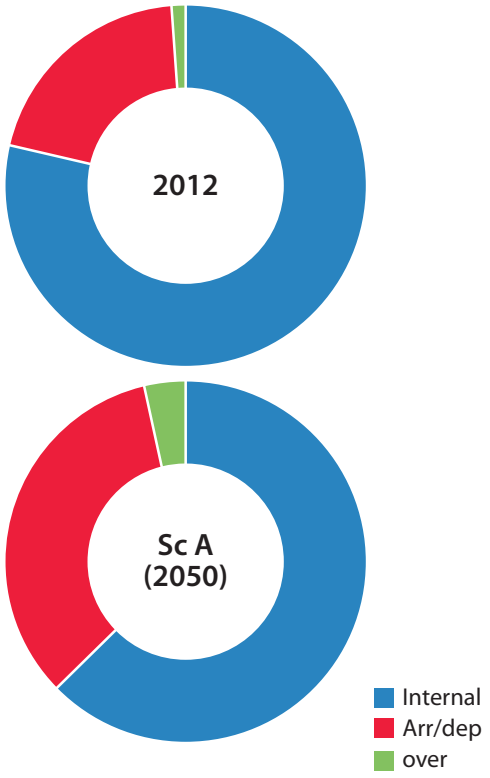


**Figure 11: Comparison of type of flights between 2012 and 2050 (for Sc A)**

## B.3 Regional flows

Growth will not be uniform across Europe for each scenario. The scenarios exhibit similar trends, but to a greater or lesser extent.

ESRA NW will remain the region with the most local IFR movements in all scenarios, but will exhibit a decline in the relative proportion of traffic for all scenarios (from 59% in 2012, to 50% in Sc A by 2050). Overall ESRA East will see the fastest percentage growth across all scenarios, with only 9% of ESRA traffic in 2012, up to 14% in Sc D by 2050, and 18% in Sc A by 2050.

| | | 2012 | Sc A | Sc C | Sc C' | Sc D |
|---|---|---|---|---|---|---|
| **ESRA NW** | Internal | 3,581 | 5,475 | 4,697 | 4,358 | 2,843 |
| | Arr/dep | 3,426 | 10,770 | 7,645 | 7,272 | 4,069 |
| | Total (ex. Overflights) | 7,008 | 16,245 | 12,342 | 11,630 | 6,912 |
| | | | | | | |
| **ESRA Med** | Internal | 1,350 | 2,637 | 1,982 | 1,912 | 1,163 |
| | Arr/dep | 2,348 | 7,738 | 5,313 | 5,060 | 2,994 |
| | Total (ex. Overflights) | 3,698 | 10,375 | 7,295 | 6,972 | 4,157 |
| | | | | | | |
| **ESRA East** | Internal | 214 | 988 | 601 | 632 | 330 |
| | Arr/dep | 879 | 4,842 | 3,007 | 3,010 | 1,527 |
| | Total (ex. Overflights) | 1,093 | 5,830 | 3,608 | 3,642 | 1,857 |

**Figure 12: Regional growth of local IFR movements (000s) to 2050 across the scenarios**

The following tables highlight the change in the top 10 regional flows (by number of IFR movements) and top 10 growth (2050 traffic as a fraction of 2012 traffic), for each scenario (Figure 14 - Figure 17); this can be compared to 2012 (Figure 13). 'ESRA NW – ESRA NW' remains the top flow for all scenarios, as for 2012. Also, 'ESRA NW – North Atlantic' drops out of the Top 10 in all scenarios. However, there are important differences between the scenarios:

- Scenario A and Scenario C' are both characterised by strong European flows, with more flows to 'Other Europe' entering the Top 10. 'ESRA NW - North Africa' is the only international flow in the Top 10.
- Scenario C and Scenario D are both most similar to 2012 flows, with again strong European flows but 'ESRA NW - North Africa' and 'ESRA NW – Asia/Pacific' remain in the Top 10.

