



SOURDINE II

D4-3

Framework for Cost Benefit Analysis of NAPs

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Summary

All major airports have addressed the issue of environmental management or management performance in a sustainable way. Some airports link environmental management closely to necessary compliance with rules and regulations or simultaneously assessment of cost and benefits. However, many of them only do what is required and financially beneficial. That's the reason why a cost benefit analysis is a requirement when a new concept, or new procedure or a new element is introduced in the complex ATM system and that's the reason why a CBA has been planned even in the SII project case.

As a first step the SII CBA methodology has been developed providing guidelines to the SII project, identifying the required input, the case studies, the actors involved, the cost and benefit categories and how to make the final economic assessment. Later the proposed methodology was applied on the SII project on the basis of input collected from other SII WPs (WP4 and WP6) and expert opinions. During the SII CBA some deviations from the original and real methodology had to be done, because not all of the required inputs were available. The results and inputs available from other WPs allowed making a preliminary framework for developing future CBA for NAPs, providing some first ideas about who can benefit and who will have to pay and for what. Further studies are then required to assess a complete picture of costs and revenues, allowing a real financial analysis and giving input to stakeholders on possible choices.

Concerning some preliminary qualitative results, the SII NAPs implementation requires an increase in the equipment and training costs for Airlines and ANSPs. The SII NAPs could generate a loss of capacity during peak hour operations and thereby an increase in the delays that translate into costs for Airlines, ANSPs and Airport Operator Companies. On the other side the reduction in the noise contours sizes, generated by the SII NAPs, is beneficial for the Airport Operator Company and people living around airports. Airport Operators could save money in insulations programs for houses (or other noise reduction programs) and improve the relationship and the discussions with people living in the airport surroundings. For the people living in the airport surroundings the SII procedures can improve their quality of life by reducing the noise impact.

The environmental capacity, meaning the sustainable capacity of an airport being compatible with the environmental requirements, it's clear that the introduction of the SII NAPs allows an increase in capacity guaranteeing the safeguard of the environmental parameters that is a benefit for airlines, ANSPs and Airport Operator Company.

More work is required for making a preliminary CBA analysis and in this case it is highly recommended to define and agree the validation strategy at the beginning of the project and clearly define all data requirements for the simulations. Besides this it is also important to identify all possible risks for the availability of the data and assess the impact of missing data for the validation assessment. When using data from various sources the consistency of the input data should be guaranteed; in the SII project case different input data were available for each NAP and for each airport, not allowing having a complete picture of effects (positive and negative) of each NAP (see Table 1 for further details). Last but not least there should be a plan how to translate input data into monetary terms and consult (external when required) experts in an early stage to retrieve this kind of information, as soon as clear requirements are available.

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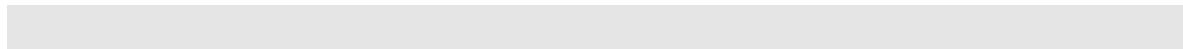
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1 Introduction

1.1 Purpose

The Sourdine II project aims to produce a set of advanced noise abatement approach and departure procedures, to validate them through capacity, safety, noise, emission, economic and user acceptance assessment and to elaborate a roadmap for implementing them.

The objective of this document is to present the results deriving from the cost benefit analysis of SII NAPs. Validation activities have been carried-out here through the collection of FTS, RTS and experts opinions.

1.2 Background

In recent years, the interest in community noise and its associated quality of life has increased and is increasing, since environmental effects (noise and emission) can act as constraints to aviation growth, in the near future as well as over long term.

Many efforts have already been spent to this end, for example making aircraft engines less noisy and with low emissions, changing the operational rules; but further actions are required to balance the increase in air traffic demand with the required high level of safety and with the reduction of costs, meeting the environmental safeguard requirements too.

The introduction of new APP/DEP procedures has been identified as an efficient way for reducing the noise impact around airports and the emissions values, but it is necessary to find a trade off between the environmental efficiency and related aspects such as safety, implementation and costs.

1.3 Glossary

ANSP	Air Navigation Service Provider
APP	Approach procedure
CBA	Cost Benefit Analysis
CDA	Continuous Descent Approach
CVM	Contingent Evaluation Method
DEP	Departure procedure
FTS	Fast Time Simulation
GDP	Gross Domestic Product
HH	Household
HP	Hedonic Pricing Method

Ku	Kosten Unit, an “objective” measure of aircraft noise nuisance used in the Netherlands)
ICAO	International Civil Aviation Organization
MTOW	Maximum Take Off Weight
NAP	Noise Abatement Procedure
NEF	Noise Exposure Forecast
NNI	Noise and Number Index
NSDI	Noise Sensitivity Depreciation Index (the average percentage change in property prices per decibel)
RTS	Real Time Simulation
TMA	Terminal Manoeuvring Area
WTP	Willing To Pay

1.4 Reference documents

[ANRPV]	Collins & Evans “Aircraft Noise and residential property values: an artificial neural-work approach”, 1994
[ATM_ACE]	Eurocontrol “ ATM Cost-Effectiveness (ACE) 2003 Benchmarking Report, 2005
[BMATS]	Phil Smith “Barriers to Marginal Social Cost Pricing in the Air Transport Sector”, May 2004
[CATDE]	Institut du Transport Aérien “Cost of air transport delay in Europe”, November 2000
[MEVTA]	Carlsson, Lampi, Matinsson “Measuring marginal values of noise disturbance: Does the time of the day matter?” February 2004
[PAMELA]	Eurocontrol “Parametric ATM Model for Long Term Economic Assessment, Validation report”, December 2001
[REBEIN]	Opschoor, J.B, A review of monetary estimates of benefits of environmental improvements in the Netherlands, 1986
[SAEVN02]	Ståle Navrud, “The State-of-Art on Economic Valuation of Noise” Final Report to European Commission DG Environment, April 14 th 2002
[SAEVN03]	Ståle Navrud, “The State-of-Art on Economic Valuation of Noise” Workshop on Economic Valuation of Health effects due to Transport, June 12-13 2003 Stockholm
[STCBA]	Eurocontrol “Standard Inputs for EUROCONTROL Cost Benefit Analyses”, 23 September 2002
[SICBA]	Eurocontrol” Standard input for Eurocontrol Cost Benefit Analysis
[SII_D1_1]	SOURDINE II, “Identification”, 2003
[SII_D4_1]	SOURDINE II, “Fast Time Simulation Assessment”, 2005
[SII_D2_1_A]	SOURDINE II “D2.1 Validation Methodology Report, Appendixes”, April 2004

[SII_D6_4]	SOURDINE II, "D6.4 Experimental design for the ATC simulation", March 2005
[SII_D6_5]	SOURDINE II, "D6.5 Experimental design for pilots simulation", November 2004

2 Overview of the study

2.1 Objective

Once assessed the SII NAPs on capacity, noise, emissions, safety and users acceptance point of view, having evaluated for example the change in the airport capacity, in the delay values, in the noise contours and in the other selected metrics, the further step planned by the SII CBA methodology was to assess on which stakeholders the measured values could have an impact, as investors or as beneficiaries.

The CBA methodology has been slightly changed because required noise results were not available and any results on emission/burned fuel were available. Less cost/benefits values have been then evaluated due to the limited data number. To this purpose, appropriate Cost/Benefit models permit the extrapolation of costs over time as well as projections of financial measures of the benefits that may be expected. Last, but not least, very often CBA is necessary to convince investors to support the implementation of the “solution”, especially when large expenditures and/or relevant infrastructures are required.

