Review of the Social Cost-Benefit Analysis of Grand Ouest Airport

Comparison with Improvements of Nantes Atlantique

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CE Delft's solutions are characterised in being politically feasible, technologically sound, economically prudent and socially equitable.

Preface

This report is the result of a process in which many people have contributed towards the end result. The Steering Group for this study included the following persons (in alphabetical order):

- François Billet
- Ronan Dantec
- Geneviève Lebouteux
- Isabelle Loirat
- Bertrand Vrain

Other useful information has been provided by:

- Bernard Fourage
- Christian Roy
- Michel Tarin
- Françoise Verchère
- Anonymous (on traffic control)

We are especially thankful to Geneviève Lebouteux for being our contact person for this study, translating various versions of this report into French and organising our visit to Nantes. Agnès Belaud and Anne Launay have provided great assistance in translating.

The authors remain responsible for any errors or omissions this report may contain.

Linda Brinke and Jasper Faber

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Summary

The French government has decided to build a new airport to the north of Nantes. Called l'Aeroport du Grand Ouest, the airport should replace Nantes Atlantique (NA) as the main airport in Loire-Atlantique. The airport will be built in an area called Notre-Dame-des-Landes (NDL), which is an alternative name for this airport used in this report as well.

In preparation for the new project, an economic impact assessment (social cost-benefit analysis, SCBA) has been performed in Pièce F of the Enquête Publique (EP) from 2006. This shows that in two or three scenarios studied, the benefits of the new airport exceed the costs. Many organisations, notably Solidarité Ecologie, have proposed to continue to use the airport of Nantes Atlantique and optimise its the structure instead of building the new airport. This would have the advantage that no new site would have to be developed in an area that currently has a high ecological quality. The economic costs and benefits of this alternative have not been studied, even though the French 'Grenelle de l'Environnement', which occurred in 2007-2009, prescribed that a study on alternative options has to be done when projects have a big impact on the environment. As a result, it is currently not possible to base a decision on the airport infrastructure in Loire-Atlantique on a review of the economic impacts of the alternatives.

The organisation of elected representatives who have doubts about this project (le Cédpa) has asked CE Delft to carry out a review of the existing SCBA and to compare the economic impacts of the new airport with the continued use of Nantes Atlantique. This is done in two ways:
1. With improved access.
2. With improved access AND another runway replacing the existing one.

A social cost-benefit analysis (SCBA) assesses all the impact of a project and expresses them in monetary terms. This is done both for market goods (for which price information is available) as for non-market goods (e.g. travel time savings, air pollution, noise, et cetera). An SCBA provides an overview of current and future pros and cons of a particular investment or policy project for society as a whole as objectively as possible. For this purpose, effects are denominated in Euros whenever possible and can be aggregated. The analysis then shows whether the project under evaluation leads to a desired increase in social welfare.

Need for a new airport?

A new airport at Notre-Dames-des-Landes has been proposed because the airport of Nantes Atlantique would be near to its maximum capacity.
This report has reviewed the evidence on the maximum capacity of Nantes Atlantique and finds that it may take a long time before it reaches its capacity because of two reasons:

1. Passenger demand growth projections are optimistic:
   - Current oil price projections are considerably higher than projections at the time of publication of the passenger projections. As a result, ticket prices are higher and demand for aviation will be lower.
   - The passenger projections do not take into account that aviation will be included in the EU ETS from 2012. As a result, ticket prices will be higher and demand for aviation will be lower.

- Two of the scenarios on which the projections are based include rather optimistic assumptions on economic growth. A less optimistic assumption would result in lower demand for aviation.
- All the scenarios presented assume that the costs of aviation will continue to decrease in the next decades. This is presumably based on the decrease of costs in the past, caused by the liberalisation of air traffic in Europe and the emergence of low cost carriers. Experience in the US shows, however, that liberalisation and emergence of low cost carriers result in a cost decrease that seems to level off over time.
- High speed rail transport is a substitute for air transport. The improvement of the LGV network (for example Nantes-Roissy and Nantes-Orly with 'Le Barreau Sud') may increase demand for rail transport at the expense of air transport.
- The market for aviation in Europe may mature and become saturated in the coming decades, which means that with rising incomes demand will not rise as quickly.

2. Runway capacity is not constrained by the number of passengers, but rather by the number of flights:
   - An analysis of traffic data of European airports shows that the number of passengers per flight at Nantes Atlantique is quite low for an airport of this size. This suggests that a growth in demand can be met at least to some extent by increasing the average number of passengers per flight, e.g. by using larger aircraft. Since this would not increase the number of flights, the limits of the current airport would be reached at a (much) later point in time.

Economic justification for Notre-Dame-des-Landes Airport

The proposal for a new airport at Notre-Dame-des-Landes has been justified on economic grounds with an analysis of the social costs and benefits (Pièce F, EP). This analysis shows that the main benefits of the new airport are the benefits to passengers, which, in turn, are predominantly savings in travel times. A second major benefit is the fact that urbanisation in the south of Nantes will be increasing, although the benefits are difficult to quantify. Other benefits, including reduced noise, are at least an order of magnitude smaller. Benefits in terms of external safety (the risk of an accident of an aircraft that causes casualties and/or damage outside the airport perimeter) are almost negligible in economic terms, even though the emotional argument is strong.

The travel time savings depend on the number of passengers projected to use the new airport. As argued above, this report concludes that the projections used in the existing social cost-benefit analysis are too optimistic. In monetary terms, the travel time savings are the product of the time saved (in hours) and the value of time (in Euros). We find that the value of time that has been presented is much higher than the value recommended in France.

In the economic justification for Notre-Dame-des-Landes Airport, published in 2006, three scenarios are presented of which one shows a negative balance of costs and benefits (the costs exceed the benefits, excluding the effect of urbanisation) while two show a positive balance. In only one scenario, the internal rate of return of the new airport is enough to compensate for the risk of the project, while in two other scenarios the rate of return is too low.

Comparison of improvements of Nantes Atlantique with the construction of a new airport

This report has recalculated the social costs and benefits of a new airport at Notre-Dame-des-Landes, taking realistic projections of passenger growth and of their value of time into account. It has compared the results with an improvement of Nantes Atlantique, where the airport would be equipped with fast taxiways, a local radar system and land access by train for passengers (Scenario 6). In Scenario 7, the same optimisations take place, but in addition a new runway is projected to be built in 2023. This new runway is built perpendicular to the current runway, in order to reduce the noise impact on Nantes. Table 1 shows the results which will be discussed below.

Table 1 Alternative social cost-benefit analysis (benefits or costs in million Euro, 2006 price level)

Cost/benefit category	Airport Grand Ouest (existing SCBA, 2006)	Airport Grand Ouest: Realistic costs and passenger numbers, realistic values of time, etc.	Airport Grand Ouest: Conservative estimate of construction costs	Optimisation of Nantes Atlantique: Capacity extension, local radar system, fast taxiways	Optimisation of Nantes Atlantique: Capacity extension, local radar system and new runway in 2023
	Scenario 2	Scenario 4	Scenario 5	Scenario 6	Scenario 7
Travel time	911	317	317	297	297
Road safety	-1	-1	-1	-1	-1
Emissions road	-1	-1	-1	-1	-1
Emissions air	-10	-26	-26	-24	-24
Noise	20	19	19	0	0
Exploitation of airport	45	42	0	40	40
Interactions with other modes	-121	-114	-114	-107	-107
Public authorities (construction costs)	-330	-304	-757	-93	-134
Water management	-	PM (-)	PM (-)	0	0
Value of nature	-	-15	-15	0	0
Loss of agricultural land	-	-26	-26	0	0
Construction of tramway/renovate train track	-	-70	-98	-4	-4
Agro-environmental plan annual cost	-	-5	-5	0	0
External safety	-	PM (+)	PM (+)	PM (-)	PM (-)
Cost of adjusting aircraft fleet	-	0	0	PM (+/-)	0
Net benefit	**514**	-184	-707	106	65
Effects on urbanisation through property market	93	93	93	0	93
Net benefit	**607**	-91	-614	106	158

PM = To be determined due to a lack of data (in between brackets the direction of the effect: plus or minus). A minus sign represents a cost to society, a plus sign represents a benefit to society.

The main difference between a new airport at Notre-Dame-des-Landes and an improvement of Nantes Atlantique is that the new airport would have higher construction costs and higher costs of damage to nature. Because of the higher construction costs, we think that possible cost overruns are higher as well.

We find that, when correcting for the extremely high valuation of time and taking oil price projections and inclusion of aviation in the EU ETS into account, the costs of the new airport at Notre-Dame-des-Landes exceed the benefits. When the benefits of urbanisation are taken into account, the SCBA still shows a small negative result. If, however, construction costs are 40% higher than anticipated, which is the average cost overrun for large infrastructural works, the costs exceed the benefits by a wide margin.

The improvement of Nantes Atlantique with fast taxiways, a local radar system and land access by train would significantly improve its capacity and service delivery. In addition, if a new runway perpendicular to the current runway is built, the noise impact on Nantes will be reduced. This report has tentatively analysed the costs and benefits of such an improvement, although the estimates on construction costs for NA are very rough since no such estimate has been made before. It finds that the benefits are higher than the costs.

In summary, based on this study, the optimisation of Nantes Atlantique appears to generate more welfare to France than the construction of a new airport at Notre-Dame-des-Landes. This presents a very strong case for a full analysis of the costs and benefits of all the options for improving air traffic in the Nantes region.

1 Introduction

The French government has decided to build a new airport to the north of Nantes. Called l'Aeroport du Grand Ouest, the airport should replace Nantes Atlantique as the main airport in Loire-Atlantique. The airport will be built in an area called Notre-Dame-des-Landes (NDL), which is an alternative name for this airport used in this report as well.

In preparation for the new project, an economic impact assessment has been performed in Pièce F of the Enquête Publique (EP) from 2006. This shows that in all scenarios studied, the benefits of the new airport exceed the costs.

Many organisations, notably Solidarité Ecologie, have proposed to continue to use the airport of Nantes Atlantique and optimise the structure instead of building the new airport. This would have the advantage that no new site would have to be developed. The economic costs and benefits of this alternative have not been studied, even though the French 'Grenelle de l'Environnement' prescribes that a study on alternative options has to be done when projects have a big impact on the environment. As a result, it is currently not possible to base a decision on the airport infrastructure in Loire-Atlantique on a review of the economic impacts of the alternatives.

The organisation of elected representatives who have doubts about this project (le Cédpa) has asked CE Delft to carry out a review of the existing SCBA and to compare the economic impacts of the new airport with the continued use of Nantes Atlantique. This is done in two ways:

1. With improved access.
2. With improved access AND another runway replacing the existing one.

1.1 What is a SCBA?

A Social Cost-Benefit Analysis (SCBA) is defined as 'an evaluation method that can be used to consider the impact of policy decisions'. The construction of a SCBA will provide an overview of current and future pros and cons of a particular investment or policy project for society as a whole as objectively as possible. For this purpose, effects are denominated in Euros whenever possible and can be aggregated. The analysis then shows whether the project under evaluation leads to a desired increase in social welfare.

This means that SCBA differs fundamentally from a financial analysis (business case), which reveals the costs and benefits for a particular party. As SCBA assesses the overall public interest, certain financial costs and benefits that are included in a business case disappear as they are offset by benefits respectively costs of another party.

