"CLEAN SKY"
Aeronautics & Air Transport JTI

Draft Proposal
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EXECUTIVE SUMMARY

Introduction

This document presents the proposal of the European aeronautics industry in response to the Commission proposal for a Joint Technology Initiative here-called "Clean Sky".This will deliver technologies for aircraft/rotorcraft and their associated equipment that will dramatically reduce the impact of air transport on the environment and helping to establish a global economical level-playing field for the European aeronautics sector.

Clean Sky will be jointly proposed by the European Commission and 9 major European aeronautics companies - AgustaWestland, Airbus, Alenia Aeronautica, Dassault Aviation, Eurocopter, Liebherr-Aerospace, Rolls-Royce, Safran and Thales - and will be a flagship programme that will bring together industry, research establishments, academia and SMEs from all European countries.

Using the best knowledge and research facilities in European aeronautics, Clean Sky will assess, design, build and test a number of innovative technology demonstrations, on-ground and in-flight, with the assessment and guidance of an evaluation tool. These results will give European industry the confidence to launch greener, more innovative products much sooner. This will contribute to European sustainable growth, minimise the environmental impact to its citizens, increase the knowledge and skills base of the European research community and maintain the competitiveness of its industry in a key sector.

The proposal is divided into three major parts, describing Why Clean Sky is necessary, What will be done to achieve the objectives and How Clean Sky will work.

"Why Clean Sky?"

This part of the proposal explains in detail the socio-economic (including the environmental) benefits, which technologies from Clean Sky will generate for the European Community.

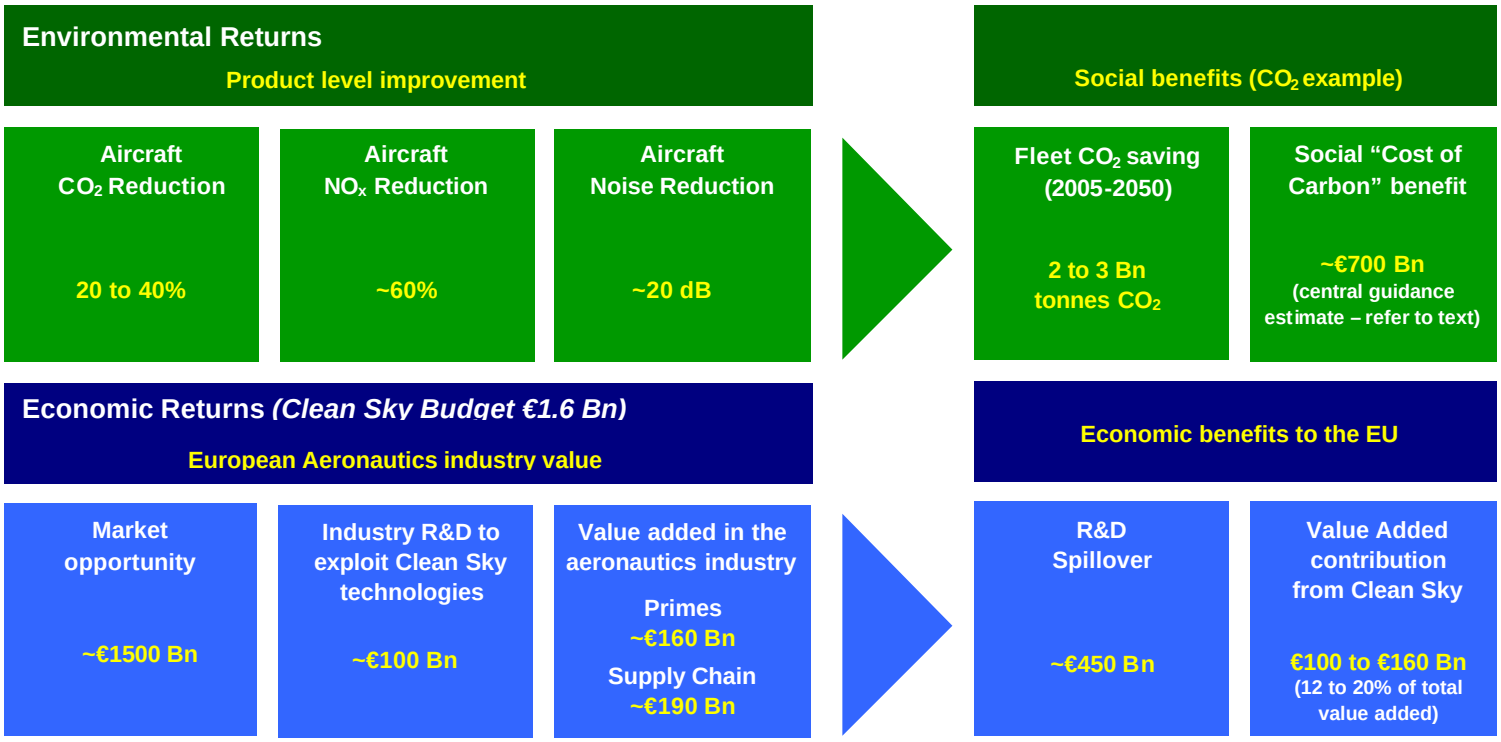
ACARE has defined a Strategic Research Agenda (SRA) that will allow the European air transport system meet a number of challenges and goals. Among these, the environmental goals are particularly ambitious: from 2000 to 2020, to decrease CO_2 (Carbon Dioxide) by 50% and NOx (Oxides of Nitrogen) by 80% per passenger-kilometre and to halve the perceived noise per aircraft operation. Not only do these goals require technological breakthroughs, but also the timescale is such that technologies have to be validated much faster than the usual R&T pace.