This deliverable presents the CBA methodology applied in the SOURDINE II project and first economic considerations obtained. The document shows also how the planned costs and expected benefits have been estimated and, where possible, evaluated.

2.2 Scope

The “Economic” is one of the validation objectives considered within the SII project, together with safety, environment and capacity aspects. Keeping the safety as first objective, the SII project focuses on environmental aspects, proposing new arrival and departure procedures on long term (beyond 2015), aiming at avoiding that noise (emissions) becomes a constraint for the increase in the airport capacity.

To perform a CBA is very difficult, above all when the evaluation on long term, thus more input parameters have to be foreseen which clearly influence the output. Once the procedures have been demonstrated efficient in noise reduction, the success of their implementation depends on the price the involved stakeholders are willing to pay and for what, answering the following questions:

- “How much is it convenient to apply a SII NAP?”
- “When is it more convenient to apply a NAP?”
- “Who is going to benefit from the SII NAP use?”
- “Who will have to pay to achieve the SII objective?”

Answer to these more questions requires to have clear the objective of the SII project, to translate all FTS and RTS in monetary terms (if possible) and compare costs and benefits identifying also who has to pay and who can benefit.

2.3 Input from other WPs and external input

Many inputs are necessary for the SII Cost Benefit Analysis, some of those are expected to come from the Fast Time Simulations, while others from Real Time Simulations and others from literature studies and expert opinions.

Most of the input comes from the FTS [SII_D4_1], giving many valuable parameters about the effectiveness of the procedures planned within the SII project.

The scheme in the following picture summarizes how the CBA has been performed, the links between WPs and external data.

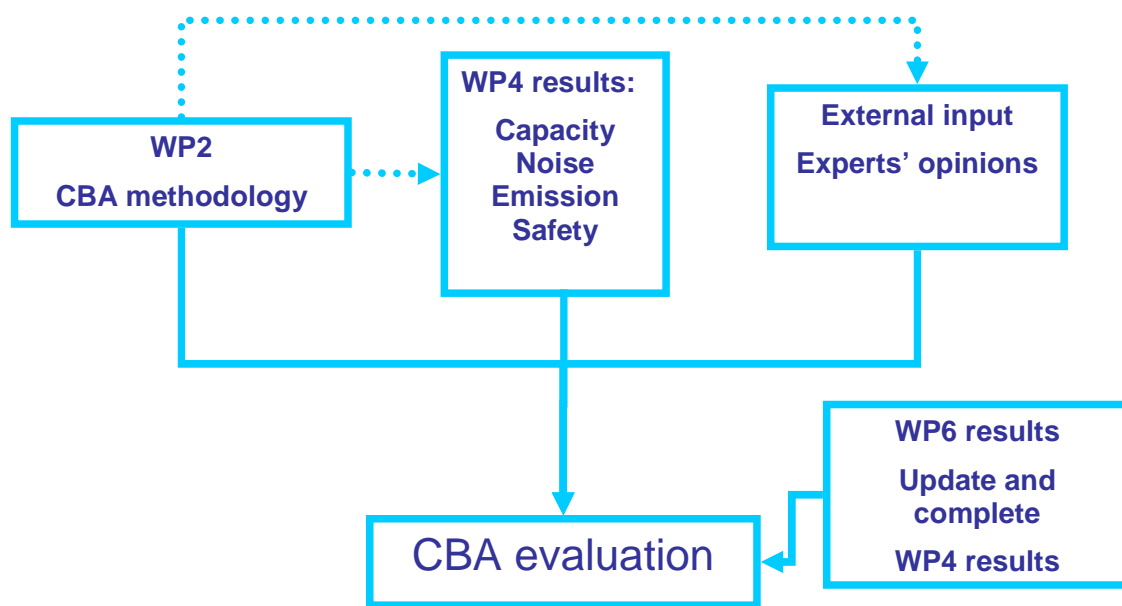


Figure 1: Cost Benefit Analysis Scheme

Looking at the scheme of Figure 1, the CBA methodology has been defined in the WP2, identifying the parameters to include in the CBA (both coming from the WP4 and from expert opinions) and the methods to calculate costs and benefits.

Results coming from the WP6 have been used to update the preliminary economic results calculated with WP4 output.

2.4 Outline of the study

As planned from the SII Validation Methodology [SII_D2_1_A], the Cost Benefit Analysis has to be developed through a pre-defined stepped sequence:

- Case identification: Do-nothing case and alternative case (s)
- Valuation types: Quantitative (€) or Qualitative (Improvement or Worsening of valuation parameters)
- Actors identification
- Cost categories identification and evaluation for each actor/stakeholder and the identified cases
- Benefit categories identification and evaluation per each actor/stakeholder and the identified cases
- Final assessment

2.4.1 Cases identification

For evaluating the costs and the benefits coming from the SII NAPs implementation it is necessary above all define the do-nothing case (if none change is planned to be applied at the selected timeframe) and the alternative cases.

The Base case is the scenario planned at 2015, with the future airport/airspace configuration, future A/D procedures, future air traffic data, future fleet mix and planned improvement/change in the ground and on-board technology planned.

The alternative cases are equal to the Base case, except for the A/D procedures (SII NAPs) and all the technological/operational changes necessary to their implementation.

2.4.2 Valuation types

Two evaluation types have been identified, one is quantitative and the other one is qualitative. In both cases methods and guidelines, required input data have been supplied for developing the CBA.

2.4.3 Stakeholders selected for the SII project

The identification of actors/stakeholders is a fundamental step towards the costs and the benefits calculation. The risk is, in fact, to exclude some of the actors from the list of those who have to pay or that can benefit from the SII NAPs implementation.

In the following lines the stakeholders involved in the SII NAPs implementation have been listed:

- Airlines
- Airport operator company

- APP/Arrival/Planning controller
- People living in the airport vicinity
- Passengers and cargo
- European Commission
- SII partners

2.4.4 Costs/Benefits identification

The costs identification is as important as the stakeholders' identification because excluding some of the costs/benefits could induce investors/beneficiaries to wrong conclusions.

- Investment costs
- Operational costs
- Social costs
- Noise charges
- Airport efficiency change (capacity/delay decrease)
- Decrease in noise levels benefits
- Decrease in emissions levels benefits (not performed and not available)
- Social costs (PM)

2.4.5 Parameters selection

For the economic analysis it was required to fix some parameters such as to make a quantitative evaluation. A document asking for the input parameters was distributed to the WP4/WP6 partners to easily collect the input data. The above mentioned document is included in the present document, as Annex A in the Appendixes section.

2.4.6 Assumptions and Hypotheses

The methodology has been developed on "Guidelines for the economic appraisal of the EATMP projects – the effective use of costs-benefit studies". The mentioned methodology is generic for ATM projects, so, some assumptions have been made when the CBA for the Souridine II project has been done.

In the following line there is a list of assumption used for the CBA:

- SII procedures will be economically evaluated at airport/TMA level
- Only commercial air traffic is taken into account
- Actual airport layout and constraints for 2015

2.4.7 FTS data availability

As seen in the paragraph 2.3 the economic analysis is really dependent from the WP4/WP6 results and experts opinions. **To make a CBA on a SII test site it should be necessary to**

have for it a complete set of information on capacity, noise, safety, emissions, burned fuel, user acceptance and workload. The following table shows the status of FTS output by each one of the SII airports (A=Amsterdam, M=Madrid, N=Naples, P=Paris CDG) and for each one of the SII NAPs.