The significant growth in all scenarios, however, comes from ESRA Mediterranean and ESRA East flows, particularly international flows to North Africa and Asia/Pacific. Where Europe – Europe flows are in the Top 10 growth, it is to Other Europe and ESRA Med. The following flows have particularly significant growth in each scenario:

- Scenario A: 'ESRA East – North-Africa' and 'ESRA East – Asia/Pacific'.
- Scenario C: 'ESRA East – Asia/Pacific' and 'ESRA East – North-Africa'.
- Scenario C': 'ESRA East – Asia/Pacific' and 'ESRA East – Other Europe'.
- Scenario D: 'ESRA East – Asia/Pacific' and 'ESRA Med – Asia/Pacific' (with only two Europe – Europe flows in the Top 10 growth).

| # | Region 1 | Region 2 | 2012 |
|---|---|---|---|
| 1 | ESRA NW | ESRA NW | 3,581 |
| 2 | ESRA Med | ESRA NW | 1,654 |
| 3 | ESRA Med | ESRA Med | 1,350 |
| 4 | ESRA East | ESRA NW | 520 |
| 5 | ESRA NW | North Atlantic | 294 |
| 6 | ESRA NW | Other Europe | 255 |
| 7 | ESRA East | ESRA East | 214 |
| 8 | ESRA NW | North Africa | 207 |
| 9 | ESRA East | ESRA Med | 194 |
| 10 | ESRA NW | Asia/Pacific | 172 |

**Figure 13: Top 10 flows in 2012 (Movements, 000s).**
**Europe – Europe flows highlighted in blue.**

| # | Region 1 | Region 2 | 2012 | 2050 | # | Region 1 | Region 2 | 2012 | 2050 |
|---|---|---|---|---|---|---|---|---|---|
| 1 | ESRA NW | ESRA NW | 3,581 | 5,475 | 1 | ESRA East | North-Africa | 18 | 329 |
| 2 | ESRA Med | ESRA NW | 1,654 | 4,088 | 2 | ESRA East | Asia/Pacific | 8 | 139 |
| 3 | ESRA Med | ESRA Med | 1,350 | 2,637 | 3 | ESRA East | Other Europe | 108 | 1,041 |
| 4 | ESRA East | ESRA NW | 520 | 2,231 | 4 | ESRA Med | North-Africa | 82 | 738 |
| 5 | ESRA NW | North Africa | 207 | 1,305 | 5 | ESRA NW | North Africa | 207 | 1,305 |
| 6 | ESRA East | Other Europe | 108 | 1,041 | 6 | ESRA Med | Other Europe | 144 | 796 |
| 7 | ESRA East | ESRA East | 214 | 988 | 7 | ESRA Med | Southern Afr | 26 | 137 |
| 8 | ESRA East | ESRA Med | 194 | 959 | 8 | ESRA East | North Atlant | 4 | 21 |
| 9 | ESRA NW | Other Europe | 255 | 905 | 9 | ESRA Med | South-Atlant | 31 | 156 |
| 10 | ESRA Med | Other Europe | 144 | 796 | 10 | ESRA East | ESRA Med | 194 | 959 |

**Figure 14: Scenario A regional flows (Movements, 000s)**
**L) Top 10 flows, R) Top 10 growth from 2012 - 2050**

| # | Region 1 | Region 2 | 2012 | 2050 | # | Region 1 | Region 2 | 2012 | 2050 |
|---|---|---|---|---|---|---|---|---|---|
| 1 | ESRA NW | ESRA NW | 3,581 | 4,697 | 1 | ESRA East | Asia/Pacific | 8 | 84 |
| 2 | ESRA Med | ESRA NW | 1,654 | 3,032 | 2 | ESRA East | North-Africa | 18 | 116 |
| 3 | ESRA Med | ESRA Med | 1,350 | 1,982 | 3 | ESRA East | Other Europe | 108 | 624 |
| 4 | ESRA East | ESRA NW | 520 | 1,448 | 4 | ESRA Med | Other Europe | 144 | 544 |
| 5 | ESRA NW | Other Europe | 255 | 716 | 5 | ESRA Med | Southern Afr | 26 | 98 |
| 6 | ESRA East | ESRA Med | 194 | 653 | 6 | ESRA Med | Asia/Pacific | 44 | 161 |
| 7 | ESRA NW | North Africa | 207 | 652 | 7 | ESRA Med | North-Africa | 82 | 299 |
| 8 | ESRA East | Other Europe | 108 | 624 | 8 | ESRA East | ESRA Med | 194 | 653 |
| 9 | ESRA East | ESRA East | 214 | 601 | 9 | ESRA Med | Middle-East | 117 | 381 |
| 10 | ESRA NW | Asia/Pacific | 172 | 557 | 10 | ESRA NW | Asia/Pacific | 172 | 557 |