The level of complexity of interaction between the proposed innovative components can only be assessed at the highest level of integration and in a real life and multi disciplinary environment. The level of resources commitment and budget is an order of magnitude above that allowed by current instruments. The high financial and technological risk associated with these requirements leads to a market failure. By

creating favourable conditions that will persuade industry to invest on long term and large multidisciplinary research, without a clear visibility on return on investment, Clean Sky is intended to overcome this market failure.

By including all the major European integrator companies, a coordinated programme of technology demonstrations can be delivered which is more integrated than existing research funding –both European Framework Programmes, and nationally funded frameworks.

The following table shows the environmental and economic returns of the Clean Sky programme to society in Europe and globally:



"What is Clean Sky?"

This part of the proposal details the technical approach and the technical content of the work, concentrating on the resulting demonstrations to be performed. Clean Sky will be built upon 6 "platforms", which will perform preliminary studies and down-selection work, followed by large-scale demonstrations, on ground or in-flight, in order bring innovative technologies to a maturity level where they can be applicable for new generation "green aircraft". Multiple links for coherence and data exchange will be ensured between the various platforms. Most of the test benches, in particular for flight-testing, will be used in common by several platforms. The platforms are:

1. The **SMART fixed wing aircraft** platform, focused on active wing technologies and new aircraft configurations. The expected contribution of this platform to the

ACARE goal is to decrease gaseous emissions by around 20% and noise by around 10 EPNdB.

2. The **Green Regional Aircraft** platform, focused on low-weight configurations and technologies using smart structures, low-noise configurations and the integration of technology developed in other platforms, such asengines, energy management and new configurations. This platform will lead to regional aircraft technologies enabling a 10% to 20% gaseous emissions reduction, and 10 EPNdB less external noise.
3. The **Green Rotorcraft platform**, focused on innovative rotor blades and engine installation for noise reduction, lower airframe drag, diesel engine and electrical systems for fuel consumption reduction and environmentally friendly flight paths. The expected benefit for rotorcraft is a 10 EPNdB noise reduction a CO2 emissions reduction of 26% to 40% with a diesel engine, and a NOx reduction of 53% to 65%.
4. The **Sustainable and Green Engine** platform will integrate technologies for low noise and lightweight low pressure systems, high efficiency, low NOx and low weight core, novel configurations such as open rotors or intercoolers. This platform will deliver technologies for a 15% to 20% CO2 reduction, 60% to 80% NOx reduction and a 16 to 20 EPNdB reduction.
5. The **Systems for Green Operations** platform will focus on all-electric aircraft equipment and systems architectures, thermal management, capabilities for "green" trajectories and mission and improved ground operations. The contribution of this platform to the ACARE goals is evaluated as an 11% emissions reduction and a 9 EPNdB noise reduction
6. The **Eco-Design** platform will focus on issues such as optimal use of raw materials, decreasing the use of non-renewable materials, natural resources, energy and the emission of noxious effluents, and recycling. This platform will also make steps towards the "oil-less power by wire" aircraft for a small cabin aircraft, to prepare the way for larger aircraft technologies.