SCBA is based on a broad definition of the term 'welfare'. Besides goods and services, SCBA takes into account intangible effects and expresses them in monetary terms. These include effects on the environment, landscape, nature and spatial quality. The value of those effects is calculated in monetary terms through specific valuation techniques, as no market prices are readily available.

A SCBA compares the costs and benefits of one or more project alternatives with a so-called baseline or business-as-usual scenario. The baseline scenario is the most likely development that will occur when no policy decision is taken. The difference between the project alternative and the baseline is the starting point for SCBA.

SCBAs are widely used in transport investment evaluations and other ex-ante policy evaluations both in France and in many other countries.

1.2 Outline of the report

In this report, we provide a review of the SCBA for the construction of NDL (Pièce F of the EP) in Chapter 2. In Section 2.2, the general setup of the SCBA is discussed and in Section 2.3, the economic scenarios are elaborated upon. In the remainder of Chapter 2, we discuss the cost categories on which we have doubts, such as travel time savings (Section 2.4) and construction costs (Section 2.5). We also discuss some cost categories which are in our opinion incorrectly omitted in Pièce F (value of nature, the cost of water management, external safety and the loss of agricultural land).

The purpose of Chapter 3 is to present an alternative social cost-benefit analysis (SCBA) for the construction of NDL in which some elements have been added, while others have been scaled down from the original analysis. Furthermore, two scenarios for the optimisation of Nantes Atlantique are discussed and quantified.

Finally, Chapter 4 draws conclusions on the economic justification for NDL airport, based on the previous analysis.

2 Review of cost-benefit analysis of Aéroport Grand Ouest

2.1 Introduction

In this chapter, we present a discussion on the parameters that have formed the basis of the existing social cost-benefit analysis (SCBA) which was made in 2006[1]. We focus on parameters in the cost-benefit analysis that in our opinion are currently not used in an appropriate way. We try to base this analysis on independent sources of information and on the French guidelines on the economic evaluation of infrastructure projects (Comité des directeurs transports, 2005). We discuss not only the methodology but also the monetary values that are used in the SCBA.

The SCBA calculates the costs and benefits against three macro-economic and aviation scenarios. The scenarios differ in national and regional growth rates, environmental legislation, propensity to fly, costs of aviation, low cost carriers and strategy of airlines. The first scenario assumes economic growth according to the historic trend, a further concentration of the airline industry and continued operation in a hub-and-spoke model. The second scenario assumes economic growth according to the historic trend, an increasing market share of low cost carriers and more point-to-point traffic. The third scenario assumes faster economic growth, an increasing market share of low cost carriers and more point-to-point traffic. The resulting social costs and benefits are presented in Piece F: Évaluation Socio-Économique et Financière presents an SCBA of the building of the Aéroport Grand Ouest. It is summarised in Table 2.

[1] Piece F: Évaluation Socio-Économique et Financière, Dossier d'enquête préalable à la déclaration d'utilité publique.

Table 2 **Social costs and benefits of Aéroport Grand Ouest (million Euro, 2006 price level)**

	Scenario 1 Tendanciel Réseau en étoile	Scenario 2 Tendanciel Réseau maillé	Scenario 3 Croissance Réseau maillé
Travel time	+225.5	+911.2	1,393.8
Road safety	-2.0	-1.1	+0.2
Emissions road	-2.8	-1.1	+0.9
Emissions air	-23.3	-9.5	-13.7
Noise	+19.9	+19.9	+19.9
Exploitation of airport	+32.6	+44.8	+57.0
Interactions with other modes	-70.5	-120.6	-156.3
Public authorities (construction costs)	-310.4	-329.6	-327.5
Net benefit	**-101**	**514.0**	**974.3**
Internal rate of return (TRI 1)	**2.6%**	**8.6%**	**11.2%**
Effects on urbanisation through property market	+92.8	+92.8	+92.8
Net benefit	**-8.2**	**606.8**	**1,067.1**
Internal rate of return (TRI 2)	**3.9%**	**9.5%**	**12.0%**
Effects on urbanisation: changes in mobility	+177.7	+177.7	+177.7
Net benefit	**76.7**	**691.7**	**1,152**
Internal rate of return (TRI 3)	**5.0%**	**9.9%**	**12.2%**

Source: Pièce F.

As shown in Table 2, the costs and benefits are calculated in three scenarios. The scenarios are discussed in Section 2.3 and in Annex B. The assumptions of the scenarios determine the balance of costs and benefits and the internal rate or return (*taux de rentabilité interne*) to a large extent.
Table 2 shows that the most important benefit of the new airport is the benefits for the users of air transport. These benefits are mainly related to avoided travel time to other airports. We have reviewed the method for arriving at these figures and the underlying data and assumptions in Section 2.4.

The most important cost items are the costs and benefits associated with the construction of the new airport and the abandonment of Nantes Atlantique (*puissance publique*) and the interactions between projects. The former is reviewed in Section 2.5.

Other costs and benefits are smaller. In the remainder of this chapter, we discuss the cost categories on which we have doubts, such as aviation emissions and aviation noise. We also include some cost categories which were not included in the original SCBA (value of nature, the cost of water management, external safety and the loss of agricultural land).

Before analysing the SCBA scenarios and items, Section 2.2 discusses the general setup of the SCBA.

2.2 General setup of the SCBA

In general, the SCBA is thorough but not always very transparent because some costs and benefits are grouped together in one item. This is the case, for example, in the item *Puissance publique*, which groups together the costs and benefits associated with the construction of the new airport and the abandonment of Nantes Atlantique.

The SCBA lacks a clear description of the baseline against which the costs and benefits are determined. In a regular SCBA, there is one reference scenario, which includes assumptions on the economic environment. In Pièce F, there are three economic scenarios, and within each scenario there are two alternatives. The first represents the business-as-usual scenario, in which there is a constraint on flying and people would have to go to other airports. In the second alternative, NDL is built and there is no constraint on flying.

Moreover, the SCBA shows a lack of risk assessment. In France, the discount rate has recently been changed from 8 to 4% (Comité des directeurs transports, 2004). However, the implicit risks that were formerly included in the 8% discount rate, have to be made explicit when using a 4% discount rate. In this analysis, no presentation of the risks is being made, apart from a sensitivity analysis on the oil price, of which the results were not incorporated in the SCBA.

The importance of a good risk assessment is elaborated upon in a new document by the French Centre d'analyse stratégique. It provides a good overview of the issues surrounding risk in public investments and one of its conclusions is that in a SCBA, a risk premium should be incorporated of between 1 and 3% (Centre d'analyse stratégique, 2011). This means that the discount rate used in Pièce F should not be 4%, but 5-8%, implying that the outcome of the first scenario in Pièce F will be much more negative, Scenario 2 will be only slightly positive and only Scenario 3 will be positive (see Annex A for an explanation).

Furthermore, in the French instruction manual on the evaluation of infrastructure projects, one section is specifically dealing with projects under concession. The main risk with a concession is that the party holding the concession is making a loss, so that the service is at risk or operating subsidies have to be granted (Comité des directeurs transports, 2004). This risk has not been taken into account.

Uncertainty in a number of specific parameters will come back in this chapter, including:

- The oil price
- Environmental policy
- Construction costs
- Residual value
- Travel time savings
- Passenger forecasts
- Aviation costs

2.3 Economic scenarios

The basis of the existing social cost-benefit analysis is formed by the macro economic scenario's that have been defined (see Annex B). In nine different variable categories, two alternative state of variables have been chosen. For example, on the cost of aviation, the two alternatives are cost decreases of -1.3 and -0.4%, depending on the scenario. Here, the variables are briefly discussed[2].

Of the three scenarios, in our opinion Scenario 1 is the most realistic, for the following reasons:

- **National GDP growth** is set to 1.9% (alternative: 2.4%), which is in line with recommendations from CIDAT (Le Comité interministériel d'aménagement et de développement du territoire). However, in Scenario 1 the oil price is set to $ 60 per barrel, which was a reasonable assumption in 2006 but is lower than the current value and oil price forecasts (see Section 2.3.1).
- **Strategy of actors**: Hub-and-spoke network (alternative: point-to-point network with many city pairs). In the past year, there has been a strong liberalisation of the market, which resulted in fierce competition between airports due to the strong growth of low cost carriers. It is not clear how this development will be in the future, because there were also many mergers and acquisitions (as is argued in Section 2.3.3).
- **Regional economic growth:** Is 0.1% higher than national GDP growth (alternative: 0.4%). This difference can be explained by a slightly higher population growth in the region of Nantes, but a much higher than national GDP growth is not likely.
- **Aviation costs**: A slight decrease in aviation costs (-0.4% per year) is more plausible than the alternative, a decrease of -1.3% per year, although cost developments are very uncertain because many factors play a role (see Section 2.3.3).
- **Propensity to fly**: A continuation of the current trend in the propensity to travel by plane except for the retired, which seems *less* likely than the alternative, a slower growth of the propensity to fly for all social groups, see Section 2.3.4.
- **Competition from TGV** increases due to the future Barreau Sud including a new line to Orly and an improved service to Roissy (alternative: current network is maintained). Since rail and air transport are substitutes, this will create competition for the new NDL airport.
- The percentage **of low cost carriers** is limited to 20% (alternative: 33%). This depends very much on the route network and the reason for travelling. Low cost carriers have a large market share for leisure flights to European destinations. For long haul traffic, comfort remains important and network carriers dominate the market (see Section 2.3.3). This has impacts on the value of travel time.
- **Environmental legislation** is strengthened (alternative: current state of affairs), in which the internalisation of external costs to the environment becomes a leading principle. We can already witness this strengthening, for example in the inclusion of aviation in the EU emissions trading scheme from 2012, see Section 2.3.2. The European Commission's 2011 transport white paper (COM(2011) 144 final) has reaffirmed the EU's strategy to work towards internalisation of external costs.

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[2] For a better understanding of the economic scenarios, see the original discussion in Pièce F, section F.5.4. (p.75-87).

– Decrease in **business travel** (alternative: current state of affairs) due to developments in communication technology, of which the rise of videoconferencing is the most important example. The empirical evidence is mixed. It is not clear whether the increasing possibilities to meet without travelling substitute for travelling or not.

To conclude, in most variables we think that the state of the variables chosen in Scenario 1 are the most realistic. The other two scenario's are more optimistic than Scenario 1, with higher GDP growth, more passengers, etc. Unfortunately, there is no cautious scenario with lower than average growth, which is a weakness of the existing SCBA.

Use of the outcomes of the different scenarios

It should be noted that the internal rate of return in Scenario 1 is 2,6%, which is convincingly lower than the social discount rate, especially when risk is taken into account. When expressed in a net benefit (which is the present value of the benefits minus the present value of the costs), the net benefit is € -101 million. This result – a net cost to society - is not highlighted in the SCBA and is missing from the discussion.

Interestingly, the Steering Committee of the NDL project (Comité de pilotage, 2006, p.7) says the following:
Avec un TRI compris entre 8.5 et 9.5% pour le scénario moyen, supérieur au taux d'actualisation des projets publics fixé à 4%, le projet d'aéroport de Notre-Dame-des-Landes affiche une réelle pertinence socio-économique
We do not claim that any of the scenarios is only 'right' or 'wrong'. From the text however, Scenario 2 is never explained to be the 'middle' scenario in the sense that it is most likely to occur. It should also be noted that Scenario 2 has an internal rate of return of 8.6%, which is only marginally higher than the previous discount rate of 8%, that accounts for risk.