Analysing the results per airport, it is clear that none of the NAPs has a complete output set, which makes it impossible to make a preliminary CBA for it, but they only allow set a preliminary framework for making a CBA on NAPs later on.

		FTS output																			
	SII NAP	Capacity Efficiency				Noise				Safety*				Emissions/ Fuel Burned							
		A	M	N	P	A	M	N	P	A	M	N	P	A	M	N	P				
ARR	Baseline	x	x	x	x	x	x	x	x												
	NAAP II(II-A)	x	x	x		x	x	x	x	x											
	NAAP III		x		x	x	x	x	x												
	NAAP IV	x	x	x		x	x	x	x												
	NAAP V	x	x	x	x	x	x	x	x		x										
DEP	NADP 1					x	x	x	x												
	NADP 2					x	x	x	x		x										
	NADP 3					x	x	x	x												

Table 1: WP4 results available for all the SII NAPs

3 Analysis of costs and benefits per stakeholder

3.1 Airport and Air Traffic Service Provider

The following table summarizes the possible costs and benefits in charge of the ANSPs in the case of the SII NAPs implementation. Comments and details on the single costs category follow in the next pages. In addition to costs and benefits categories, there is the TBD category, since no type of assessment was available for that parameter neither the qualitative assessment was possible. These last items, included, for information completeness in the table, have been written in grey. The grey background rows report those cost/benefit categories for which no results in charge of ANSPs have been found in charge.

Costs	Investment costs	On the ground equipment tools	Monitoring/Management tools	
		ATCOs training on the new NAPs and on new tools	Ghosting tool	
			Naples	~30 ATCOs
			Amsterdam/Madrid (App)	~70 ATCOs
		Transition costs	All the necessary investments for migrating to the SII NAPs implementation, not included in the above categories	
	Possible Modification on the TMA structure			
	Operating costs			
Social costs				
Airport charges				
TBD	Change in the emissions values			
	Change in the fuel consumption			
Benefits	Decrease in noise nuisance			

The above table shows how much ANSPs are involved in the SII NAPs process implementation, how much they have to pay and how much they can benefit from the SII NAPs implementation. In the second column the kinds of costs/benefits/TBD are detailed and in the third and fourth column a summary of the items in the list are reported.

In the following lines, details on the single item have been explained.

3.1.1 Investment costs

Training costs

The SII NAPs are long term procedures and, as seen from the FTS and RTS results, they require the introduction of new tools supporting the technical ANSP staff for their implementation and application.

Conceptually speaking, the SII NAAPs keep constant one of the three aircraft performance parameters (speed, altitude and thrust) and plays on the other two performance parameters. So once an aircraft starts flying a NAAP, only configuration changes linked to the NAP are allowed. This means that the inbound traffic has to be managed before the CDA starts and this can be done with the support of arrival management/monitoring tools developed for the SII NAPs, together with the Ghosting tool, that foresees the aircraft position when merging a/c flows in approach and provides earlier sequencing of the inbound traffic, making easy the monitoring too. The introduction of new systems and procedures requires also the training of the operational staff, because ATCO have to become confident and have to feel safe in using them.

The introduction of the SII NADPs is easier because they imply fewer changes in the controllers operating way so there are fewer constraints to their application.

A preliminary assessment of the controllers' time training has been done through the RTS on Amsterdam Schiphol airport and, as result, it has been found that 3 days training are the minimum requirement [SII_D6_4] for the controllers training, having assumed only that the controllers have to manage night air traffic. On the basis of assumptions done, three days are not sufficient for a full controllers training, in fact further RTS should be required for an estimation of ATCO training for managing the daily traffic, but as a first assessment, each airport has to taken into account a minimum budget for the controllers training, as described in the following lines.

The hourly parameter of an ATCO depends on the State where the controller works, indeed these costs depend on costs of living, which differ widely across the States in which the ANSPs are located.

Due to unavailability of hourly ATCO parameter costs for each state, it has been decided to use an average hourly value. At the European system level, it has been estimated that the average employment costs per ATCO-hour are €69 [ATM_ACE]. This value has been chosen as common value for the hourly controllers training, just to have an order of magnitude of the minimum effort required to the ANSP for the controllers training. The following table shows some sample of ATCO training costs calculation for the application of SII NAAPs. The first column lists the number of controllers to be trained by three airports (Madrid, Naples and Schiphol), the second one lists the hourly ATCO costs update at 2004 and the last one summarizes the calculated costs for the three days training:

	Number of controllers	Costs for one hour ATCo (€)	Training costs(€)
Madrid Barajas	70	70,6€*	118.608,00 €
Naples Capodichino	35		59.304,00 €
Amsterdam Schiphol	75		127.080,00 €

These costs have to be taken into account for the all the NAAPs, because the SII arrival procedures introduce a new working way for the controllers: they that have to manage the traffic before a CDA is been started, after that they are in charge of monitoring the landing aircraft. About the departure procedures, they do not require any particular training or support to be implemented, so no investment costs are required to the ANSP for their implementation.

New equipment costs

The following table lists which are the new tools necessary for the implementation of the SII NAPs:

		Costs in charges of ANSP
SII NAAPS	NAAP II	Implementation of new tools: – Monitoring/Management tools – Ghosting tool Training of controllers on new tools and on new NADPs
	NAAP III	
	NAAP IV	
	NAAP V	
SII NADPs	NADP Close-in	None necessary
	NADP Distant	

* 2004 Rate

3.2 Airlines

The following table summarizes the possible costs and the benefits in charge of the airlines for the SII NAPs implementation. Comments and details on the single costs category follow in the next pages. In addition to costs and benefits categories, there is the TBD category, since no type of assessment was available for that parameter neither the qualitative assessment was possible. These last items, included for information completeness in the table, have been written in grey. The grey background rows report those cost/benefit categories for which no results in charge of Airlines have been found.

Costs	Investment costs	On board- equipment tools	Flap deployment cue	
			Vertical Navigation Display	
			Tool to optimise thrust level/gradual thrust increase	
			Modifications on FMS and on Engine Control Systems	
		Pilots training on the new NAPs and on new tools	Naples/Paris Amsterdam/Madrid (App)	All pilots of the airlines flying on that airports
	Transition costs	All the necessary investments for migrating to the SII NAPs implementation, not included in the above categories		
	Airport Charges			
	Operating costs	Increase in average delay per flight		
		Maintenance and overhead costs	NADPs -Possible impact in the number of engines' maintenance cycles NAAPs -Possible change in the number of checks for speed brakes/flaps	
	Social costs			-
Airport charges			-	
TBD	Change in the emissions values			-
	Change in the fuel consumption			-
	Emissions charges	Emissions charges are based on Kgs of produced pollutants. A possible reduction of produced pollutants thanks to the use of SII NAPs could introduce a reduction in the emissions taxes charged to airlines		
Benefits	Decrease in noise nuisance			-
	Noise Charges	Noise charges are currently based on Aircraft Noise category (Chapter1, ..., Chapter4) and on their operating weight. The use of a SII NAP could be internalized in the charges system introducing a discount factor depending on the used procedure		

The above table shows how much airlines are involved in the SII NAPs process implementation, how much they have to pay and how much they can benefit for the SII NAPs' use. The second column lists the identified cost/benefit/TBD categories and the third and fourth columns give details about the costs/benefits identified in the third column. In the following lines, details of the single items have been explained.