A **Technology Evaluator** will be the first available European complete integrated tool delivering direct relationship between advanced technologies, still under development, and high-level local or global environment impact. It will consider inputs from both inside and outside the "Clean Sky" perimeter to deliver environmental metrics and the levels of aircraft, airport and earth (global). These metrics, including noise and emissions models, will be used internally for "Clean Sky", for tuning or orienting technology insertion within the conceptual aircraft solutions. Airport and global metrics will also permit assessment of expected Air Transport System impact with respect to the ACARE goals.

"How does Clean Sky work?"

This part of the proposal details the mechanisms and bodies which relate to the corporate structure and governance of Clean Sky. This includes the principles of operation, types of membership, management rules, the partner selection process through open calls, and financing.

Principle of operation and formation

A Joint Undertaking (JU) - a legal entity created as a Community organisation under article 171 of the European treaty, will be created to implement and manage "Clean Sky". This JU will be created by a regulation of the Council of the EU. The statutes of the "Clean Sky" will be annexed to the regulation.

The Community and the founding companies will sign a stakeholders' agreement fixing their technical and financial commitment over 7 years.

Membership

There will be 3 types of "Clean Sky" cost-sharing members:

- **Platform Leaders** which are the 9 companies proposing Clean Sky
- **Associates** will be strategic participants who are members of the Steering Committees set up to manage each platform.
- **Partners** will be introduced by the Platform Steering Committees after selection through an open and transparent competitive process to deliver a specific work-package within the Platform.

Bodies and internal management

The "Clean Sky" managing bodies will be:

- The **Executive Board** will be the governing authority of the JU. It will include a representative from the Commission, a representative from each of the Platform Leaders and possibly a representative from any associatewich brings strategic industrial capacity and significant financial commitment to the whole "Clean Sky" programme.
- The **Steering Committee** for each Platform will comprise representatives of the Platforms Leader(s) and each Associate participating in the Platform. It will assume responsibility for the contractual Platform deliverables.
- A **General Assembly** consisting of representatives of all members of the "Clean Sky" JU

A Director will carry out the day-to-day management of the JU. The Director will be the chief executive and legal representative of the JU and shall perform his/her duties with complete independence. The Director will report and be accountable to the Executive Board. He/she will be supported by an administrative staff including a focal pointfor SMEs and new Member States.

Selection of Partners

The JU will encourage access to the research programme of SME and industrial participants in all Member States. In addition, the JU will commit to place 12% of the total "Clean Sky" activity with SMEs.

The Calls for Proposals (CFP) will be carried out at the level of each platform. The Platform Leader will prepare and manage the CFP. The platform Steering Committee will make the final decision. A review of a selection by an appeal board will be possible. The Commission will have powers of audit to verify the correct and fair execution of the CFP process.

Resources

The JU research activities will be resourced by in kind industrial contributions and annual subscriptions from the Commission. Research within the Platforms will normally be funded by the JU at the rate of 50% of eligible costs (75% for SME, Universities and Research Institutes, unless they are participating as Associates). The Platform Leaders and Associates will make an annual contribution (matched by the Commission) towards the costs of the JU Director and small support staff.

On the base of the above mentioned funding rates it is expected that the EC contribution will allow this programme of 1,6 B€.

This is a relatively small amount compared to the expected increase in private investment in new products and the even larger returns to society in Europe which is in essence the argument for government intervention

The full contents of the proposal explain the above points in more detail. Together, the three parts of this document clarify the commitment of the European aeronautical industry to mobilise the resources necessary to create a Joint Technology Initiative. The resulting programme will culminate in the demonstration of a step-change in technology, providing society at large with substantial economic and environmental benefits.

PART 1 - WHY "CLEAN SKY"?

1. INTRODUCTION

This document presents the proposal of the European aeronautics industry to create a Joint Technology Initiative (JTI), called “Clean Sky”, that will deliver technologies for aircraft, rotorcraft and their associated equipment that will dramatically improve the impact of air transport on the environment while securing a global economical level-playing field to the European aeronautics sector.