2.3.1 Oil price

In Pièce F, an oil price of $ 60 (Scenario 1 and 2) and $ 80 (Scenario 3) in 2025 is assumed. The number of passengers is also modelled with different oil prices of $ 80 and $ 120 (as a sensitivity analysis) but these alternative passenger numbers are not used in the SCBA. The assumed oil prices are on the low side, because:

– The IEA has recently made a projection – the World Energy Outlook - according to which we will reach an oil price of $ 120 by 2025 (in 2009 Dollars).
– The US EIA Annual Energy Outlook 2011 predicts an oil price of approximately $ 120 by 2025 (in 2009 Dollars).

In Pièce F, a Dollar/Euro parity (which means an exchange rate of 1 $/€) is assumed, while the current exchange rate is higher. So although the oil price projection is currently higher than assumed in Pièce F, this effect is counteracted by the lower exchange rate. A projected oil price of $ 120 with the current exchange rate of 1.33 $/€ results in the same fuel price as an oil price of $ 90 with Euro/Dollar parity. Hence, corrected for this exchange rate effect, current projections suggest that the oil price could be 15 to 50% higher than assumed in Pièce F.

A higher oil price results in higher ticket costs and lower demand for air travel. Oum et al. (2010) show the effect of fuel price on the passenger traffic measured in revenue passenger kilometres (RPK). The fuel price elasticity estimate of RPK is -0.058. This implies that 10% increase in fuel price reduces RPK by 0.58%. The reason for this relatively small impacts on RPK is that

airlines improve fuel productivity (RPKs/litre of fuel) by achieving higher load factor, and by retiring old and fuel inefficient aircraft faster when fuel price increases.

If we assume that passengers do not change their destinations and that the global elasticity also holds for France, passenger demand could be 1-3% lower than forecasted due to higher oil prices. This is in line with projections made by the current SCBA which claim that with a higher oil price, passenger numbers will be on average 3% lower (see Pièce F, p.78, 80, 82).

2.3.2 Environmental policy affects demand

In Scenario 1 and 3, a stricter environmental policy is taken into account which includes 'new methods to value external costs' (Pièce F, p.77). However, it is not clear how strict the assumed environmental policy is and how the effect of this on the number of flights is quantified.

Recently, the European Union has adopted a Directive that brings the aviation industry under ETS policy, from January 1st, 2012 onwards. The ETS is an emission trading scheme for CO_2 allowances that currently exists for large emitters of CO_2 such as power plants.

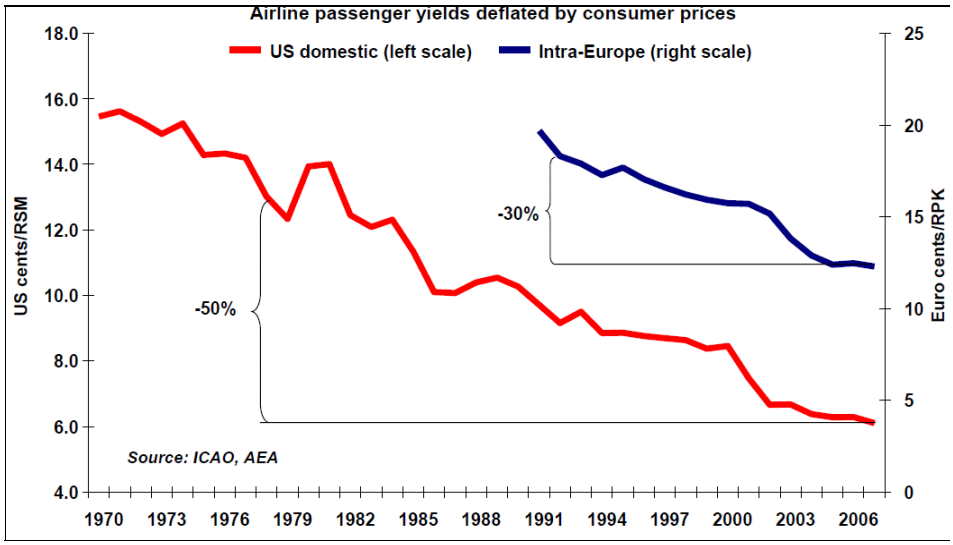
According to CE (2009), inclusion of aviation in the EU ETS with an allowance price of € 25 per tonne of CO_2 would lead to a decrease in the number of flights of about 2% in 2020 (an average for intra-EU and intercontinental flights). The decrease in passenger demand would be 2.4%. These results are calculated using AERO-MS, which was specifically designed to model the effects of environmental policy on aviation.

2.3.3 Cost of aviation

In this SCBA, a yearly aviation cost decrease in real terms is assumed. As is mentioned on p. 76 (Pièce F), this assumption is based on the outcome of different cost factors that sometimes work in opposite directions. On the one hand, we find the higher cost of security measures, kerosene and fuel taxes, on the other hand we find the influence of low cost carriers, liberalisation and technological development which makes airplanes more efficient.

In the past few years, liberalisation of the aviation sector was an important factor in the strong cost decreases (CE, 2009). Figure 1 shows the decreasing passenger yields over time.

Figure 1 Liberalisation has led to lower passenger yields



Source: IATA, 2008 (quoted in CE, 2009).

Liberalisation has led to the rise of low cost carriers, which are characterised by direct internet booking, less services on board and a shorter time on the ground in between flights. However, liberalisation of the intra-EU aviation industry was completed in 1997, which makes it unlikely that strong cost reduction on intra-EU flights will continue indefinitely.

On intercontinental flights it is possible that liberalisation will continue to have an effect on prices, because on many routes the aviation industry is still governed by bilateral agreements. On the other hand, it is unlikely that low cost carriers will gain a large market share in the intercontinental market, because some of the cost improvements cannot be achieved on these flights. For example, services on board become more important when flights are longer.

Also, a consolidation movement with mergers/acquisitions is currently taking place, examples being Air France and KLM, BA and Iberia, Lufthansa and Austrian Airlines. When this trend continues, increased market power may well lead to higher prices. Finally, aviation costs are influenced by the oil price (Section 2.3.1) and stricter environmental policy (Section 2.3.2).

To conclude, it is not clear whether the strong decrease in aviation costs will continue, because there are many factors that influence the price and it is not clear which effect will dominate.

2.3.4 Passenger forecast

According to CIADT, the French GDP growth until 2025 will lie between 1.5 and 2.3% (depending on the economic scenario considered). The air traffic growth will be between 1.3 and 3.1% (Pièce F, p.66). After 2025, both GDP growth and air traffic growth are expected to slow down. Between 2025 and 2050, GDP growth is forecasted to be between 1 and 2%, while traffic growth lies between 1.1 and 2.5%.

The forecasted growth of NDL which is shown in Figure 2 (Scenario 2) is in line with the forecast of the CIADT.

Figure 2 **Traffic forecast project NDL**

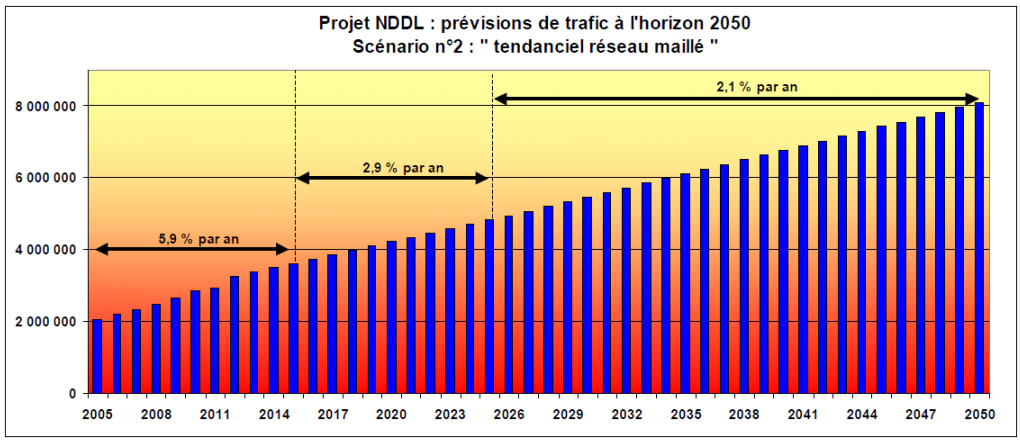


Table 3 shows the observed traffic for 2006-2010, to see whether the first five years of the forecast have been accurate.

Table 3 **Observed traffic on Nantes Atlantique airport**

	2006	2007	2008	2009	2010	var° 10/09	var° 10/06
Passagers locaux	2,345,122	2,519,589	2,662,382	2,561,099	2,954,936	15.4%	5.9%
Internationaux	1,097,869	1,246,585	1,439,531	1,303,200	1,475,653	13.2%	7.7%
Nationaux	1,247,253	1,273,004	1,222,851	1,257,899	1,479,283	17.6%	4.4%
Transit	78,656	70,301	69,181	89,512	76,574	-14.5%	-0.7%
Total	2,423,778	2,589,890	2,731,563	2,650,611	3,031,510	14.4%	5.8%
Low cost	200,400	284,698	413,228	386,144	652,779	69.1%	34.3%

Source: http://www.aeroport.fr/les-aeroports-de-l-uaf/stats-nantes-atlantique.php

With hindsight, the forecast for 2006-2010 - 5.9% yearly growth - was very well estimated, because the observed traffic growth was exactly 5.9%. In the short term, we can conclude that the passenger forecast seems to be accurate.

We have some questions about the long term, however. As the population is ageing, GDP growth will be declining and the market for air travel might be saturated at some point. After all, people only have holidays a few times a year. Furthermore, concerns about the environment as well as on safety may induce people to only fly when 'necessary' (once or twice a year). A final factor may be competition from the TGV. KIM (2008) shows that high speed rail and aviation are substitutes up to 800 kilometres. An improved TGV service could therefore make people decide to take the train.

Also from a survey mentioned in the SCBA follows that the propensity to fly has been decreasing (Pièce F, p.70). However, the percentage of people that flies at least once a year has remained constant. This is not in line with the passenger forecasts that have been made for the long term.

Finally, if a tram-train is not built, then the total passenger number may also be lower, because without the tram-train the parking costs make air travel more expensive.

Conclusion: While the passenger growth rates are high, they are in line with GDP growth figures and the available data on income elasticities of demand. They do, however, not take fuel price increases and ETS into account (see Sections 2.3.1 and 2.3.2). They may also not take into account the competition with other modes of transport, and the possibility that the tram-train is not built. Moreover, a sensitivity analysis of passenger growth would improve the analysis.

One more comment should be made, which concerns the difference in passengers between the NA and NDL scenarios (Table 4). On p.95 (Pièce F) it is stated that due to the new airport there will be between 280,000 and 330,000 new passengers, of which 65,000-80,000 passengers come from Paris. The question is, whether it is realistic that people are going to come from Paris, which is about four hours travel by car and more than two hours by train. Furthermore, there are regional airports which are closer to Paris which also host low cost carriers, for example. On the issue of Rennes, there is overlap in the catchments areas of Rennes and NDL, which makes it even more difficult to predict the passenger number of NDL because consumer choices are sometimes unpredictable. Furthermore, it is also expected that once there is a high speed connection from Rennes to Paris in 2020/2025, citizens of Rennes will be more inclined to take the TGV to Paris than to travel to NDL.