3.2.1 Investment costs

As expected, airlines are the main actors in the SII NAPs implementation process because pilots are in charge of applying the SII NAPs. The SII NAPs implementation will call for relevant investment costs for the airlines, because new tools are required for both approach and departure procedures, such as flap deployment cue and vertical navigation display, but demonstrated as very useful to a pilot because he has more information available on the NAP he is flying and he can act on the aircraft in order to reach the required noise abatement procedure performance.

Even for the airlines, as already seen for the ANSPs, the introduction of new systems and procedures requires the training of the operational staff, because pilots have to become confident and have to feel safe in using them. In the pilots' case, this point is more emphasized, because they are in charge of flying correctly the NAP playing on the performance parameters to respect the conditions imposed by a continuous descent approach or from a noise abatement departure procedure.

A preliminary assessment of the pilots training has been done through the RTS and as result it has been found that 2 days training are the minimum requirement [SII_D6_4] for the pilots training. This does not mean that two days are sufficient, thus a wider training programme has to be planned for the actual pilots.

So, synthetically speaking, if airlines want to "act" to reduce the environmental impact due to their operations, by flying a new NAP, they have to invest on the following items:

- Additional aids on the flight deck
 - Flap deployment cue
 - Vertical Navigation display
- Additional tools/modifications
 - Tool for automating the thrust and reaching the gradual thrust increase
 - Modifications on the FMS and update of procedure database
- Training of pilots on the new NAPs

3.2.2 Operating costs

As expected, when an aircraft flies a NAP, there are changes in the operational field, that means changes in the operating costs in charge of airlines.

The operating costs include all the costs pertinent to the aircraft operations, so in the SII project three items have been addressed in this costs category:

- Maintenance and overhead costs
- Delay costs
- Crew and staff costs
- Fuel costs

3.2.2.1 Maintenance and overhead costs

About the first one, it is not easy to foresee the impact of the SII NAPs on an aircraft maintenance cycle, because changes in the intervals between two succeeding interventions can be done only after years and years of observations on aircraft components once the operational change, that means the SII NAPs implementation, has been applied.

If an airline is interested in assessing how much a factor influences the time between two succeeding interventions on a component, it should investigate on this factor for years, draw the related conclusions and, eventually, propose to the aircraft manufacturer a change in the maintenance/overhaul cycle. Aircraft manufacturers have the last word on the approval of the proposed changes.

So, in the Sourdine II specific case, the time interval between two succeeding maintenance interventions could be modified introducing the SII NAPs, but it requires long term studies for the airlines and final approval by aircraft manufacturers.

In any case it is interesting to make some preliminary hypotheses on possible effects on the aircraft maintenance process caused by implementing the SII NAPs.

Taking into account the operating aircraft life, the maintenance process is currently based on the aircraft flown hours, which determine different kinds of intervention, such as smaller intervention (Group A see Table 2) or in-depth overhaul and maintenance intervention (Group D see Table 2). Table 2 in next page reports a sample of overhaul and maintenance scheme, it has to be read just as an example, because, actually, the hourly values of maintenance process depend on the aircraft type and on the airline, but it just helps in having an order of magnitude of the intervention characteristics.

	Aircraft check types		
	A	D
Flight hours between 2 checks	250-600h	4000-5000h (15-20 M/L)
Intervention duration	-	1500-2000 HM

Table 2: Sample of maintenance and overhaul scheme

Looking at the table, the first row reports the aircraft check types, from A to D, where A is the shortest intervention type and D is the deepest one. Between A and D there are other intervention types, B and C, with intervention sub-group types. Just to give an example of how to read the table in the last column, an aircraft with an operating life of 15-20 years, after 4000/5000 flight hours has to be stopped and overhauled for about 1500-2000HM.

In the airline’s interests it’s clear that during maintenance/overhaul cycles, combining more scheduled interventions as possible in one aircraft stop is the optimum, rather than having the aircraft frequently stuck on the ground. In the SII project case some of the arrival procedures could require a change in the flown hours between two succeeding checks, because flaps and speed brakes are used for longer time, but at the same time engines are used differently, so related checks could be re-scheduled

Concerning the departure procedures, past studies have demonstrated that the use of de-rated thrust can affect the maintenance costs (EMCWG, Engine Maintenance Cost Working Group), to assess quantitatively these costs is very difficult, because they depend on the engine model and operational use conditions.

In the SII project case, assessing these costs could be more difficult because of the need to assess a "typical derate": not easy to define since it is highly dependant upon the runway characteristics, the takeoff environment conditions, the aircraft TOW and finally the installed thrust.

Further analyses are required for investigating the possible effects of the de-rated thrust on the engines maintenance/overhaul.

3.2.2.2 Delay costs

As seen from the fast time simulations assessment, the new arrival SII NAPs bring about an increase in the average delay per flight, which has been quantified for each airport and for each procedure.

The most recent study on the costs of delay have examined the above according to different types of delay: duration, phase of flight and whether the delay is absorbed into schedules (strategic) or in addition to schedule buffers (tactical), thus calculate a single averaging value of delay costs is difficult. An average value of €72² per minute [SICBA] has been determined for the cost of ATFM delay at the European level. Given the nonlinearity of the cost of delay, it has been suggested to apply this value to delays of 15 minutes and above, while on the other hand to apply a zero cost to delays below 15 minutes.

Since the delays calculated within the SII project are related just to the use of the SII arrival procedures, they have been calculated on the last part of the flight (from 7000ft to the THR) it has been assumed that all aircraft flying a SII NAAP have accumulated an ATFM delay of 15 minutes before they start the CDA.

The Table 3 summarizes the results coming from the FTS assessment for the four SII airports and for the assessed NAAPs.

		Baseline	NAAP_II	NAAP_III	NAAP_IV	NAAP_V
Average Arrival Delay (min.)	Naples	2,7	2,9	0,0	4,4	3,7
	Madrid	1,8	3,9	3,6	4,6	3,7
	Schiphol	3,9	4,9	0,0	8,6	5,6
	Paris	2,9	3,2	3,3	0,0	3,3

Table 3: Average arrival delay for SII Arrival noise abatement procedures

Taking into account the daily movements number planned to fly by 2015 in the four airports:

Naples	301
Madrid	1799
Schiphol	1800
Paris	1689

Table 4: Total daily movements foreseen at 2015 per airport

and using as standard value for the delay the values of 72€, it has been assessed the daily percentage variation of the delay costs due to the SII NAPs implementation, as shown in the next table:

² 2004 value

Percentage Variation of SII NAAPs delay costs with respect to the Baseline ones				
	<i>NAAP_II vs. Baseline</i>	<i>NAAP_III vs. Baseline</i>	<i>NAAP_IV vs. Baseline</i>	<i>NAAP_V vs. Baseline</i>
Naples	7,41%		62,96%	37,04%
Madrid	116,67%	100,00%	155,56%	105,56%
Schiphol	25,64%		120,51%	43,59%
Paris	10,34%	13,79%		13,79%

Table 5: Percentage Variation of delay costs with respect to those of the Baseline ones

Looking at Table 5 you can see that all the NAPs bring about an increase in delay costs, that vary from airport to airport. In Naples', Schiphol's and Paris' case NAAP II has been assessed as the procedure generating less delay costs, while in Madrid the procedures costing less in terms of delay costs is the NAAP V.