This first part of the proposal provides a detailed explanation of why Europe needs the Clean Sky Joint Technology Initiative. The aeronautics sector is of significant importance for the enlarged European economy and global competitiveness, for building Europe and to our way of life. Air traffic is expected to grow considerably in the next decades. But air transport generates noise and emissions that are detrimental to the environment and contribute to global warming. Europe will not accept the air traffic growth at any environmental price and this is reflected in the Vision 2020 goals and the ACARE Strategic research Agenda. The environmental goals are so ambitious that they require technological breakthroughs to be validated faster than the usual R&T pace. The high financial and technological risk associated with these requirements lead to a market failure. By creating favourable conditions that will persuade industry to invest on long term and large multidisciplinary research programmes without a clear visibility on return on investment, Clean Sky is intended to overcome this market failure.

This chapter also describes how Clean Sky meets the requirements set by the European Commission for a Joint Technology Initiative

2. SOCIO-ECONOMIC AND ENVIRONMENTAL BENEFIT.

The objectives of the 'Clean Sky' proposal are to evolve the way that the European aeronautics industry acquires technology whilst providing a specific stimulus to accelerate improvements in the environmental performance of air transport. Huge technological and industrial progress has been made and further development in both areas will depend upon greater integration of technical and industrial contributions from across European industry.

There is a compelling global case for government intervention to correct the market failures associated both with R&D and the environment. The full social value of R&D extends beyond the companies that undertake it. As a result, the level of R&D in general is inevitably below the optimum for society and this is a special problem in relation to the environment where the social impact can be large and trans-national. This demands co-ordination across Europe and hence intervention at an EU level.

The European 'Framework' research programmes have become an important stimulus to distant-from-market, collaborative research. But in comparison with the USA, where public support for industrial research is far greater, EU (and member state) support has not placed sufficient emphasis on validating complex systems at large scale and at high technology-readiness levels in order to position industry for rapid exploitation in industrial products at acceptable risk.

The Clean Sky JTI seeks to overcome such deficiencies by creating a new structure in which European industry can collaborate with the EC in setting social and market based technological goals and co-funding the programmes to achieve them. This joint leadership role is expected to encourage a greater degree of coordination between national, EU and industry sponsored research thus raising the efficiency of innovation within Europe by removing duplication and by setting coherent targets around which industry leaders and their supply chains can coalesce. There may also be wider benefits to come from taking the lead in signalling clear environmental objectives at a global level.

Clean Sky should therefore lead to greater industrial and inter-national integration within the Union. It should start to correct the distortions that exist as a result of the provision of public support outside Europe whilst focusing the stimulus on socially desirable environmental improvements.

This section of the proposal describes the headline environmental goals for the Clean Sky programme and offers an assessment of the economic benefits that will arise. Clearly, there will be a direct impact upon industry leaders and their suppliers by raising the competitiveness of European aeronautics - but the social impact will be far greater.

By improving the technology base, we can expect to accelerate the timing, improve the market success or even permit the existence of new products – whether entire new vehicles or major components such as engines or systems. We believe that Clean Sky will therefore make large-scale private investment in European aeronautics more certain and more successful.

The consequences of this will be seen through increased manufacturing value-added throughout the supply chain and, more importantly, through the very large social returns as characterised below, will generate benefits that in combination will extend across the EU-25:

a) Raising the level of Research & Development

b) Accelerating the attainment of environmental improvements

c) Reducing the environmental constraints to economically beneficial air traffic growth.

These large and positive socio-economic benefits are discussed and quantified. Whilst acknowledging the inevitable uncertainty about the precise level of these returns, it is argued that a strong case exists for European intervention at this level

Clean Sky JTI - Balance Sheet

- Percentage environmental targets shown are the percentage points contribution from Clean Sky towards the ACARE 2020 targets
- All economics expressed in 2006 prices using a risk free discount rate of 3.5%
- All market values relate to 1st generation Clean Sky products first entering into service between 2015 and 2025 and sold between 2015 and 2035.

Environmental Returns

Product level improvement

Aircraft CO_2 Reduction	Aircraft NO_x Reduction	Aircraft Noise Reduction
20 to 40%	~60%	~20 dB

Social benefits (CO_2 example)

Fleet CO_2 saving (2005-2050)	Social "Cost of Carbon" benefit
2 to 3 Bn tonnes CO_2	~€700 Bn (central guidance estimate – refer to text)

Economic Returns *(Clean Sky Budget €1.6 Bn)*

European Aeronautics industry value

Market opportunity	Industry R&D to exploit Clean Sky technologies	Value added in the aeronautics industry
~€1500 Bn	~€100 Bn	Primes ~€160 Bn Supply Chain ~€190 Bn

Economic benefits to the EU

R&D Spillover	Value Added contribution from Clean Sky
~€450 Bn	€100 to €160 Bn (12 to 20% of total value added)

2.1 The importance of Aviation to the European Union

The air transport industry is vital to the mobility and future economic growth of the Union in addition to aerospace representing a strategically important knowledge based European industry.