Table 4 Difference in passengers between NA and NDL in 2025

Variation du nombre de passagers entre Notre-Dame-des-Landes et Nantes Atlantique	Scénario 1 Tendanciel Réseau en étoile	Scénario 2 Tendanciel Réseau maillé	Scénario 3 Croissance Réseau maillé
Total	280,000	310,000	330,000
Dont origine Paris	65,000	75,000	80,000
Dont origine Rennes	150,000	170,000	190,000

Source: ITA and JLR Conseil.

We conclude that it is very uncertain that passengers will come from Paris and Rennes to the new airport.

2.4 Travel time savings

According to the SCBA, all the benefits to air passengers come from savings in travel time. Unfortunately, the treatment of travel time savings is not very transparent. There is a considerable reduction in hours spent travelling, even though the number of kilometres travelled by car and by public transport increases. Our interpretation is that there is unmet demand in the baseline scenario where Nantes Atlantique is functioning. Some air passengers cannot use Nantes Atlantique but travel to other airports. So when NDL is being built, then these passengers are now able to 'return' to the region and this results in travel time savings. We call this 'avoided travel time'. (Another interpretation is that in the baseline scenario, people fly from Nantes Atlantique to other airports to transfer there to their final destination, but when NDL is built, there is sufficient demand for a larger number of destinations. We consider this option to be less likely because the passenger numbers between the baseline case and the scenarios do not differ much in the first years.

There seems to be a contradiction in the scheme on p.97 (PièceF), however. Even though travel time savings are being made, there is an increase in the number of vehicle kilometres of cars and public transport. We do not understand how this is possible.

Apart from this 'avoided travel time' effect, there is a location effect. The NA airport is situated 10 km outside of the city centre, while the NDL airport will be situated some 20 km outside of the city centre.

When the airport is moved, the number of people within two hours drive of the airport increases with approx. 300,000 to 5.4 million (Pièce F, p.68). The largest effect comes from the group that lives between 45 and 60 min. away (+279,918). For passengers coming from Rennes, the journey to the airport is shortened by approximately 20 min by car. However, less people live within 45 min. travel from the airport (-30,797). For passengers coming from the south of Nantes (Vendée, etc.), as well as for the people from Nantes, their journey will be longer. We know that 47% of the passengers comes from Loire-Atlantique.

Travel time valuation

According to Boiteux, the value of travel time savings for interurban transport by car lies between € 8.94 (less than 50 km) and € 14.50 (more than 400 km) per hour (Comité des directeurs transports, 2005). These values are expressed in prices of the year 2000. For a distance of 200 km, the value lies at € 11.30, which translates into € 12.69 for 2006 (corrected for inflation). The highest value (€ 14.50) translates into € 16.28 in 2006.

From the travel time values in 2012, we can deduct that a valuation of € 15.5 has been used in all three scenarios. In the study, it is not specified which price level is being used, but we assume it is 2006. So this is correct.

For 2025, however, travel costs used in the SCBA are far too high. According to Boiteux, the travel time values used change from year to year with household consumption (in constant prices), with an elasticity of 0.7. If we approximate household consumption to regional GDP growth, then the value in 2025:

1. In Scenario 1 (with 2% regional growth) should be equal to € 18.6.
2. In Scenario 2 (with 2.4% regional growth) should be equal to € 19.25.
3. In Scenario 3 (with 2.8% regional growth) should be equal to € 20.0.

Instead, the SCBA uses the following values for 2025:

1. € 25.5 in Scenario 1.
2. € 98.1 in Scenario 2.
3. € 68.20 in Scenario 3.

In Chapter 3, we will show the effect of these alternative values on the outcome of the SCBA.

2.5 Construction of NDL and abandonment of Nantes Atlantique

2.5.1 Construction costs

The budget for construction of the new airport was estimated to be € 581 million in 2006 (Pièce F). However, no reservation is made for cost overruns caused by unforeseen factors. For example, since NDL is quite a hilly terrain, the cost of levelling the ground of the construction site could be far higher than anticipated.

Secondly, on p.94 of Pièce F, it is stated that 30 million of the total construction costs are services to airlines which will be paid by the airlines. Therefore, the 30 million is deducted from the budget in the SCBA. However, this amount should be included in the budget, because a SCBA intends to establish the net benefit to society and it does not matter who pays for certain costs. It can only be left out if it is paid by foreign airlines.

Thirdly, the cost of a tram/train way is not included in the budget, even though the effects of such a tramway are included in the analysis (in terms of travel time savings, etc). Recently, Jean-Louis Borloo, Minister of Ecology, Transport and Sustainable Development has announced that NDL will be connected to Nantes through a link with the tram-trainway Nantes-Châteaubriant, which is currently being built. There is no official cost estimate for building such as a tram-train yet, but a similar tram-train from Mulhouse to Thann is projected to cost 5 million €/km. Other tram-train projects have been more expensive, but these tracks are located in urban areas (Grillot, 2008). In this paper, we use the conservative cost estimate of € 75 million for 15 km. of track (€ 5 million/km), which is also the estimate of Mr Borloo and was confirmed by the SNCF.

It appears that the costs of building the new airport are higher than reported, because some cost categories such as building the tramway are not included. This may have a large impact on the internal rate of return as the building costs are borne in the beginning of the project and consequently have a high value.

Finally, the cost estimate of 2006 is no longer the most recent estimate. In Chapter 3, we therefore use more recent VINCI plans for the construction of NDL, which includes the breakdown of the construction into different phases.

2.5.2 Residual value

The residual value of the airport which is set to € 160-200 million in the SCBA is not supported by arguments. It all depends on the possibility that a buyer will be found for the complex, while an airport is a very specific type of infrastructure that is not in its current state very valuable for any other type of business. In case a potential buyer is interested in the site but the price is low, then the overall residual value to society will be lower or even negative because the cost of demolition of the site also has to be included in the SCBA (Comité des directeurs transports, 2004, p.23).

2.5.3 Possibility that the runway of NA is maintained for Airbus

Closing the runway would mean that Airbus becomes more vulnerable and that the risk of a closure of the factory in case of a restructuring of the company is increased. This would have a negative impact on the region in terms of value added and employment. On p. 94 of the SCBA, it is stated that only part of the airport will be abandoned, because the runway will be used by Airbus.

It seems that it is decided that the runway of NA is maintained for Airbus (while the airport terminal is closed), which means that:

- The costs of repairing/maintaining the runway (€ 35 million) are not foregone and should be added to the public expenditures.
- The residual value of € 160–200 million cannot be fully claimed.

2.5.4 Compensation payments

Airbus has built a facility next to Nantes Atlantique because of the value it attaches to having a runway nearby. Airbus uses the runway of Nantes Atlantiques to transport central wing boxes to the factory in Hamburg, which amounts to one or two flights a week or even more (Sayagh, newspaper article). In case the runway is closed, there is a large possibility that Airbus is going to request for compensation because its production costs will go up when using different transportation methods (by road and barge). If the runway remains open, no compensation payments have to be made but instead there will be the maintenance costs of the runway. Furthermore, there are three hotels in the very near vicinity of the airport, as well as four car hire offices and many shops, bars and restaurants on the airport. These companies will have to be compensated too. To sum up, compensation costs have to be taken into account in this analysis.

2.6 Taxes

It is clearly stated in the instruction manual on the valuation of infrastructure projects that taxes should not be part of the SCBA (Comité des directeurs transports, p. 22):
"On procédera à un bilan actualisé des coûts et des avantages pour la collectivité, **exprimés hors taxes**, par rapport à la situation de référence".

Taxes should not be included in a SCBA because they are simply transfers from citizens or companies to the government and should not be incorporated in the calculation of the overall net benefit to society. Therefore reported benefits that follow from these taxes should be excluded:

- Variation des charges foncières (property charges)
- VAT
- Fuel taxes

2.7 Emissions from aviation

On p.100 of Pièce F, it is stated that lifting the constraint on air traffic in the Nantes region leads to additional air traffic by people that would otherwise have been discouraged to fly. Interestingly, the pollution costs do not increase proportionately with the number of passengers (which grows stronger in Scenario 3 than in 1), as one would expect. Instead, it is argued in Pièce F that in Scenarios 2 and 3 the pollution costs increase less strongly than in Scenario 1 because there are more point-to-point links (réseau maillé) in these scenarios than in Scenario 1 which features a hub-and-spoke network (réseau en étoile). As a result, the load factors in the business-as-usual scenario in Scenario 2 and 3 are lower, which means that additional passengers as a result of the construction of NDL fill up more 'empty seats' than in Scenario 1. For this reasons, the climate impact is lower.

In our opinion, this analysis is not correct because airlines operate according to a cost optimisation model, which makes it unlikely that load factors are on average low. After all, having low load factors increase costs, and in a competitive market this is not sustainable. Furthermore, in the analysis of Scenario 2 and 3, the assumed yearly cost decrease is the same (Scenario 3) or even higher (Scenario 2), so this is inconsistent. Finally, the hub-and-spoke network is only very efficient on long haul flights, but intra-EU it should not have a large influence on load factors.

In the alternative SCBA, we will use a higher total cost of pollution for Scenario 2 and 3 which rises proportionally with passenger numbers from Scenario 1 (€ 23.3 million).

2.8 Noise costs

At first sight, it looks strange that the noise benefits are the same in all three scenarios, even though the passenger numbers (and the number of flights, we assume) differ. This is strange because noise costs are determined by counting the number of people within a certain noise zone (Lden). When the number of flights increases, the noise also increases and the noise boundaries move away from the airport. As a result, more inhabitants fall under the noise boundaries.

The fact that noise benefits are stable seems to indicate that there are no noise costs around NDL (no matter how many flights there are) and that therefore the benefits compared to NA are always the same. This raises the question whether a thorough research has been executed on the noise costs of NDL.

2.9 Effects on urbanisation

Nantes Atlantique is situated on the periphery of the city of Nantes, while NDL is planned to be built in a rural area. The removal of NA will lift some of the constraints on the urbanisation in the south of Nantes because the noise regulation is no longer a restriction on development in the surrounding area. It must be noted that in Pièce F, (future) noise maps that have been used are based on assumptions such as on the number of flight movements. They do not necessarily represent future noise.

There are several ways to reduce aviation noise, and several are already implemented at Nantes Atlantique (flight path restrictions, the continuous descent approach[3], etc.). However, there is still scope to reduce aviation noise by other means, e.g. by noise-differentiated landing charges, banning night flights or a ban on noisy aircraft under Directive 2002/30/EC (MPD et al., 2007). These measures could significantly reduce the noise contour and thus reduce the impact of the current airport on land and property values. They appear not to have been considered in the existing SCBA. If implemented, these measures would reduce the urbanisation benefits of NDL and a new perpendicular runway at Nantes Atlantique.

In Pièce F, the effects on urbanisation have been dealt with in a special way. Two alternative approaches of the quantification of the effects are described (TRI 2 and TRI 3), but they are additions to the original analysis (TRI 1). It is important to note these two approaches are alternatives and therefore, they cannot be added to TRI 1 at the same time. The reader may choose which one is the most relevant/realistic. This appears to reflect the uncertainty of the authors about the quantification of this effect.

The first approach discusses the impact on the property market and property taxes. In the areas surrounding Nantes Antlantique, the density of housing and inhabitants is lower than in other areas of Nantes (Pièce F). The assumption is that after NA has closed, the area will experience a boom in development. The

[3] The continuous descent approach is one of the improvement strategies in the 'Code de bonne conduite environnementale pour l'aéroport de Nantes Atlantique', signed in 2009

difference in the price of land compared to other areas of Nantes (especially in the north) is used to estimate the impact on the municipal tax income 'charges foncières'.