Unfortunately no output is available for departures, so it has not been possible to make the same type of evaluation for them, assessing if airlines can save or not part of the operating costs by using them.

3.2.2.3 Flight and cabin crew salaries and expenses

Crew costs are particularly difficult to assign to particular incidences of delay for the two following reasons. The first one is that the crew payment schemes are very complex, their calculations take into account total duty hours, flight duty hours, time spent at outstations (with corresponding allowances – which may make up a significant part of overall pay) overtime hours, experience and rating.

The second one is the difficulty in allocating costs accurately to a particular leg, because if a crew's hours expire on one rotation due to a delay, and an extra crew is brought in, this extra crew may then be available to serve subsequent rotations, such that the cost of delay should not be allocated to only one. These problems are complicated by the fact that crew costs comprise such a relatively high proportion of total costs for many airlines, such that errors in these estimations are made more significant (e.g. have greater consequences on the final delay costs per minute calculated than would a proportional error in the fuel cost calculations). In addition, airline practice varies greatly regarding the allocation of crew payments, with payments being made on a sector-flown basis, in proportion to total hours worked, or only by actual off-block.

That's the reason why these costs have been identified among the SII costs categories, but they haven't been included in the SII costs assessment.

3.2.2.4 Noise Charges

The noise charges are primary based on the certified aircraft noise-level [SII_D1_1], according to the standards of ICAO, Annex 16 or FAR Part 36 and to their MTOW.

They are different for each country, where the local government fixes the taxes rate, but the basic principle is the same. It could be then proposed to add as third factor for the noise charges calculation the use of a noise abatement procedure. As seen, in fact the, new SII NAPs are noise reduction beneficial, in fact they allow to reduce the noise in a good percentage.

3.3 Airport operator company

The following table summarizes the possible costs and the benefits in charge of the airport operator company for the SII NAPs implementation. Comments and details on the single costs category follow in the next pages. In addition to costs and benefits categories, there is the TBD category, since no type of assessment was available for that parameter neither the qualitative assessment was possible. These last items, included for information completeness in the table, have been written in grey. The grey background rows report those cost/benefit categories for which no results in charge of airport operator company have been found.

Costs	Investment costs	-
	Operating costs	-
	Social costs	-
	Airport charges	-
TBD	Change in the emissions values	-
	Change in the fuel consumption	-
	Change in the emission charges	-
Benefits	Decrease in noise levels	Improving the relationship with people living around the airport and decreasing costs for sound-proofing programs and/or compensation costs for noise nuisance
	Noise charges	-

The airport operator company will benefit from the use of the SII NAPs, because, from a qualitative aspect, the relationship with the people living in the airport surroundings will improve, due to the decrease in noise levels around airports.

The come true of this event is really dependent from the distribution of houses around an airport, so it should be verified by each test site (the four SII airports) and for all the procedures. Unfortunately within the SII project, it has been not possible to assess the change in the number of houses within the noise contours for all the NAPs, so only qualitative considerations can be done.

Qualitatively speaking, on the economic point of view, the SII NAPs implementation could save money, because the noise contour size will be reduced and probably the number of houses within a noise contour will decrease, that means consequences on houses insulation programs or increase in air traffic volume.

Airport operator companies use residential insulation programs such as instrument for reducing the impact of the aircraft noise on the houses in the airport surroundings improving then the quality of life for residents. If the SII NAPs' implementation generates a decrease in the number of houses within a fixed noise contour, there are less houses to insulate and airport operator companies can save money, or there is the chance to increase the traffic volume without requiring new insulation for the houses.

Alternatively, Airport Operator Company can decide not to sound-proof houses, but give money to people within a fixed noise contour thus compensating the noise nuisance they are subject to.

		Benefits for the Airport Operator Company
SII NAAPS	NAAP II	Improving the relationship with people living in an airport surroundings and decrease in costs for sound-proofing programs and/or compensation costs for noise nuisance
	NAAP III	
	NAAP IV	
	NAAP V	
SII NADPs	NADP Close-in	
	NADP Distant	

3.4 Passengers and cargo

The following table summarizes the possible costs and the benefits in charge of Passengers/Cargo for the SII NAPs implementation. Comments and details on the single costs category follow in the next pages. In addition to costs and benefits categories, there is the TBD category, since no type of assessment was available for that parameter neither the qualitative assessment was possible. These last items, included for information completeness in the table, have been written in grey. The grey background rows report those cost/benefit categories for which no results in charge of Airlines have been found.

Costs	Investment costs	-
	Operating costs	Increase in average delay per a single flight causes an increase in the passengers travel time.
	Social costs	-
	Airport charges	-
TBD	Change in the emissions values	-
	Change in the fuel consumption	-
	Change in the emission charges	-
Benefits	Decrease in noise levels	-
	Noise charges	-

As seen from the fast time simulations assessment, the new arrival NAPs bring about an increase in the average delay per flight, which has been quantified for each airport and for each procedure.

The average delay per flight should be a parameter to take into account also for passengers, because it is a customer satisfaction index, but when it is calculated it has to be referred to the delay accumulated from the departure gate to the arrival gate, so it has been decided to leave out this parameter from the SII CBA.

3.5 Third parties/Citizens living around airports

The following table summarizes the possible costs and the benefits in charge of third parties/Citizens for the SII NAPs implementation. Comments and details on the single costs category follow in the next pages. In addition to costs and benefits categories, there is the TBD category, since no type of assessment was available for that parameter neither the qualitative assessment was possible. These last items, included for information completeness in the table, have been written in grey. The grey background rows report those cost/benefit categories for which no results in charge of third parties/citizens have been found.

Costs	Investment costs	-																					
	Operating costs	-																					
	Social costs	Increase in the property value of houses around airports																					
	Airport charges	-																					
TBD	Change in the emissions values	-																					
	Change in the fuel consumption	-																					
	Change in the emission charges	-																					
Benefits	Decrease in noise levels	<p>Sensible reduction in the noise contour has been assessed with the use of the SII NAPs. Supposedly the number of people exposed to noise level should decrease</p> <table border="1"> <thead> <tr> <th colspan="7">Percentage decrease in Noise contour L_{den}</th> </tr> <tr> <th>L_{den}</th> <th>II</th> <th>III</th> <th>IV</th> <th>V</th> <th>Dep_1</th> <th>Dep_2</th> </tr> </thead> <tbody> <tr> <td>55-70dBA</td> <td>-2%/-8%</td> <td>-20%/-36%</td> <td>-5%/-20%</td> <td>-4%/10%</td> <td>-23%/8%</td> <td>-40%/-3%</td> </tr> </tbody> </table>	Percentage decrease in Noise contour L _{den}							L _{den}	II	III	IV	V	Dep_1	Dep_2	55-70dBA	-2%/-8%	-20%/-36%	-5%/-20%	-4%/10%	-23%/8%	-40%/-3%
	Percentage decrease in Noise contour L _{den}																						
L _{den}	II	III	IV	V	Dep_1	Dep_2																	
55-70dBA	-2%/-8%	-20%/-36%	-5%/-20%	-4%/10%	-23%/8%	-40%/-3%																	
Noise charges	-																						

From the airport financial point of view, the noise and more in general the environment, is considered such as an externality, because the environmental aspects are not relevant for the airport decision makers but they influence community life.