The air transport sector in the EU is a substantial industry with recent studies showing that in combination airlines, airports, Air Traffic Management and aerospace manufacturers - account for 2.6% of GDP, support 3.1 million jobs[1] and contribute some €31,8 Bn to a positive trade balance for Europe.[2]

2.2 The external effects of air traffic

However the contribution of air transport to the Union's competitiveness and growth goes much wider than the economic benefits captured by the industry itself. Aviation is a key factor in the future competitiveness of European business and is expected to be a major contributor to the integration and economic development of the new member states. The growth in air traffic required to facilitate this development will present a significant environmental challenge.

Aviation's Positive and Negative externalities

An *externality* occurs when the activities of an entity (individual or organisation) affect others and the consequences are not taken into account by the party undertaking the activity.

Such externalities are either *positive* or *negative where:*

- A *positive externality* is defined as one in which the affected party *benefits* from the activity at no cost to themselves.
- A *negative externality* is defined as being where the affected party *suffers* as a result of the activity without receiving compensation.

2.2.1 Aviation's positive externalities - Economic benefits

"Through the facilitation of exchange of knowledge and ideas, aviation acts as a spur to innovation and stimulates economic growth and development".[3]

The growth of air transport usage over the next twenty years is projected to contribute an additional 1.8% of GDP to the EU25 through increased investment,

[1] *ACARE, "The Economic Impact and Strategic Importance of Air Transport in Europe" in Strategic Research Agenda Volume 1, October 2004*

[2] *ACARE "ACARE opinion on the JTI Clean Sky", April 2006*

[3] *A strategy towards sustainable development of UK aviation June 2005*

productivity and other supply-side impacts (equivalent to €200 billion a year in today's prices).

Aviation is a vital component of the EU's transport infrastructure, enabling the success of the Union in a number of ways:

- **Trade (both Goods & Services)**

  Globally, 40% of the value of inter-regional trade in manufactured goods is now transported by air and the corresponding value of exports from the European Union has been estimated to be in excess of €300 billion[4].

  Access to efficient and affordable air travel is important to the high value, fast growing knowledge-based sectors, such as financial & business services and R&D activities, where factors such as personal networking are key to success.

  Air travel is also important for enabling European companies to win and support international business and overseas clients, particularly for facilitating trade exports with long haul emerging market economies such as India and China.

- **Investment**

  Access to air services is an important factor in influencing companies' investment decisions. Studies by Oxford Economic Forecasting suggest a strong and positive correlation between air transport and the level of business investment[5]. Furthermore a recent survey of companies by IATA[6], found that almost two-thirds of firms consider that the accessibility to global markets provided by air is vital or very important to regional investment decisions.

- **Productivity and competitiveness**

  Air services increase the potential market that European business can serve allowing companies to exploit economies of scale more fully and encouraging increased specialisation and competition, stimulating higher efficiency and productivity. A study for EUROCONTROL[7] found that a 10% increase in air transport usage facilitates a long-term increase of 0.56% in productivity.

- **Tourism**

  The World Travel and Tourism Council estimates that the tourism industry directly supports 8.6 million jobs in the European Union. With 40% of international tourists

[4] *ATAG, The Economic and Social Benefits of Air Transport, 2005*

[5] *EUROCONTROL, The Economic Catalytic Effects of Air Transport in Europe, 2005 EEC Note: EEC/SEE/2005/004*

[6] *IATA, Airline Network Benefits, 2006*

now travelling by air[7], the European tourism industry depends critically on the air transport network.

The net impact of tourism by air is positive for the 10 new members of the Union with spending in 2003 by foreign visitors some 1.6 billion euros higher than the spending by their residents abroad, equivalent to 0.4% of GDP.

- **Research & Development**

  Research and Development (R&D) enhances productivity in the firm undertaking R&D and hence increases profits in that firm. However the economic benefits resulting from R&D do not accrue solely to the firm that undertakes it. Indeed it has long been recognised that R&D and R&D intensive industries can produce substantial wider economic benefits.

- **Technology spillover - a "market failure" on the optimum level of R&D**

  Although it is difficult to quantify these benefits there is substantial evidence from academic literature that the wider economic impact of R&D is large and positive and that social returns from this "technology spillover" overwhelm private returns.