We believe that the impact on the property market should be taken into account, but we question the way this is done in the SCBA. First of all, taxes should be left out in a SCBA, because they constitute a transfer from citizens to the municipality. Rather, the net increase in the property values in the entire system should be taken into account. Secondly, assuming that the relocation of the airport does not significantly affect the demand for residential property in Nantes, the increase in the value of land in the south of Nantes means that the demand for land in other parts of Nantes declines. For the SCBA, the balance of the increase in value in the south and the decrease elsewhere should be taken into account, not just the increase. We believe the balance will be close to zero since the overall demand for residential property will hardly be affected. Third, the residual value of NA (180 million) might already include some of the benefits on the surrounding area of NA, this is not clear.

The second approach deals with the impact on urban mobility. It is assumed that inhabitants of the south of Nantes – which is closer to the city centre than the northern suburbs – travel shorter distances than other inhabitants of Nantes, which means that if this area is developed more, there are lower transport costs, less pollution and a lower risk of accidents. However, if investments in public transport in the north of Nantes are made, then this argument no longer holds. Furthermore, it follows from Table 5 that there are more paid jobs in the north of Nantes (128,000) than in the centre and south of Nantes combined (117,100). This means that increased urbanisation in the south will not lead to decreased mobility, but rather to more mobility, at least in the short to medium term.

Table 5 **Salaried employment in different districts of the urban unit of Nantes**

Location	Number of paid job per 1/1/08
Districts in the centre of Nantes	47,400
Districts in the north of Nantes	128,000
Districts in the south of Nantes	69,700

Source: Insee, census of 2008.

This leads us to the following conclusions:

1. Due to the uncertainties in the quantification of the benefits on urbanisation, we believe that to guarantee a positive outcome of this project for society, the SCBA should have a positive outcome without taking into account the urbanisation benefits. Practically, this means that a cautious reader should look at TRI 1, and not at TRI 2 or TRI 3.
2. In case the reader does want to incorporate urbanisation effects, the property market approach (TRI 2) is more plausible than the mobility approach (TRI 3).
3. We will apply the same urbanisation benefits of NDL in the case of an optimisation of NA involving a runway in a perpendicular direction. This is done because the noise in urban areas will be reduced significantly and the property developments in the south of Nantes will no longer be restricted.

2.10 Exploitation of the airport

As noted in the French instruction manual (Comité des directeurs transports), the risk with a public concession is that the party holding the concession gets into financial problems. In the SCBA, no risk analysis is made of the chance that this will happen and that subsidies are needed to keep the party away from bankruptcy.

2.11 Cost of water management

The report written by the Commission d'Enquête (2007) states that the construction of the airport at NDL increases the chance of flooding in the northern basins, especially those of le Plongeon, la Goujonnière, la Remauda towards the canal of Nantes to Brest and that of l'Isac. These zones of flooding are well known and some municipalities are equipped with a PPR (plans for the prevention of foreseeable natural disasters).

In order to estimate the additional water management costs as a result of the construction of NDL, the following cost categories need to be estimated:
- Avoidance costs (building extra dikes, need for extra water pumps, cost to agricultural crops/pastures due to the changed water level).
- Increased chance of flooding times the cost of flooding to society.

Unfortunately, we do not have such cost figures. This cost category will therefore be included as a PM (pro memoriam) cost category, which means that when more information is gathered, it should be included.

2.12 Valuation of nature

While the valuation of nature/open space is an important aspect of any SCBA, it is very difficult to put monetary values on nature and therefore it is not always included in the SCBA. There are several possible valuation strategies, in which a distinction can be made between use values and non use values (see for example Dziegielewska, 2009)

Examples of use values include recreational use (walking, swimming, fishing) and commercial use (the extraction of timber, berries). Non-use values refer to the value that is attached to the particular area, even if it only concerns indirect use. In economic theory, three important types of non-use values of nature exist, namely option value (the opportunity to use it in the future), existence value (the value derived from the mere existence of it) and bequest value (the values attached to preserving it for future generations).

In the case of NDL, a report by Biotope and Acemav (2002) cites different functions of the area. Firstly, this concerns the support of wildlife that relies on the wetlands, including protected species of birds, insects and amphibians. Some of these depend on the availability of a network of ponds. Secondly, it hosts several threatened and protected plant species. Moreover, the area functions as a bridge between other areas of great natural interest. When the NDL disappears as nature, this also affects the quality of other neighbouring areas.

Apart from these effects, the area acts as a storage for carbon in the soil and its biomass. The net present value of carbon capture can be estimated at around € 10.5 million. A hectare of grassland captures approximately 2 kg of carbon, according to a Dutch handbook on storage of carbon (Ministerie van

LNV, 2006) which should be valued at € 100 per kilogram in 2010 (Comité des Directeurs Transports, 2005). In this study, we assume that the project of NDL covers approximately 2,000 ha[4].

The recreational value of the forests in France has been estimated by Berger and Peyron (2005) to be 126 €/ha/year. The net present value of the area (2,000 ha) is then € 4.5 million. Although the NDL area is only for a small part forest land, this value is a good proxy for recreational value of the area because of its biodiversity. Furthermore, the study states that the recreational value of land in the vicinity of cities is higher than the average value.

Adding up the recreational value and the carbon capture function of the NDL area, we arrive at € 15 million, which is an underestimate of the real value because non-use values are missing[5]. It is very difficult to estimate the non-use values of this area (existence value, option value, bequest value), because it requires people to be asked about their willingness-to-pay to keep the area as it is.

The valuation of the water control management function of the area has been discussed in Section 2.11.

2.13 Loss of agricultural land

The land on which the airport of NDL will be built is predominantly agricultural (dairy farming). The value added of a French dairy farm of 75 ha. – type 2C 'Lait spécialisé silo fermé' which is a typical farm for the NDL area - is on average € 89,700 annually (Chambre d'Agriculture en Pays-de-la-Loire, 2009). The value added that is foregone over 30 years is therefore almost € 26 million. Although it is likely that the farmers will relocate to other areas, the amount of agricultural land in France is limited, and therefore they will merely replace other farmers that quit farming.

2.14 Environmental plan

In the 2006 NDL budget, € 40 million is reserved for the agro-environmental plan, which includes the acquisition of compensation land, as well as the creation of new ponds, hedges, etc. It is difficult to assess whether this budget is estimated correctly. For example, the cost of creating new hedges is around € 15,110 which does not include the uprooting of the existing hedges (personal communication with Civam Défis). The other costs are more difficult to determine.

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4 This figure of 2,000 ha is higher than the official figure of 1,520 ha, because according to association CéDpa, the latter does not include land use for road exits/connections, the tram-train, or any area of (business) activity.

5 A different approach at valuing nature at the NDL area involves taking into account the total external costs of converting grassland with hedges and small bushes to built land (continuous urban) using the Shadow Prices Handbook (CE, 2010). External costs that are included in this handbook come from greenhouse gas emissions and toxic pollutants, among others. Using this methodology, the cost of converting this grassland can be estimated at € 44 million over 30 years. However, these external cost values are based on estimates and the European average and we prefer the method used in the text.

In the environmental plan ('Plan de gestion agri-environnemental') in the report of the Steering Committee (Comité de pilotage) it is stated that € 0.3 million is needed every year for the execution of this plan. However, we did not find this number in the SCBA. The cost of constructing NDL is therefore understated by approximately € 5.4 million.

2.15 External safety

One of the arguments for the construction of a new airport in the public debate, is the external safety risk of airplanes that fly over the city centre of Nantes. Although there is a high emotional value attached to this argument, it was not included in the original SCBA, perhaps because from an economic point of view this argument is not very important.

A study by Rand Europe (2004) of airports in The Netherlands shows that external safety costs are several orders of magnitudes less than other external costs (see Table 6). While these airports are different from Nantes Atlantique, external safety costs are much lower both for airports in urban areas (Rotterdam for example) and in more rural areas (Groningen for example).

The external safety costs are calculated on the basis of 'localised risk', which is the annual risk that a person who lives close to an airport dies as a result of a plane crash. This risk is multiplied by the cost, which is set to € 1 million. The total costs are thus dependent on the number of people that live within a specific safety zone.

Table 6 **Total external costs (x € 1,000 Euro) per regional airport in the Netherlands**

	Rotterdam	Maastricht	Eindhoven	Groningen	Enschede	Lelystad
Emissions	5,219	2,748	1,906	1,168	39	1,235
Noise	9,105	4,720	3,201	2,026	66	2,195
External safety	14	9	8	1	0	0
Total	14,338	7,476	5,115	3,195	105	3,430

Source: Rand Europe (2004).

Of these airports, Rotterdam is the most comparable to Nantes, because it is located in a densely populated area on the edge of the city, although it has fewer flights and passengers.[6] We cannot calculate the external safety cost for Nantes because it requires information about the number of people within a safety zone. Still, we can conclude on the basis of the Rotterdam data that the external safety cost is only a small fraction (1/1,000) of the total external cost.

2.16 Conclusion

Table 7 shows our conclusions on the existing SCBA, with the *original* values in the columns Scenario 1, Scenario 2 and Scenario 3. The column Remarks features the most important conclusions on the cost categories.

[6] In 2009, Nantes Atlantique had more than 2.5 million passengers and over 37,000 flights, while Rotterdam has less than 1 million passengers and over 15,000 flights (source: Eurostat).

Table 7 Social costs and benefits of Aéroport Grand Ouest in existing SCBA (in million Euros)

	Scen. 1	Scen. 2	Scen. 3	Remarks
Travel time savings	+225.5	+911.2	+1393.8	Passenger numbers could be lower due to: – Higher fuel prices – Inclusion of aviation in the EU ETS The benefits for these passengers would decrease. Also, the benefits are calculated with (too) high values of time for the passengers
Road accidents	-2.0	-1.1	+0.2	
Road pollution	-2.8	-1.1	+0.9	
Aviation pollution	-23.3	-9.5	-13.7	The cost of pollution in Scenarios 2 and 3 is underestimated, because passenger load factors are on average not lower than in Scenario 1
Aviation noise	+19.9	+19.9	+19.9	Should be increasing with passenger numbers
Exploitation of the airport	+32.6	+44.8	+57.0	Might be overestimated, perform risk analysis
Interactions with other projects	-70.5	-120.6	-156.3	
Construction costs	-310.4	-329.6	-327.5	– Some of the costs of the new airport have not been properly included, e.g. the contribution of airlines to the construction costs – The cost of building the proposed tram/train way was not included – Some taxes have been regarded as benefits which is not justified The residual value of the airport may not be realised because of the Airbus plant
Cost of water management	--	--	--	The cost of additional water management and the increased risk of flooding was not included
Value of nature	--	--	--	The value of the current site for NDL is not accounted for. It has a recreational value as well as a value as provider of eco-services, notably water retainment and carbon capture
Loss of agricultural land	--	--	--	The loss of agricultural land and the foregone agricultural value added were not included in the analysis
Environmental plan	--	--	--	Annual expenditures on the environmental plan were omitted
External safety	--	--	--	Changes in external safety were omitted, although there are very small
Net benefit	**-101.0**	**+514.0**	**+974.3**	The balance is negative for Scenario 1. This is not presented in the SCBA
Internal rate of return (TRI 1)	2.6%	8.6%	11.2%	The 'risk free' social discount rate is 4% in France. A risk adjusted rate of return should be higher. The larger the uncertainty over the costs and the benefits, the higher the rate of return should be
Effects on urbanisation through property market	+92.8	+92.8	+92.8	The methodology for arriving at this figure is not clear, is it a gross or a net effect? Taxes are not supposed to be part of a SCBA
Internal rate of return (TRI 2)	3.9%	9.5%	12.0%	
Effects on urbanisation: changes in mobility	+177.7	+177.7	+177.7	The argumentaion is flawed, because most of the jobs are in the north of Nantes
Internal rate of return (TRI 3)	5.0%	9.9%	12.2%	

Source: Pièce F, EP.