**Figure 15: Scenario C regional flows (Movements, 000s)**
**L) Top 10 flows, R) Top 10 growth from 2012 - 2050**

| # | Region 1 | Region 2 | 2012 | 2050 | # | Region 1 | Region 2 | 2012 | 2050 |
|---|---|---|---|---|---|---|---|---|---|
| 1 | ESRA NW | ESRA NW | 3,581 | 4,358 | 1 | ESRA East | Asia/Pacific | 8 | 65 |
| 2 | ESRA Med | ESRA NW | 1,654 | 2,869 | 2 | ESRA East | Other Europe | 108 | 632 |
| 3 | ESRA Med | ESRA Med | 1,350 | 1,912 | 3 | ESRA East | North-Africa | 18 | 96 |
| 4 | ESRA East | ESRA NW | 520 | 1,450 | 4 | ESRA Med | Other Europe | 144 | 565 |
| 5 | ESRA NW | Other Europe | 255 | 705 | 5 | ESRA East | ESRA Med | 194 | 695 |
| 6 | ESRA East | ESRA Med | 194 | 695 | 6 | ESRA Med | Asia/Pacific | 44 | 144 |
| 7 | ESRA East | ESRA East | 214 | 632 | 7 | ESRA Med | Southern Afr | 26 | 85 |
| 8 | ESRA East | Other Europe | 108 | 632 | 8 | ESRA Med | North-Africa | 82 | 258 |
| 9 | ESRA NW | North Africa | 207 | 600 | 9 | ESRA NW | Asia/Pacific | 172 | 521 |
| 10 | ESRA Med | Other Europe | 144 | 565 | 10 | ESRA East | ESRA East | 214 | 632 |

**Figure 16: Scenario C' regional flows (Movements, 000s)**
**L) Top 10 flows, R) Top 10 growth from 2012 - 2050**

| # | Region 1 | Region 2 | 2012 | 2050 | # | Region 1 | Region 2 | 2012 | 2050 |
|---|---|---|---|---|---|---|---|---|---|
| 1 | ESRA NW | ESRA NW | 3,581 | 2,843 | 1 | ESRA East | Asia/Pacific | 8 | 36 |
| 2 | ESRA Med | ESRA NW | 1,654 | 1,599 | 2 | ESRA Med | Asia/Pacific | 44 | 126 |
| 3 | ESRA Med | ESRA Med | 1,350 | 1,163 | 3 | ESRA East | Other Europe | 108 | 308 |
| 4 | ESRA East | ESRA NW | 520 | 719 | 4 | ESRA East | North-Africa | 18 | 49 |
| 5 | ESRA NW | Other Europe | 255 | 390 | 5 | ESRA Med | Southern Afr | 26 | 64 |
| 6 | ESRA East | ESRA Med | 194 | 372 | 6 | ESRA Med | North-Africa | 82 | 176 |
| 7 | ESRA NW | North Africa | 207 | 346 | 7 | ESRA East | ESRA Med | 194 | 372 |
| 8 | ESRA East | ESRA East | 214 | 330 | 8 | ESRA NW | Asia/Pacific | 172 | 327 |
| 9 | ESRA NW | Asia/Pacific | 172 | 327 | 9 | ESRA NW | South Africa | 69 | 131 |
| 10 | ESRA East | Other Europe | 108 | 308 | 10 | ESRA Med | Middle-East | 117 | 220 |

**Figure 17: Scenario D regional flows (Movements, 000s)**
**L) Top 10 flows, R) Top 10 growth from 2012 - 2050**

### B.4 Distance travelled per passenger

The proportion of passengers flying medium- and long-haul increases from 2035 in all scenarios. This is more pronounced for Scenario A than for the other scenarios.