There is a considerable literature on this type of problem, and, in particular a few studies that aim at pricing the external effects due to aircraft noise nuisance. These studies either use revealed preference methods (e.g., the hedonic price method), or direct stated preference methods (e.g., the contingent valuation method). In the SII project case it was initially proposed to use an Hedonic pricing method and as metric for the evaluation of the noise assessment the selected Noise Sensitivity Depreciation Index (NSDI), that is the average percentage change in property prices per decibel, that means, if the NSDI is about 0.5-0.7 and the noise nuisance increases by 10 units, then, the property prices decrease by 5-7%.

Many studies have been performed on the economic value of aircraft noise and they suggest to use a value of NSDI between 0.5% and 1%, so a proposal could be to make an assessment with a minimum, a maximum and an average value of proposed NSDI range and analyze the economic effects of choosing on of them through the sensitivity analysis. Unfortunately data on the number of houses within noise contours for the baseline and the SII NAPs have not been calculated, so the mentioned methodology was not applicable rather a qualitative analysis of the results has been done. The introduction of the new SII NAPs generates a decrease in the noise contour sizes, that could mean a decrease in the number of houses within some noise levels, but it should be assessed airport by airport and NAP by NAP because people are not uniformly distributed around airports.

4 Problems encountered

This section draws together some of the issues/lessons learnt that arose from the development of the Framework for Cost Benefit Analysis. Main goal is to give a summary of the problems encountered in developing the analysis and to provide recommendation for future projects.

Within the validation methodology it was defined (and agreed within the project) to perform the cost benefit analysis of the new noise abatement procedures. The methodology defined a set of input requirements to be supplied, that at that time were thought feasible to be derived from the project results. For instance, the CBA methodology required to have the number of people within noise contours for each procedure and airport. During the noise assessment however, it became clear that not all airports were able to fulfil this requirement.

More in general, during the project problems have been encountered concerning the amount and the kind of data available to perform the cost benefit analysis required. The initial Validation Methodology was updated during the project, but a risks identification was missing. Another important part in a CBA is to translate data from the simulations (for example required technology) into monetary terms. Experts from for example industrial partners should be consulted in an early stage to retrieve this kind of information (e.g. equipment costs, maintenance costs, etc.), as soon as new implementation requirements are available. The observance of deadlines in the project is then a must.

A validation strategy should be clearly defined at the beginning of the project, so it can be assured that simulations can take the data requirements into account in due time.

In case of similar projects it is highly recommended to:

- Define and agree the validation strategy at the beginning of the project and clearly define all data requirements for the simulations. Check that all participants can guarantee the delivery of that data (Check for problems on data confidentiality)
- Identify possible risks for the availability of the data and the impact of missing data for the validation assessment
- Guarantee the consistency of input data when data from various sources is used
- Have a plan how to translate input data into monetary terms and consult (external) experts in an early stage (as soon clear requirements are available) to retrieve this kind of information.

5 Conclusions and Recommendations

As seen from the previous pages it has not been possible to set up a complete picture of the necessary costs and benefits in the case of the SII NAPs being implemented. It is therefore not possible to make further financial analysis.

The results and inputs available from other WPs allowed making a preliminary framework for future developments of CBA for NAPs. This document provides some first ideas about who can benefit and who will have to pay and for what. Further studies are then required to assess a complete picture of costs and revenues, allowing a real financial analysis and giving input to stakeholders on possible choices.

The following table summarizes the qualitative results found with the current CBA preliminary assessment. The first column indicates the costs and the benefits categories, while the first row indicates the involved stakeholders. The cells of the table report the effect of implementing the SII NAPs for each stakeholder and for each cost/benefit categories. Looking at the table, the SII NAPs implementation requires an increase in the equipment and training costs for Airlines and ANSPs. The SII NAPs could generate also an increase in the delays, translated into costs for Airlines, ANSPs and Airport Operator Companies.

Concerning safety, much work has already been done on some NAPs, in fact high level assessment on all the NAPs highlighted critical aspects which needed further and deeper analysis. The qualitative safety analysis on the NAAPs II and V and on NADP 2 has made clear the point where it is necessary to investigate the safety aspect further. Additional work is required for providing more information on the safety aspects of the SII NAPs. That is also one of the reasons why qualitative economic assessment on the safety of the proposed NAPs has not been possible.

If the SII NAPs would be applied there could be benefits for both Airport Operator Company and people living around airports. The Airport Operator improves the relationships with people in the airport surroundings and saves money in housing insulation programs or other noise reduction programs. For the people living around airports the SII NAPs can improve their quality of life.

At the same time the reduction in the noise levels could be internalised in the current noise taxonomy system, increasing the benefits for the airlines applying the SII NAPs. Speaking about the environmental capacity, that is sustainable capacity of an airport compatible with the environmental requirements, it's clear that the introduction of the SII NAPs allows increasing the capacity value guaranteeing the safeguard of the environmental parameters. This is a clear benefit for airlines, ANSPs and Airport Operator Companies.



<i>Stakeholders</i>					
<i>Cost/benefit categories</i>	Airport/ATC Service Provider	Airlines/Pilots	Airport Operator Company	Passengers and cargo	Third Parties/ Citizens around airport
New Equipment Costs	Increase	Increase	-	-	-
Training Costs	Increase	Increase	-	-	-
Fuel Consumption	I.N.A	I.N.A	I.N.A	I.N.A	I.N.A
Delay Costs	Increase	Increase	Increase	-	-
Safety	Work needed	Work needed	-	-	-
Emission	I.N.A	I.N.A	I.N.A	I.N.A	I.N.A
Noise reduction Benefits	-	-	Increase	-	Increase
Environmental capacity	Increase	Increase	Increase	-	-
Noise/Emission Charges Benefits	-	Increase	-	-	-

I.N.A= Input Not Available



Appendixes



Annex A: Input parameters for the CBA

The following document has been distributed to SII partners during the development of the SII project for collecting part of FTS and RTS results.

Introduction

The issue of this document is to supply a friendly working document for supporting the cost benefit analysis and the implementation of the SII NAPs in each one of the selected airports.

Many inputs are necessary for the SII cost benefit analysis, some of those are expected to come from the Fast Time Simulations, while others from Real Time Simulations and others from literature studies and Expert opinions.

This document is focused mostly on inputs coming from FTS, which give many valuable parameters about the effectiveness of the procedures planned within the SII project.

Some of the tables require experts' judgement.

Needed inputs from FTS

Each involved partner is asked for filling in the following tables with results coming from the FTS and from experts' evaluation. In some cases, numerical data are required, in others, qualitative estimations are sufficient, that means to say if the proposed alternative case generates a decrease or an increase in the selected measures with respect to the base case.

CAPACITY ASSESSMENT

Capacity is one of the most important parameters for measuring the effectiveness of the SII NAPs. The SII project goal is, in fact, to reduce the noise nuisance around the airports through advanced noise abatement departure and arrival procedures trying to keep the capacity values stated in the base case.

As far as it is known, a CDA conceptually requires greater separations between two succeeding aircraft, which means a decrease in the arrivals number and possibly in the number of departures.

The FTS are a useful instrument for assessing quantitatively the effect of the SII NAPs on capacity point of view. The results obtained from the FTS capacity assessment have to be summarized in Table 6 and in Table 7. The first table lets us quantify costs in charge of airlines due to the delay for each SII scenario, that means for each economic alternative case. The second table lets us assess the "costs" of the delay in charge of passengers (business, personal), to assess how much the time that people spend because of flight delay costs.