3 Alternative social cost-benefit analysis

3.1 Introduction

In Chapter 2, we have identified some issues with underlying assumptions in the existing SCBA. The purpose of this chapter is to present an alternative SCBA in which some elements have been added, while others have been scaled down from the original analysis. Even though in Chapter 2 we have argued that Scenario 1 is to our opinion the most realistic, we will take Scenario 2 as the basis of our alternative SCBA. The reason is that we would like to show the impact of alternative assumptions when the scenario is more optimistic than in Scenario 1.

3.2 Optimisation of Nantes Atlantique

When we are dealing with the optimisation of Nantes Atlantique, then it is inevitable to discuss the causes of the presumed 'constraint' on the development of Nantes Atlantique. In the SCBA (Pièce F) different reasons are cited for the 'saturation' of Nantes Atlantique:

- Capacity of the runway.
- Capacity of the terminal.
- Noise pollution and its consequences in terms of urban planning.
- The capacity of the parking area.

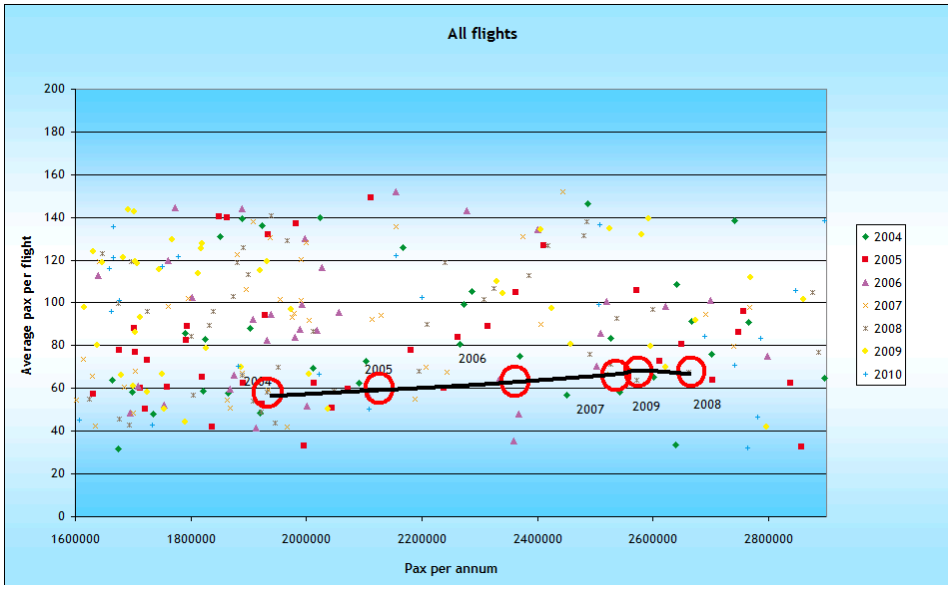
The capacity of the terminal and the parking facilities is influenced by the cyclical nature of the traffic at Nantes Atlantique, which is caused by the fact that charter flights are an important addition to the other traffic, mainly in spring and summer. In Scenario 2 of the SCBA, NA is expected to be saturated in 2019.

However, the 'saturation' of NA may be further away than 2019 because:

- As argued in Section 2.3.4, the passenger forecast is too optimistic (due to oil price increases, the effect of the ETS on ticket prices, etc.).
- In terms of noise, aviation noise has decreased over the last decades. Therefore, the saturation of NA is not easy to determine as it might seem.
- The capacity of the runway is far from being satisfied. London Gatwick, which has two runways but can only use one at a time (almost always the 3300 meter runway), accommodated 31,407,256 passengers in 2010 in 233,403 flight movements. Furthermore, Glasgow international airport had close to nine million passengers in 2005 and 2006 (almost 100,000 movements) with only one runway (2,665 m). In comparison, Nantes Atlantique accommodated 3 million passengers in almost 40,000 flight movements with a runway of 2,900 meter in 2010.
- Runway capacity is determined by the number of flights, not by the number of passengers. The analysis below shows that Nantes Atlantique currently stands out for its low average number of passengers per flight. It appears therefore to be possible to expand the airport passenger capacity without saturating runway capacity.

One possibility to increase its capacity is to increase the number of passengers per flight. Figure 3 provides an overview of the average number of passengers on all flights for European airports. The data points with a red circle represent the data for Nantes Atlantique for the years 2004-2009 (2010 was not yet available for NA).

Figure 3 Overview of average number of passengers on all flights for European airports



It becomes clear from Figure 3 that the average number of passengers on flights to/from NA is one of the lowest of European airports with a comparable annual number of passengers. This means that the number of passengers at NA can be increased by deploying larger aircraft, without requiring more runways.

3.2.1 Modifications to Nantes Atlantique

We expect the saturation date of NA to be further away than is assumed in the SCBA (2019). We acknowledge that the capacity of NA is limited in its current state but that it can be expanded. The following modifications would result in an increase in the capacity and the service offered to passengers:

1. **A local radar system**
   Building an approach radar on an airfield allows the Air Traffic Control to decrease the horizontal separation between two aircraft which increases capacity and safety. On a non-radar airport, if two aircraft want to land at the same time, the second one must wait until the first one has landed and is vacating the runway before starting the approach procedure, at least if there is no departing plane in between. In Nantes Atlantique, there is no radar system on the airport but information is transmitted from Brest-Loperhet and La Roche-sur-Yon. If a radar system were built, it would increase the capacity to accommodate planes with the same runway (1 and ½ minutes between two aircraft on ILS instead of four currently).

2. **Fast taxiways**
   Another measure to increase the capacity of the runway is to build fast taxiways (which are in a 45° angle to the runway). Currently, the taxiways at NA do not allow a quick handling of aircraft, because it takes relatively much time to reach the end of the runway after landing. There currently are six taxiways along the runway of NA but the angle is too large for aircraft at high speed (almost 90°) so the aircraft has to break very hard to be able to use these.

3. **A larger terminal, more parking places**
   The terminal is currently one of the constraints on a further growth of the number of passengers. New extensions to the terminal will have to be built, since the current terminal can accommodate 4.5 million passengers. If there are not enough gates where passengers can board the aircraft directly, we can imagine that aircraft of low cost airlines do not directly make contact with the main terminal. They rather use shuttle buses, as is the case in many other airports with low cost operators such as Dusseldorf-Weeze. In the future, more parking places could be built. The parking problem can also be solved by making it easier to access NA by public transport.

4. **Improved public transport access**
   On the site of NA, there is a train track which is two kilometres away from the main network. However, it is currently only used for freight transport. The advantage of making NA accessible by train is that there is a connection to other neighbouring cities as well. Furthermore, the cost of renovating this piece of rail track will be much lower than extending the tramway to NA. Another possibility to improve public transport access is to increase the frequency of the shuttle bus (navette), or to use larger busses.

5. **Extra runway**
   An extra runway could be built if the noise becomes close to its maximum allowed level and the number of aircraft flying over Nantes is constrained. If the new runway would be built perpendicular to the old one (east-west instead of north-south), it would result in lower noise costs because there are fewer inhabitants of the area affected by the noise. Some modifications to the control tower are needed when a new runway is built; e.g. the equipment has to be turned to face the new runway.

3.3 An alternative SCBA

In this section we will present our alternative SCBA. It must be noted that with our limited time and budget, the following scenarios do not show exact figures, but rather good estimates. Our intention with this analysis is to show that different assumptions and different values used can generate very different results. As explained in Chapter 2, the SCBA which was performed in 2006, did not take into account some cost categories, and it used values which are sometimes disputable. Furthermore, it does not show a scenario in which Nantes Atlantique is modified and remains in service.

In Table 8, we show the results for the review of the existing SCBA (Scenario 2), as well as the results for the two new scenarios of the optimisation of Nantes Atlantique (Scenario 6 and 7). Below, the scenarios are explained in more detail.

Table 8 Alternative social cost-benefit analysis (benefits or costs in million Euro, 2006 price level)

Cost/benefit category	**Airport Grand Ouest (existing SCBA, 2006)**	Airport Grand Ouest: realistic costs and passenger numbers, realistic values of time, etc.	Airport Grand Ouest: Conservative estimate of construction costs	Optimisation of Nantes Atlantique: Capacity extension, local radar system, fast taxiways	Optimisation of Nantes Atlantique: Capacity extension, local radar system, and new runway in 2023
	Scenario 2	Scenario 4	Scenario 5	Scenario 6	Scenario 7
Travel time (1)	911	317	317	297	297
Road safety (2)	-1	-1	-1	-1	-1
Emissions road (3)	-1	-1	-1	-1	-1
Emissions air (4)	-10	-26	-26	-24	-24
Noise (5)	20	19	19	0	0
Exploitation of airport (6)	45	42	0	40	40
Interactions with other modes (7)	-121	-114	-114	-107	-107
Public authorities (construction costs) (8)	-330	-304	-757	-93	-134
Water management (9)	-	PM (-)	PM (-)	0	0
Value of nature (10)	-	-15	-15	0	0
Loss of agricultural land (11)	-	-26	-26	0	0
Construction of tramway/renovate train track (12)	-	-70	-98	-4	-4
Agro-environmental plan annual cost (13)	-	-5	-5	0	0
External safety (14)	-	PM (+)	PM (+)	PM (-)	PM (-)
Cost of adjusting aircraft fleet (15)	-	0	0	PM (+/-)	0
Net benefit	**514**	**-184**	**-707**	**106**	**65**
Effects on urbanisation through property market	93	93	93	0	93
Net benefit	**607**	**-91**	**-614**	**106**	**158**

PM = to be determined due to a lack of data (in between brackets the direction of the effect: plus or minus). A minus sign represents a cost to society, a plus sign represents a benefit to society.

3.4 Scenario 4

In Scenario 4 there are some major changes compared to the original estimate (Scenario 2):

- Overall, the passenger number was scaled down by approximately 5.4% (3% due to the higher oil price, 2.4% due to the ETS). Cost/benefit categories 1-7) have also been scaled down by this factor, because they are dependent on passenger numbers. The other categories 9-14 are 'fixed costs' (they do not depend on passenger numbers) and were not scaled down.
- The travel time savings are much lower, because a lower valuation was used (see Section 2.4).
- The emissions from air transport are higher, because they were set equal to Scenario 1 and multiplied by the difference in passenger numbers between Scenarios 1 and 2. This is explained in Section 2.7.

- The original construction budget from 2006 envisaged that the whole airport of NDL would be built at once. Since then, VINCI (the winner of the concession contract for NDL) has adapted its plans and cut the project into several stages. The total construction costs were estimated to be somewhat higher than in the original plan (€ 700 milion in current prices, and even higher when including expenses for roads, agro-environmental plan and territorial measures). However, since some of the investments are done in the future, the present value of the construction costs is lower, because a discount factor of 4% has been used.
- The value of the loss of nature was added, see Section 2.12
- The loss of agricultural land was added, see Section 2.13
- The construction of a tramway was added, see Section 2.5.1.
- The annual cost of the agro-environmental plan was added, see Section 2.14
- External safety was added, see Section 2.15.