This is likely a consequence of the fact that in all the scenarios the major growth will come with international arrival/departures, with internal flights declining as a percentage of the total forecast. This in turn is likely due to the major GDP growth and traffic growth being outside of Europe by 2050.

A comparison of Scenario C and C′ at first looks surprising – Scenario C exhibits a larger proportion of short-haul flights than the inward-facing Scenario C′. However, in Scenario C′, much of the growth comes from flows to Other Europe which will be characterised by more medium-haul flights, as many of these routes are over 1,500 km.

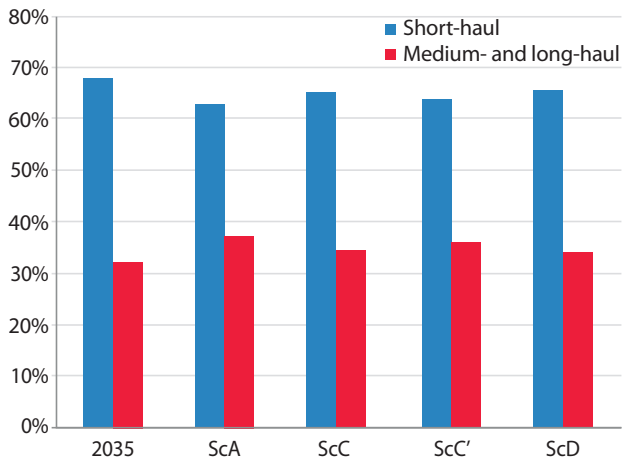


**Figure 18: A comparison of the total distance flown by passengers in the different scenarios**

## B.5 Unaccommodated demand

The unconstrained forecasts represent underlying estimates of demand in the absence of airport capacity constraints. The difference between the unconstrained forecast and the constrained forecast represents the unaccommodated demand - the difference between demand for air travel, and the flights that can be accommodated given airports. Unaccommodated demand is an indicator of a challenge – even if for the 2035-2050 period we have had to make assumptions about long-term capacity.

As for the LTF, Scenario A exhibits the highest unaccommodated demand. By 2035 there is 20% unaccommodated demand by 2035 in Scenario A; by 2050 this has risen to 36%.

| | Unaccommodated IFR Flights (million) |
|---|---|
| | 2050 |
| **A:** Global Growth | 15 |
| **C:** Regulated Growth | 4.4 |
| **C':** Happy Localism | 3 |
| **D:** Fragmenting World | 0.5 |