  This positive economic externality is a market failure with important consequences. Since the company/industry undertaking the R&D does not capture all of the return arising from that investment, market economies inevitably under-invest. As a result, there is a strong economic case for governments to intervene to encourage greater R&D. This is particularly the case in sectors, involving highly innovative R&D activities with a strong propensity to spill-over into the wider economy, such as aerospace.

- **The social benefit**

  Academic literature suggests that this extra value or 'social return' is large. Recent work[8] indicates that the social rate of return to aerospace R&D is around 70% overall with civil aerospace having a particularly high benefit of around 100%. This indicates that a one time expenditure of 1% of GDP on civil aerospace R&D will tend to increase annual GDP by 1% on a recurring basis in future years, hence leading to substantial cumulative benefits over the long term for sustained R&D expenditure.

- **Technology spillover mechanisms**

[7] *ICAO, Economic Contribution of Civil Aviation, 2004*

[8] "*The wider economic benefits of R&D - a research paper on spillovers*", by OEF, PWC and Rolls Royce (October 2004)

There are a number of channels through which the wider economic impacts of R&D are transmitted. These include:

- **Supply chain interactions with suppliers and customers.**

  Bringing a new product to market that embodies a tranche of R&D spending implies, in the 'development' phase, building a supply chain to create that product. The whole supply chain will benefit to some degree from the R&D in the project, even if they have not undertaken that R&D themselves.

  Being part of the supply chain to a source of R&D enables firms to improve their productivity across the board. The process improvements or technical skills that they acquire will be, to some extent, transferable into other processes and other products made by that firm.

- **Foreign direct investment (FDI)**

  FDI often introduces new products or processes into an economy, so influencing the supply chain and the skills embedded in the labour force as foreign investors take on and train new employees. Further raising the technology base and productivity of European industry would be expected to attract additional FDI.

2.2.2 Aviation's negative effects - Environmental "market failure"

The European Union accounts for about half of the international emissions from aviation, a figure equivalent to 2.3% of the Unions total.[9]

Although the environmental impact of aviation is relatively small it may become increasingly visible especially if other, more significant sources of emissions (i.e. electricity generation) reduce through improvements in technology and the introduction of low carbon sources such as wind energy.

Historically improvements in aircraft fuel efficiency (~CO_2 emissions) have been some 1-2% per annum, however with air transport forecast to grow at around 4-6% the net effect could be an annual growth in emissions of between 3 and 4%.

The whole transport sector does not pay the full external costs of its effects on the climate. This negative externality represents a market failure that results in sub-optimal investment in, and deployment of, new environmentally beneficial technologies.

- **Policy options to control the emissions from aviation**

There are essentially two methods of limiting the emissions from aviation, imposing limits on the growth of traffic or investing in technology to reduce the environmental impact of aircraft. Given the economic benefit of air travel, measures to restrict growth would lead to negative economic and social effects.

In contrast, investing in technology through instruments such as the Clean Sky programme has the potential to secure and increase the positive external effects and to reduce the negative effects.

[9] *"Reducing the Climate Change Impact of Aviation", Commission of the European Communities, September 2005*

2.3 The European Strategic Research Agenda

In 2001, the "*European Aeronautics: A Vision for 2020*" initiative pioneered an integrated vision of the European Air Transport System (ATS) for the next 20 years. It established, as its top-level objectives, the need to respond to society's needs of enhancing mobility and economic growth and to secure European leadership in environmentally focused R&D. It recommended the formation of the Advisory Council for Aeronautic Research in Europe (ACARE) who, in 2002, produced the first Strategic Research Agenda (SRA).

Addressing the issues of noise, local air pollution and contribution to climate change is of paramount importance in satisfying the needs of European citizens. The SRA details the research strategy required to achieve the environmental goals of vision 2020. These are:

- Reduce CO2 by 50% per passenger kilometre

  CO_2 is a significant contributor to global warming and is directly related to fuel consumption. The target of a 50% reduction in CO2 has been allocated across the sector: 20 to 25% fuel consumption reduction due to aircraft improvement, 15 to 20 % engine specific fuel consumption reduction, 5 to 10 % fuel consumption due to air traffic management and operational improvements.

- Reduce perceived noise to one half of current average levels

  Despite major technology improvements over the past twenty years, aircraft noise remains a problem for airport neighbourhoods, in part due to greater awareness of the impact of noise on public health.