3.5 Scenario 5

- In Scenario 5, we perform a sensitivity analysis[7] by calculating a scenario where the costs for the public authorities (construction costs) are much higher than expected. In European countries, it is very common that large transport infrastructure projects suffer from cost overruns. Flyvbjerg et al. (2003) estimate that rail projects suffer from an average cost overrun of 45%, fixed links (tunnels and bridges) 34% and road projects 20%. The research was based on data for 37 projects in Denmark, France, Germany, Sweden and the UK.
- We take the average of the overruns for rail and fixed links, which is 40%, and apply this to the budget. Remember that we are using the *average* overrun, which is not even a 'worst case' scenario. In the Netherlands for example, the planned 'North-South metroline' in Amsterdam has seen cost overruns which total 100% at the moment, and the project is not even finished.
- The other assumptions in this scenario, are:
  - The residual value of the airport cannot be claimed due to the use of the runway for Airbus, see Section 2.5.2.
  - The foregone maintenance costs of NA of € 35 million cannot be claimed for the same reason, see Section 2.5.3.
  - € 30 million is spent on compensation payments for businesses around the airport, see Section 2.5.4.
  - The exploitation of the airport turns out to be much less profitable, which results in a zero benefit. A possible explanation can be that security costs go up, the annual maintenance costs turn out to be higher than expected, and so on.

[7] See glossary in Annex A.

3.6 Scenario 6

- Scenarios 6 shows the effect on the net benefit to society if the existing airport NA is modified. Scenario 6 includes the following construction phases:
  - In 2013, the train track is upgraded to bring passengers up to the train station of Nantes.
  - In 2015, the taxiways are replaced by fast taxiways and the local radar system is built.
  - In 2017, the terminal and parking places are extended.
  - In 2024 and 2031, the terminal is again extended.
- For cost categories 1-4, the effect in Scenario 6 is almost the same as in Scenario 4, except for the fact that the number of passengers in NA is slightly lower than in NDL (Pièce F). The effect is almost the same because also in this scenario people no longer have to travel to other airports far (such as Paris) because they are constrained in their choice of flying from NA.
- The interactions with other modes are the same as in Scenario 2, just adjusted for passenger numbers.
- The construction costs were estimated using the original budget estimates for NDL from 2006, and then the investments were phased over time. For example, in the original budget, € 34 million was reserved for traffic control equipment, so we are using this amount to estimate the costs for NA. Since the investments take place in later years than in Pièce F, the new present value of the cost is lower.
- In this scenario, we assume that the growth in passenger number can be absorbed by NA with the current runway through the use of larger aircraft, as well as noise reduction strategies. Aircraft operators may have to renew their fleet earlier than planned, which imposes a capital cost on them. On the other hand, aircraft operators can benefit from economies of scale by using larger aircraft (i.e. the average cost of transporting one passenger goes down as more passengers are transported at the same time). The total cost/benefit is uncertain, therefore this cost category is marked by PM.
- The other cost categories are zero because they do not differ from the reference scenario (NA as it currently is).

3.7 Scenario 7

- Scenarios 7 is almost the same as Scenario 6, with one difference: a new runway is built in 2023. The year 2023 is a conservative estimate and the runway might not be necessary until years later if the number of passengers on each flight increases (as argued in Section 3.2) or if additional noise reduction measures were taken. Still, we would like to show the effect on social welfare if the runway were built in 2023[8].
- Once more, we present an overview of the construction developments:
  - In 2013, the train track is upgraded to bring passengers up to the train station of Nantes.
  - In 2015, the taxiways are replaced by fast taxiways and the local radar system is built.
  - In 2017, the terminal and parking places are extended.

[8] In fact, the chosen year does not have a large influence on the final result. If the runway were built in 2018, the total net benefit of this scenario would be € 56 million (excluding urbanisation benefits). If the runway were built in 2028, the total net benefit would be € 72 million, excluding urbanisation benefits.

- In 2023, a new runway perpendicular to the old one is built
- In 2024 and 2031, the terminal is again extended.

– Remember, the construction costs were estimated using the original budget estimates for NDL from 2006, and then the investments were phased over time. For example, in the original budget, € 160 million was reserved for the construction of two runways and its taxiways. To estimate the cost of building one runway at NA, we took half of this amount (€ 80 million), but placed the investment in the future.
– For noise, the benefit is set to 0, even though we believe that there is a benefit of between 0 (equal to NA in its current form) and 20 (NDL). Since we are not able to draw up noise maps, we have to take a conservative estimate of the benefit of modifying NA with a new runway.
– The construction of a new runway will render the same urbanisation benefits as in the case of NDL, since the urbanisation in the south of Nantes will no longer be constrained.
– The cost of adjusting the aircraft fleet are 0 in this case.
– The other cost categories are the same as in Scenario 6.

3.8 Results

Table 9 **Results (benefits or costs in million Euro, 2006 price level)**

Cost/benefit category	**Airport Grand Ouest (existing SCBA, 2006)**	Airport Grand Ouest: realistic costs and passenger numbers, realistic values of time, etc.	Airport Grand Ouest: Conservative estimate of construction costs	Optimisation of Nantes Atlantique: Capacity extension, local radar system, fast taxiways	Optimisation of Nantes Atlantique: Capacity extension, local radar system and new runway in 2023
	Scenario 2	Scenario 4	Scenario 5	Scenario 6	Scenario 7
Total million	**514**	**-184**	**-707**	**106**	**65**
Effects on urbanisation through property market	93	93	93	0	93
Total million	**607**	**-91**	**-614**	**106**	**158**

Table 9 summarises the results from Table 8. What becomes clear is that while Scenario 2 originally showed a very convincing benefit (more than € 600 million including urbanisation effects), in our analysis the benefit has changed into a net cost to society of a few million Euro. When we use a conservative estimate of the costs, the cost to society may be around € 614 million, or even € 707 million, depending on whether the effects on urbanisation are included. Remember that we concluded in Section 2.9 that the urbanisation benefits are very uncertain.

On the other hand, the scenarios in which Nantes Atlantique is optimised show a net benefit to society. The benefit is € 106 million in Scenario 6 and € 65 million (or € 158 million incl. urbanisation benefits) in Scenario 7.

The benefits from urbanisation are included as an extra cost/benefit category. We acknowledge that there are benefits from developing Nantes further in the south of Nantes (rather than having many suburbs in the north that are far away from the city centre). Still, we think that this benefit is very uncertain, especially since we do not know how it was calculated.

Overall, when comparing the construction of the new airport at NDL and the modification of NA, the modification of NA is better for society as a whole, according to this analysis. The result is strengthened by the fact that the inherent risk in the cost estimates is smaller at NA than at NDL, simply because a large part of the airport infrastructure already exists.

4 Conclusions

4.1 Is there a need for a new airport?

A new airport at Notre-Dames-des-Landes has been proposed because the airport of Nantes Atlantique would be near to its maximum capacity. This report has reviewed the evidence on the maximum capacity of Nantes Atlantique and finds that it may take a long time before it reaches its capacity because of two reasons:

1. Passenger demand growth projections are optimistic
   - Current oil price projections are considerably higher than projections at the time of publication of the passenger projections. As a result, ticket prices are higher and demand for aviation will be lower.
   - The passenger projections do not take into account that aviation will be included in the EU ETS from 2012. As a result, ticket prices will be higher and demand for aviation will be lower.
   - Two of the scenarios on which the projections are based include rather optimistic assumptions on economic growth. A less optimistic assumption would result in lower demand for aviation.
   - All the scenarios presented assume that the costs of aviation will continue to decrease in the next decades. This is presumably based on the decrease of costs in the past, caused by the liberalisation of air traffic in Europe and the emergence of low cost carriers. Experience in the US shows, however, that liberalisation and emergence of low cost carriers results in a cost decrease that seems to level off over time.
   - High speed rail transport is a substitute for air transport. The improvement of the LGV network (for example Nantes-Roissy and Nantes-Orly with 'Le Barreau Sud') may increase demand for rail transport at the expense of air transport.
   - The market for aviation in Europe may mature and become saturated in the coming decades, which means that with rising incomes demand will not rise as quickly.

2. Runway capacity is not constrained by the number of passengers, but rather by the number of flights
   - An analysis of traffic data of European airports shows that the number of passengers per flight at Nantes Atlantique is quite low for an airport of this size. This suggests that a growth in demand can be met at least to some extent by increasing the average number of passengers per flight, e.g. by using larger aircraft. Since this would not increase the number of flights, the limits of the current airport would be reached at a (much) later point in time.

4.2 Economic justification for Notre-Dame-des-Landes Airport

The proposal for a new airport at Notre-Dame-des-Landes has been justified on economic grounds with an analysis of the social costs and benefits (Pièce F, EP). This analysis shows that the main benefits of the new airport are the benefits to passengers, which, in turn, are predominantly savings in travel time. A second major benefit is the fact that urbanisation in the south of Nantes will be increasing, although the benefits are difficult to quantify. Other benefits, including reduced noise, are at least an order of magnitude smaller.

Benefits in terms of external safety (the risk of an accident of an aircraft that causes casualties and/or damage outside the airport perimeter) are almost negligible in economic terms, even though the emotional argument is strong.

The travel time savings depend on the number of passengers projected to use the new airport. As argued above, this report concludes that the projections used in the existing social cost-benefit analysis are too optimistic. In monetary terms, the travel time savings are the product of the time saved (in hours) and the value of time (in Euros). We find that the value of time that has been presented is much higher than the value recommended in France.

In the economic justification for Notre-Dame-des-Landes Airport, published in 2006, three scenarios are presented of which one shows a negative balance of costs and benefits (the costs exceed the benefits, excluding the effect of urbanisation) while two show a positive balance. In only one scenario, the internal rate of return of the new airport is enough to compensate for the risk of the project, while in two other scenarios the rate of return is too low.

4.3 A comparison of improvements of Nantes Atlantique with the construction of a new airport

This report has recalculated the social costs and benefits of a new airport at Notre-Dame-des-Landes, taking realistic projections of passenger growth and of their value of time into account. It has compared the results with an improvement of Nantes Atlantique, where the airport would be equipped with fast taxiways, a local radar system and land access by train for passengers. At some point in time, a new runway is projected to be built, perpendicular to the current runway, in order to reduce the noise impact on Nantes. The main difference between a new airport at Notre-Dame-des-Landes and an improvement of Nantes Atlantique is that the new airport would have higher construction costs and higher costs of damage to nature. In terms of risks, the improvement of Nantes Atlantique has a lower risk of cost overruns than the construction of a new airport.

We find that, when correcting for the extremely high valuation of time and taking oil price projections and inclusion of aviation in the EU ETS into account, the costs of the new airport at Notre-Dame-des-Landes exceed the benefits. When the benefits of urbanisation are taken into account, the SCBA still shows a small negative result. If, however, construction costs are 40% higher than anticipated, which is the average cost overrun for large infrastructural works, the costs exceed the benefits by a wide margin.

The improvement of Nantes Atlantique with fast taxiways, a local radar system and land access by train would significantly improve its capacity and service delivery. If a new runway is built, perpendicular to the current runway, the noise impact on Nantes will be reduced. This report has tentatively analysed the costs and benefits of such an improvement, although the estimates on construction costs for NA are very rough since no such estimate has been made before. It finds that the benefits are higher than the costs.