In the airlines' case, it is easier to translate the measured delay into monetary terms because there are standard international values for quantifying the delay into monetary terms, while in the passengers' case it is a bit more complicated, even if standard values have been published in past literature studies, making differences between passengers and business people [STCBA].

Once performed the capacity assessment you will fill in the tables 6 and 7 with the following required data:

- A/D movements' number
- Airborne delay values calculated for each SII scenario
- Ground delay values calculated for each SII scenario

If you are not able to supply different values for ground and airborne side, please put the global delay value.

Table 6: Please fill in the first three columns (yellow background) for your airport, leaving out last three columns, that will be filled by SICTA after approval from the SII Consortium.

Table 7: Please fill in the first column (yellow background), leaving out the last three ones, that will be filled by SICTA after approval from the SII Consortium [STCBA].

DELAY COSTS	A/D Number	Overall Average Airborne Delay (min.)	Overall Average Ground Delay (min.)	Cost of one delay minute for airlines (€/min)		Total delay costs for airlines (€)
				Ground delay cost €/min	Airborne delay cost €/min	
Scenario						
Baseline						
Scenario 1						
Scenario 2						
Scenario 3						
Scenario 4						

Table 6: Delay costs

PASSENGERS VALUE OF TIME	Overall Average Delay (min.)	Cost of one delay minute for passengers (€/min)		Total costs for passengers delay (€)	
		Business	Personal	Business	Personal
Scenario					
Baseline					
Scenario 1					
Scenario 2					
Scenario 3					
Scenario 4					

Table 7: Passengers time valuation

If delay values are too big, there will be a domino effect on general air traffic: delays can indeed generate congestions for the inbound and the outbound traffic, so there could be indirect air navigation costs relating to re-routing traffic needs, that can be linked to delay costs, but there will not be considered here [PAMELA].

CONTROLLERS TRAINING AND WORKLOAD

The proposed SII NAPs are conceptually new for most airports, except Schiphol-Amsterdam, where air traffic controllers are already familiar with CDA procedures.

That's the reason why it is necessary to look at the two following points:

- to assess the monetary effort in charge of local ANSPs for the controllers training on the new SII NAPs
- to assess if the controllers' workload increases or decreases.

In the following Table 8, moving from the second column to the end, you have to fill in with the:

- Number of controllers to train for each scenario

- Number of training hours that each controller needs to become confident with the CDA concept. It is clear that part of the above required input does not come directly from the FTS, but opinions of local ATCOs' expertise and RTS results are required.

Controllers' training	Number of needed controllers	Yearly costs for one controller	Number of training-hours for each controller (h)	Cost for one hour of ATCo training (€ / h)	Total costs for the controllers' training (€)
Baseline					
Scenario 1					
Scenario 2					
Scenario 3					
Scenario 4					

Table 8: Controllers' training

In addition to the above information it is necessary also to know if the controllers workload increases or decreases. If you have quantitative data for the controllers workload, then fill in the first column (yellow background), otherwise, if your judgment is based on experts opinion please fill in last column (pink background) of the following Table 9:

Controllers workload	Controllers' Workload (min/h)	Percentage change of controllers' workload (%) in relation to the baseline scenario	Qualitative results (+/-)
Baseline			
Scenario 1			
Scenario 2			
Scenario 3			
Scenario 4			

Table 9: Controllers workload

NOISE ASSESSMENT

The economical assessment of noise nuisance is the most important judgement parameter for evaluating the effectiveness of the SII NAPs and it is, also, one of the most difficult parameters to calculate. Noise costs are, in fact, called "externalities", that means they are not relevant for who takes decisions, but they influence community life.

So, before moving to needed inputs from FTS, it is better to have a quick overview of literature studies, past and on-going discussions, about how to assess environmental aspects linked to airport activities on economic point of view.

Generally speaking, the worsening of environmental conditions generate consequences on human life, that can be translated into various actual costs, such us:

- Sanitary costs
- Reduction in productive capacity for people and resources (i.e. terrain fruitfulness)
- Mitigation measures

Environmental goods, so called externalities, are often not directly quantifiable so, they need a substitution market to be quantified and most times a real estate market is used because environmental conditions influence house prices.

A new study would require a long-term analysis of local real estate prices in relation to the local environmental parameters. Successively a multiple regression analysis would let to estimate the relation between the environmental aspects and the real estate prices and to quantify them. Of course this way requires a big amount of data collection with consequent expense of energy, not always available.

Alternatively, for the calculation of environmental goods, it is possible to use price estimations coming from other studies (Benefit Transfer Techniques), which the method proposed in the SII project case.

This practice of course can give questionable results when values of a study carried out in a country are used for economic assessment in other countries.

Two measures “exposure-based” are generally used to assess the economic value of noise nuisance:

- Willingness To Pay (WTP), that represents the willingness to pay or to receive money per each dB change per person (or household) per year €/dB/hh/year. This measure is obtained through the Stated Preference Method.
- Noise Sensitivity Depreciation Index (NSDI), calculated through Hedonic Method, is the average percentage change in property prices per decibel. That means, if the Noise Depreciation Index is about 0.5-0.7 and the noise nuisance increases by 10 units, then, property prices decrease by 5-7%.

Many studies on economic assessment of noise have been performed so far but, often, they have been done under different experimental conditions, different metrics and so, results are not directly comparable.

Different databases and research studies have been also set up, most of these are included in the EVRI database (Environmental Valuation Reference Inventory), that is a searchable storehouse of empirical studies on the economic value of environmental benefits and human health effects database and it contains many transportation noise evaluation studies. An other useful database is the Australian ENVALUE, that is a systematic collection of environmental valuation studies presented in an on-line database and it includes 24 studies on airport noise.

The Department of Environment, Transport and Regions (DETR) made a survey of 64 studies in a number of European States, giving the following average results:

- 24-48€ per dB (A) per household per year (covering a total of 4 studies).
- 0,08%-2.30% the change in estates values per dB (A) (covering a total of 43 studies)
- 0.02-2.27 GDP (covering a total of 15 studies)
-

On 14 December 2001, during the workshop “State-of-the-art in noise valuation” held in Brussels many topics were tackled. It has been decided to harmonize the lower cut-off point for noise valuation and it has been chosen Lden 55 value.

On the same occasion it has been debated about a possible value of noise per decibel per person affected and it has been decided that a rough assessment could be between €5 and €50 per household per decibel per year. It has also made been clear that the supplied euro values should be customized for different noise sources and for different EU Member States.

Many studies have been performed about the economic value of aircraft noise, that are mostly summarized in the following table, including information on the location of the study, the date and results. The studies have been divided in two groups depending on measures “exposure-based” calculated NSDI (Noise Sensitivity Depreciation Index NSDI) or WTP. These two groups have been in their turn shared in other three categories minimum, maximum and average, if that data is available otherwise you have just the average value.

It is necessary to look carefully at the following table because the reported values have been calculated using different noise metrics, in different countries, in different years and under different conditions.