- Reduce NOx emissions by 80%

  NOx emissions have an effect on the environment both for global (greenhouse effect) and local pollution. Improvements in the efficiency of airframes, systems and engines can all contribute to reductions in NOx but improved engine combustion technologies are necessary to meet the ACARE goals.

- Minimise the whole life cycle environmental impact of aircraft manufacture, maintenance, overhaul, repair and disposal.

The goals from the ACARE Strategic Research Agenda are so ambitious that they will not be reached without technological breakthrough, i.e. radical changes in technology requiring a substantial amount of research and validation. The Clean Sky programme is a major step towards the implementation of the Strategic Research Agenda.

2.4 The positive effect of investing in technology

In line with the European Council's March 2000 Lisbon Agenda, investing in technology would:

1. Mitigate potential environmental constraints on the future economic growth of the European Union.
2. Encourage the European aerospace industry to lead the market in the development and export of clean technology.
3. Encourage the global aviation sector (the US in particular) to increase efforts in environmentally orientated R&D in order to remain competitive.
4. Deliver technology that can be applied beyond the aerospace sector, enhancing the industrial and scientific base of the Union.

   Investing in technology complements the introduction of Emissions Trading Schemes (ETS). Putting a price on emissions through such schemes introduces incentives for those who can most cost effectively reduce emissions to do so, creating a "market" for new solutions.

2.5 The need for a new initiative

A new mechanism is required to accelerate the development and application of new technology. Whilst advances in technology have the promise to deliver significant performance improvements they will need to be developed, validated and applied much faster than the industry has traditionally been able to do if we are to mitigate the environmental impact of the expected growth rates in air traffic.

- **The need to go beyond existing "Framework" programmes**

  Although an essential part of establishing the core technical base the existing relatively small, short duration Framework Programmes do not offer Europe the same degree of technology validation benefits of the full-scale demonstrator projects enjoyed by other non-European aerospace nations.

  Furthermore Europe's current Framework selection process, based on discrete calls for proposals introduces an element of randomness that is detrimental to the necessary continuity and coherence required to bring a technology to maturity.

- **The Clean Sky Joint Technology Initiative**

  The proposed Clean Sky Joint Technology Initiative is a large scale, flexible R&D programme designed to allow validation of technology in a real context.

  Compared to the existing Framework programme the JTI gives a number of advantages:

- The "whole system" validation approach allows the interaction of new technologies to be better understood and their application to be optimised in sufficient time to be exploited in the market place.
- The focus on representative scale demonstrators with a high degree of functional integration will mobilise a critical mass of necessary resources and accelerate the realisation of goals and innovation by pooling together and co-ordinating industry networks, Research Centres and Universities.
- The flexibility proposed for the JTI would ensure that programme objectives are aligned and adapted to evolving industry requirements. Particularly promising technologies may be "fast tracked", providing the option of early market introduction.
- The programme would enable a long term R&T policy supported by the commitment of all stakeholders, i.e. the industrial partners, the research community, the EC and the member states. It would help to ensure continuity and consistency of R&T activities over a long period (e.g. 7 years) across the European aerospace sector thus minimising the fragmentation of R&T and increasing the efficiency of innovation.

  The JTI promises to complement the ongoing development of risk sharing partnership arrangements between primes and suppliers through which suppliers are taking an increasingly active role, both intellectually and financially, in the development of new aircraft and systems.

  Strengthening the technical ability of Europe's supply chain enhances its ability to act as a participant in international programmes and alleviates pressure from emerging competitors in lower-cost developing countries.[10]

[10] *Baseline study to identify the technological capabilities of the aeronautical sector in the EU15 and three Accession Countries, March 2004 Technopolis Ltd on behalf of ACARE*

2.6 Quantifying the environmental benefit of Clean Sky

Clean Sky has the potential to both deliver an improvement in overall environmental performance and to bring the technology to market earlier.

The environmental objectives of each work package are summarised in the table on the following page. Each thematic work package contains activities that will contribute to a range of environmental targets, shown in respect of reductions in CO_2, NO_x and Noise. A number of possible future aircraft have been targeted in accordance with achievable environmental objectives to illustrate the potential additional contribution that the Clean Sky programme is expected to deliver.

The following chart illustrates the potential saving in CO_2 from a 30% improvement in aircraft entering into service from 2020.