In summary, based on this study, the optimisation of Nantes Atlantique appears to generate more welfare to France than the construction of a new airport at Notre-Dame-des-Landes. This presents a very strong case for a full analysis of the costs and benefits of all the options for improving air traffic in the Nantes region.

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Annex A Glossary

Discount rate:
Is the rate of return that could be earned on an alternative investment with a similar risk, which in economics is called the 'opportunity cost of capital'. One of the opportunity costs includes the interest the capital would receive if saved on a bank account. Therefore, one Euro in the future is worth more than one Euro in the present. It is common in economics and finance to calculate the 'net present value', the discounted present value of capital in the future. The formula for calculating the net present value is:

$$NPV = X / (1+i)^t$$

Where X=amount of capital, t=year and i=discount rate

Internal rate of return (IRR):
Is the rate of return a project generates, not taking into account the cost of the capital that is being used. The IRR is equal to the variable i in the following equation:

$$NPV = X / (1+i)^t = 0$$

In general, projects that generate a higher internal rate of return than the social discount rate (in this project 4%) should be undertaken because they generate wealth to society.

Sensitivity analysis:
Determines how the outcome of an analysis changes with a different input in the analysis. In the context of this paper, lowering the passenger number to see how the outcome of the SCBA changes, is a sensitivity analysis.

Social cost-benefit analysis:
Is an evaluation method that can be used to consider the impact of policy decisions. The construction of a SCBA will provide an overview of current and future pros and cons of a particular investment or policy project for society as a whole as objectively as possible. For this purpose, effects are denominated in Euros whenever possible and can be aggregated. The analysis then shows whether the project under evaluation leads to a desired increase in social welfare.

Social discount rate:
The social discount rate is the discount rate which has been agreed in a country to be used to evaluate public investments. It is the opportunity cost on the use of public capital. In France, the social discount rate is currently 4%, while it used to be 8%. The following is an illustration of the influence of the height of the social discount rate on the outcome of a SCBA. Suppose, there is a project with an initial investment of 1,000, in year 1 (t=1). The project generates annual social benefits of 130 in the years 2 to 10.

1. With a discount rate of 4% , the equation looks as follows:

   Net present value = Σ 130/(1+0,04)^t -1,000 = 54,4

2. With a discount rate of 7% , the equation becomes:
   Net present value = Σ 130/(1+0,07)^t -1,000 = -86,9

The conclusion is that in the first case, the project is a good investment for society, while in the latter case the project has a negative outcome for society.

Annex B Economic scenarios of the original SCBA

The following information on the characteristics of the economic scenarios was taken from the original SCBA (Pièce F, EP):

Le scénario 1 : tendanciel avec concentration du secteur aérien et réseaux en étoile
« Les cases grisées indiquent la combinaison des états des variables clefs qui constituent le scénario considéré »

Les 9 variables clés retenues		Etat 1 des variables	Etat 2 des variables
A	Economie mondiale, géopolitique et prix du pétrole	PIB Monde : +4 % par an PIB France : +1,9 % par an Prix du pétrole 60 $ en 2025 (test à 80 $) Pas de nouveaux conflits	PIB Monde : +5 % par an PIB France : +2,4 % par an Prix du pétrole 80 $ en 2025, (test à 120 $) Mondialisation renforcée Pas de nouveaux conflits
B	Stratégie des acteurs	Hubs, encombrements et fusions Renforcement de la desserte de Roissy, Lyon et autres hubs Faible concurrence entre aéroports Un transporteur largement dominant à Nantes	Réseaux maillés et diversité de transporteurs Plus de destinations en direct Forte concurrence entre aéroports Diversité de transporteurs à Nantes
C	Economie régionale	PIB régional : +2 % par an Démographie : tendance 1982-1999 Attractivité touristique : fil de l'eau	PIB régional : + 2,8 % par an Démographie : tendance 1990-1999 Attractivité touristique plus forte Image identifiée du Grand-Ouest
D	Prix du transport aérien et coût des facteurs	-1,3 % par an	- 0,4 % par an
E	Propension à voyager par avion	Fil de l'eau sauf pour les retraités après 2015 (ralentissement)	Ralentissement de la croissance de la PAV en raison des facteurs externes pour toutes les catégories sociales
F	Concurrence du TGV	Barreau sud avec construction d'une ligne nouvelle desservant Orly Nette amélioration de la desserte ferroviaire de Roissy (fréquence et accords tarifaires)	Barreau sud avec aménagement des lignes existantes, offre minimale et sans desserte d'Orly
G	Part des " *low-costs* " à Nantes et en Europe	Part des low-cost croissante mais limitée à 20 % du marché régulier intra-européen en 2025	Les low-cost contribuent jusqu'a un tiers du marché régulier intra-européen
H	Enjeux environnementaux	Fil de l'eau	Contraintes fortes (Ecotaxe, bruit, etc.)
I	Evolution des nouvelles techniques de télécom.	Fil de l'eau	Perte de parts du marché "*Affaires*" après 2015

Source: Peèce F, EP, p. 79.

Le scénario 2 : tendanciel expansion rapide des compagnies à bas tarifs et réseaux maillés
« Les cases grisées indiquent la combinaison des états des variables clefs qui constituent le scénario considéré »

Les 9 variables clés retenues		Etat 1 des variables	Etat 2 des variables
A	Economie mondiale, géopolitique et prix du pétrole	PIB Monde : +4 % par an PIB France : +1,9% par an Prix du pétrole 60 $ en 2025 (test à 80 $) Pas de nouveaux conflits	PIB Monde : +5% par an PIB France : +2,4% par an Prix du pétrole 80 $ en 2025, (test à 120 $) Mondialisation renforcée Pas de nouveaux conflits
B	Stratégie des acteurs	Hubs, encombrements et fusions Renforcement de la desserte de Roissy, Lyon et autres hubs Faible concurrence entre aéroports Un transporteur largement dominant à Nantes	Réseaux maillés et diversité de transporteurs Plus de destinations en direct Forte concurrence entre aéroports Diversité de transporteurs à Nantes
C	Economie régionale	PIB régional : + 2,4 % par an Démographie : tendance 1982-1999 Attractivité touristique : fil de l'eau	PIB régional : + 2,8% par an Démographie : tendance 1990-1999 Attractivité touristique plus forte Image identifiée du Grand-Ouest
D	Prix du transport aérien et coût des facteurs	-1,3% par an	- 0,4% par an
E	Propension à voyager par avion	Fil de l'eau sauf pour les retraités après 2015 (ralentissement)	Ralentissement de la croissance de la PAV en raison des facteurs externes pour toutes les catégories sociales
F	Concurrence du TGV	Barreau sud avec construction d'une ligne nouvelle desservant Orly Nette amélioration de la desserte ferroviaire de Roissy (fréquence et accords tarifaires)	Barreau sud avec aménagement des lignes existantes, offre minimale et sans desserte d'Orly
G	Part des low-costs à Nantes et en Europe	Part des low-cost croissante mais limitée à 20% du marché régulier intra-européen en 2025	Les low-cost contribuent jusqu'a un tiers du marché régulier intra-européen
H	Enjeux environnementaux	Fil de l'eau	Contraintes fortes (écotaxe, bruit, etc.)
I	Evolution des nouvelles techniques de télécom.	Fil de l'eau	Perte de parts du marché "*Affaires*" après 2015

Source : Pièce F, EP, p. 81.

Le scénario 3 : croissance avec expansion rapide des compagnies à bas tarifs et réseaux maillés
« Les cases grisées indiquent la combinaison des états des variables clefs qui constituent le scénario considéré »

Les 9 variables clés retenues		Etat 1 des variables	Etat 2 des variables
A	Economie mondiale, géopolitique et prix du pétrole	PIB Monde : +4% par an PIB France : +1,9% par an Prix du pétrole 60 $ en 2025 (test à 80 $) Pas de nouveaux conflits	PIB Monde : +5% par an PIB France : +2,4% par an Prix du pétrole 80 $ en 2025, (test à 120 $) Mondialisation renforcée Pas de nouveaux conflits
B	Stratégie des acteurs	Hubs, encombrements et fusions Renforcement de la desserte de Roissy, Lyon et autres hubs Faible concurrence entre aéroports Un transporteur largement dominant à Nantes	Réseaux maillés et diversité de transporteurs Plus de destinations en direct Forte concurrence entre aéroports Diversité de transporteurs à Nantes
C	Economie régionale	PIB régional : + 2,4 % par an Démographie : tendance 1982-1999 Attractivité touristique : fil de l'eau	PIB régional : + 2,8% par an Démographie : tendance 1990-1999 Attractivité touristique plus forte Image identifiée du Grand-Ouest
D	Prix du transport aérien et coût des facteurs	-1,3% par an	- 0,4% par an
E	Propension à voyager par avion	Fil de l'eau sauf pour les retraités après 2015 (ralentissement)	Ralentissement de la croissance de la PAV en raison des facteurs externes pour toutes les catégories sociales
F	Concurrence du TGV	Barreau sud avec construction d'une ligne nouvelle desservant Orly Nette amélioration de la desserte ferroviaire de Roissy (fréquence et accords tarifaires)	Barreau sud avec aménagement des lignes existantes, offre minimale et sans desserte d'Orly
G	Part des " *low-costs* " à Nantes et en Europe	Part des "*low-cost*" croissante mais limitée à 20% du marché régulier intra-européen en 2025	Les "*low-cost*" contribuent jusqu'a un tiers du marché régulier intra-européen
H	Enjeux environnementaux	Fil de l'eau	Contraintes fortes (Ecotaxe, bruit, etc.)
I	Evolution des nouvelles techniques de télécom.	Fil de l'eau	Perte de parts du marché "*Affaires*" après 2015

Source: Pièce F, EP, p. 83.

Annex C About CE Delft

CE Delft has a long track record in studying environmental and economic impacts of aviation and airports. It has consulted the European Commission, DG Environment, on the inclusion of aviation in the EU ETS (Giving Wings to Emissions Trading, 2005) and DG TREN on how to address the non-CO_2 climate impacts of aviation (Lower NO_x at a Higher Altitude, 2008). It has done studies on the impacts of an ETS on the aviation sector for the Dutch Ministry of Transport (Competitiveness issues for Dutch aviation from EU ETS, 2008, for example), the UK DfT (The impacts of the Use of Different Benchmarking Methodologies on the Initial Allocation of Emission Trading Scheme Permits to Airlines, 2007), and for NGOs (Allocation of allowances for aviation in the EU ETS, 2007, for example).

CE Delft has reviewed the Dutch Aviation White Paper for a large environmental NGO (Hoe groen kunnen we vliegen? – How Green Can We Fly?, 2009).

With regards to airport expansions, it has critically assessed a number of economic impact studies and found that many of them have serious flaws (The contribution of aviation to the economy: Assessment of arguments put forward, 2005). It has reviewed the impact assessments of a third runway at Heathrow (The economics of Heathrow expansion, 2008) and recently made a social cost-benefit analysis of a night flight ban at Heathrow (Ban on night flights at Heathrow Airport: A quick scan Social Cost-benefit Analysis, 2010).

CE Delft has an extensive track record on social cost-benefit analysis. Having written the official Dutch guidelines for the SCBA of environmental policies (Guidelines SCBA in Environmental Policies, 2007) and guidelines for local SCBAs (SCBA Sustainable Industrial Zones, 2010), it has led and contributed to a large number of both national and local SCBAs, including SCBAs of renovation of industrial areas, port areas, et cetera.