Authors	Studies' location	Year study	NSDI			WTP/dB/hh/year	
			Min %	Max %	Mean %	Min €	Max €
Gillen and Levesque	U.S cities	1989	0.4	1.1	0.5-0.6		
Pearce and Makandya			0.70 NEF U.S, 0.50 NNI UK				
Gillen and Levesque	Canada	1990	0.08*	0.43**			
Pennington at al (1990)	Manchester	1985	0.47				
Gillen and Levesque	Canada	1991	0.21*	0.48**			
Uyeno et al (1993)		1987	0.65**	0.90*	1.66***		
Collins and Evans (1994)	Manchester	1985	0.65	1.28			
Levesque (1994)	Winnipeg		1.3				
Schipper		1996	EU 0.33%, US 0.65%				
Yamaguchi(1996)	London Heathrow	1996	1.51				
	London Gatwick		2.30				
Bateman et al		2000	0.29	2.3			
Morrell, Cherie H-Y.Lu	Amsterdam,Ku	2000	0.4				
Bateman et al	Model IV- Glasgow	2001	0.25				
Thune-Larsen	Oslo Airport, L _{aeq}	2001					
Faburel	Paris – Orly airport, L _{amax}	2001				8**	
Barreiro et al	Pamplona, Spain	2001				4**	
Carlsson, Lampi, Martinsson [MEVTA]	Arlanda and Bromma airport, Stockholm's air port	2003					

Table 10: Literature studies on economic assessment of noise nuisance

- * - For condominiums
- ** - For single/semi-detached houses
- *** - Vacant Land
- ** - 2001 prices

Prof. Nåvrud, from Norway University, delivered a report to the European Commission in April 2002, which contains the Start-of-the-Art on economic valuation of Noise and aims to supply an interim economic value for the noise. Many studies about different noise sources (road, rail and air traffic) have been included in the report, but he concludes that the number and kind of studies on air traffic are not sufficient to calculate an interim value for noise coming from air traffic.

During the last Workshop on Economic Valuation of Health Effects due to Transport in Stockholm (June 12-13 2003) prof. Nåvrud showed that EU DG Environment recommends as an interim value for road traffic the value 25€/dB/hh/year (2001 prices), but he reported that for the air traffic noise it is reasonable to use a range of NSDI values, from 0.29% to 2.30%, with an average value of 0.85%.

Many studies suggest to use a value of NSDI between 0.5% and 1%, so a proposal could be to make an assessment with a minimum, a maximum and an average value of proposed NSDI range and analyze the economic effects of choosing on of them through the sensitivity analysis. The selected methodology for assessing monetarily externalities generated from the SII NAPs leaves out the effects on human health as established from the SII DoW.

Interesting is to look shortly at the study performed by Baarsma (2000), slightly different from the previous studies. The study is an economical assessment of aircraft noise around Schiphol airport outside Amsterdam using Conjoint Analysis (CA) and two other new valuation methods (i.e. welfare evaluation method and the well-being evaluation method) for the year 1998.

The method proposed by Baarsma takes into account net monthly household incomes and presence of reinforced soundproofing in the house in addition to the noise exposure situation. Results of Baarsma's study have been summarized in the following table:

Ku Levels	Number of households concerned	Average monthly amount per household concerned	Total yearly amount of compensation million
>20Ku (46 L _{den})	148.063 (17.9%)	€272	€484.7
>25Ku (49.2 L _{den})	80.478 (9.7%)	€192	€185.8
>30Ku (52.3 L _{den})	26.734 (3.2%)	€136	€43.5
>35Ku (55.5 L _{den})	11.851(1.4%)	€92	€13.0
>40Ku (58.7 L _{den})	6.030 (0.7%)	€73	€5.3

Table 11: Noise CBA - Baarsma results

In the SII case, the selected economic measure depends on the availability of data for each one of the selected airport. Please fill in the following table with your FTS results:

Noise assessment L _{den}	N° of houses (or people) per 55dB	N° of houses (or people) per 60dB	N° of houses (or people) per 65dB	N° of houses (or people) per 70dB	N° of houses (or people) per 75dB	N° of houses (or people) per 80dB	N° of houses (or people) per 85dB	N° of houses (or people) per 90dB
Baseline								
Scenario 1								
Scenario 2								
Scenario 3								
Scenario 4								

Table 12: Number of houses (or people) per noise level per scenario

EMISSIONS ASSESSMENT

Emission assessment is as difficult as the noise evaluation, or even more.

Noise and emissions are both externalities but, in the first case, the effects generated from the airport have tangible consequences on people living around airports, in the second case, the consequences due to the increase in the emissions levels are not palpable, but they have effects on the life of trees and plants, the earth temperature and animal and human life over a long period of time.

To assess completely the monetary effects of the changes in the emissions values is not always easy, in fact part of the aspects are quantifiable, such as the change in the emissions' taxes in charge of airlines due to a variation in the burnt fuel, in line with the European principle "Who pollutes pays". Others are not computable, such as the consequences on life cycles, on health and so on.

About the first point if it is possible to calculate the percentage of produced pollutants (increase or decrease) then it is possible to calculate the change in the emissions' taxes in charge of airlines, to this end please fill in the following two tables:

Table 13: Please fill in all columns with the emissions charges applied in your own country

Table 14: Please fill in the first column with the burnt fuel per each SII scenario and the others with the corresponding emissions values you assessed by your airport for each SII scenario.

Emissions	Hydrocarbons €/ton/year	NO _x €/ton/year	CO €/ton/year	CO ₂ €/ton/year	SO ₂ €/ton/year	Benzene €/ton/year
Charge on air pollution ITALY sample		104.84			53.19	

Table 13: Emissions charges values

Please, specify also people that have to pay and to which authority the revenues go.

Emissions assessment	Burnt fuel (Kg)	Hydrocarbons (g/kg fuel flow)	NO _x (yearly g/kg fuel flow)	CO (yearly g/kg fuel flow)	CO ₂ (yearly g/kg fuel flow)	SO ₂ (yearly g/kg fuel flow)	Benzene (yearly g/kg fuel flow)
Baseline							
Scenario 1							
Scenario 2							
Scenario 3							
Scenario 4							

Table 14: Change in the emissions charge per each scenario

Once evaluated the consumed emission values per kg of burnt fuel, it is possible to calculate the saving or the increase in money spent per emissions charges, see next table.

Emissions assessment	Burnt fuel (Kg)	Euros spent per calculated grams of Hydrocarbons	Euros spent per grams of NO _x	Euros spent per grams of CO	Euros spent per grams of CO ₂	Euros spent per grams of SO ₂	Euros spent per grams of Benzene
Baseline							
Scenario 1							
Scenario 2							
Scenario 3							
Scenario 4							

The operational costs linked to the burnt fuel have been included in this paragraph because they come from the STBEC tool output together with emissions values.

The fuel consumption is another important measure parameter, defined as the amount of fuel in kilograms consumed by an aircraft to complete a given operation. It depends on the aircraft type and the flight profile (speed, altitude, route length, etc). It is a relevant operating cost for airlines, which are one of the biggest stakeholders involved in the SII NAPs implementation process.

Of course, the less fuel is burnt, the more money airlines save. If that happens, it could convince airlines into adopting the new proposed procedures, otherwise, an increase in the fuel consumption could slow down or stop the implementation of the SII NAPs from the airlines point of view.

In the following table you have to put the burned fuel values (yellow column) for each SII scenario to assess if the new procedures imply extra fuel consumption in relation to the baseline case.

BURNT FUEL	Burned fuel (kg)	Unitary cost of fuel (€/kg)	Total costs (€)
Scenarios			
Baseline			
Scenario 1			
Scenario 2			
Scenario 3			
Scenario 4			