**Figure 19: Unaccommodated demand per scenario**

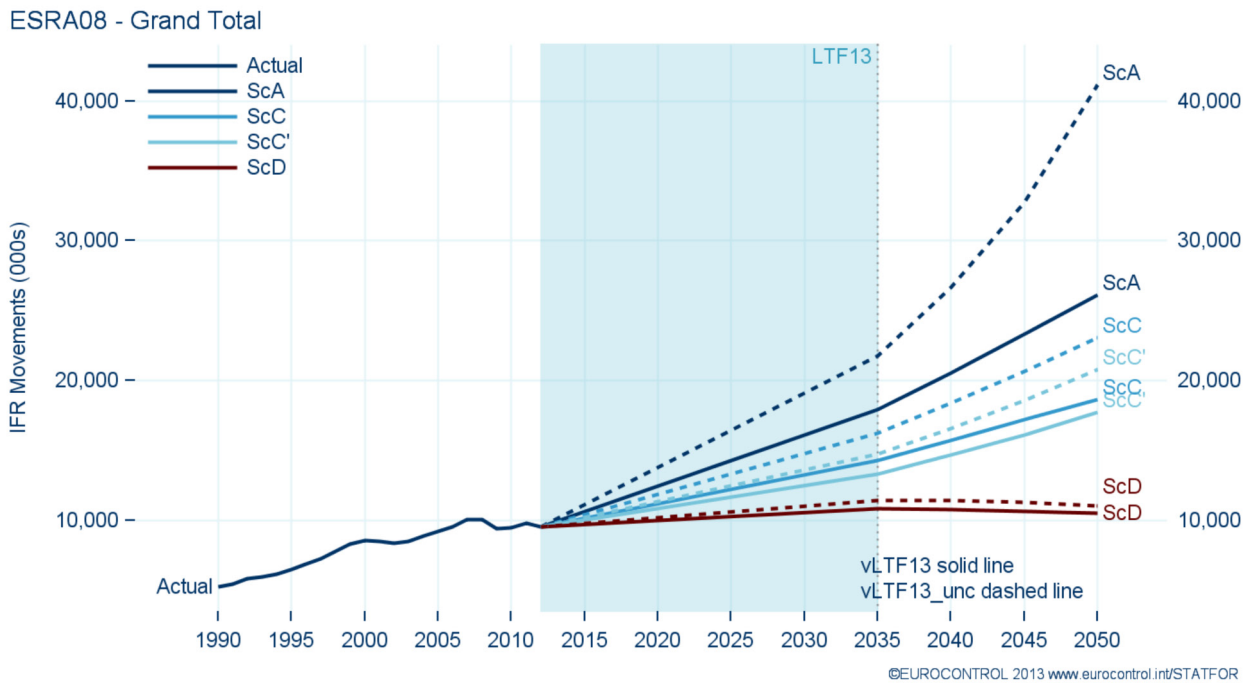


**Figure 20: Unconstrained forecast for 2050 (combined with the MTF and LTF) represented by the dashed lines. The solid lines are the constrained forecast.**

The following table provides a breakdown of the unaccommodated demand by ESRA region. It can be seen that the majority of the unaccommodated demand is in ESRA Mediterranean for all scenarios by 2050. This extends from the LTF which assesses that Turkey will have above 30% excess of demand for arrivals and departures at their airports, not accommodated by 2035 in Scenario A.

ESRA NW and ESRA East also exhibit significant capacity constraints by 2050, of similar magnitudes. However for ESRA East the unaccommodated demand is primarily in international arrivals/departures, whilst for ESRA NW there is a significant unaccommodated demand for internal flights as well particularly in Scenario A.

| | ESRA NW | | | | ESRA East | | | | ESRA Mediterranean | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Difference in movements (000s) | | % unaccomm | | Difference in movements (000s) | | % unaccomm | | Difference in movements (000s) | | % unaccomm | |
| | 2035 | 2050 | 2035 | 2050 | 2035 | 2050 | 2035 | 2050 | 2035 | 2050 | 2035 | 2050 |
| **ScA** | 1,523 | 7,218 | 11% | 31% | 377 | 2,406 | 11% | 29% | 2,954 | 10,004 | 29% | 49% |
| **ScC** | 635 | 1,639 | 6% | 12% | 179 | 482 | 7% | 12% | 1,647 | 3,508 | 23% | 32% |
| **ScC'** | 388 | 955 | 4% | 8% | 146 | 415 | 6% | 10% | 1,281 | 2,681 | 19% | 28% |
| **ScD** | 96 | 83 | 1% | 1% | 60 | 64 | 4% | 3% | 591 | 540 | 12% | 11% |

**Figure 21: Total unaccommodated demand (excluding overflights) by ESRA region**

### B.6 HST effect

HST is a competitor to flying short distances. For the 2050 forecast we used the same HST network assumptions as the LTF13 which are ambitious (particularly for Scenario A), with many improvements introduced in the later years which would have an effect in the 2050 forecast. We then considered a 'what if' to see how the forecasts were affected by other expansions of the network including:

- A significant reduction in travel times on 23 lines e.g. Frankfurt – Paris).
- Two new lines added to connect Europe to the East: Berlin-Moscow and Berlin-Warsaw, assuming a Maglev line based on currently available and proven maglev technologies (Ref. 24).

This produced minimal effect on the unaccommodated demand, reducing it by 35,000 IFR movements in 2050 for Scenario A. Analysis suggests that this is largely because the HST effect on these lines has already been 'banked' by 2035 and the further reduction in time has little additional effect. However, a much more significant expansion of the HST network could have more impact (Ref. 5).

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