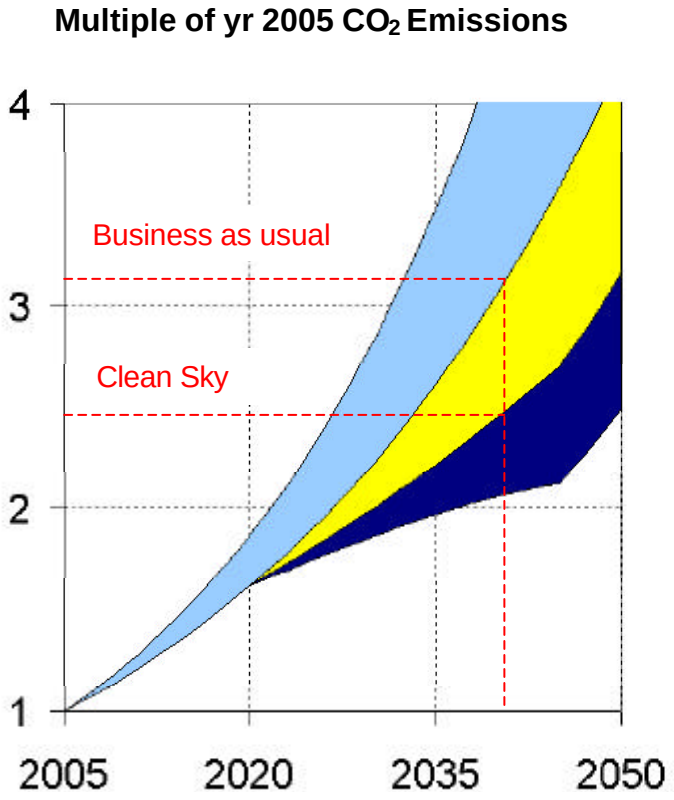
Without Clean Sky	**CO_2 emissions in 2040 = 3.1 x 2005**
With Clean Sky	**CO_2 emissions in 2040 = 2.4 x 2005**

Assuming an expected traffic growth of 4.25% per annum

Emissions reduction expected from existing technology programmes

Expected CO_2 reduction from Clean Sky

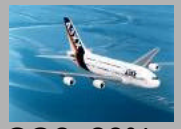
Gap to ACARE target of 50% emissions reduction from a year 2000 base traffic



The "middle" region in the above chart (shaded in yellow) represents the CO_2 emissions avoided as a result of the JTI programme. Although it takes some time for the new cleaner aircraft to displace the existing fleet it is apparent that the JTI makes a significant step towards reducing the environmental impact of the industry.

Clean Sky JTI - Environmental Targets by Programme & Illustrative Examples of "Product" Environmental Contribution

- Targets shown are the conntribution (% points improvement) from Clean Sky towards the ACARE 2020 targets
- For reference - ACARE performance targets for 2020 are -50% CO_2, -80% NOx & -10dB Noise relative to yr 2000 technology standards

	Technology Evaluator					
Programme	**Smart Fixed Wing Aircraft**	**Green Regional**	**Green Rotorcraft**	**Sustainable & Green Engines**	**Systems for Green Operations**	**Eco Design**
Activities	Active Wing New Aircraft Configurations	Advanced Aerodynamics (Low Drag & Noise) Low Weight Structures	New Powerplants Innovative Blades & Rotors New Aircraft Configurations	Advanced LP & HP System Technology New Engine Concepts (i.e. Open Rotor)	Mission & Trajectory Management Aircraft Energy Management	Whole Life Cycle Environmental Impact Analysis
Targets	CO2 ~12 to 20% Noise ~10dB	CO_2 ~10 to 20% Noise ~10dB	CO2 ~26 to 40% NOx ~53 to 65% Noise ~10dB	CO2 ~15 to 20% NOx ~60% Noise ~18dB	CO2 ~10 to 15% Noise ~9dB	CO2 ~10%
Products	**Widebody 2020**  CO2 -30% NOx -60% Noise -20dB	**Narrowbody 2015**  CO2 -20% NOx -60% Noise -15dB	**Regional 2020**  CO_2 -40% NOx -60% Noise -20dB	**Corporate 2020**  CO2 -30% NOx -30% Noise -10dB	**Rotorcraft 2020**  CO2 -30% NOx -60% Noise -10dB	

The Social cost of carbon

An alternative way of considering the environmental benefit of the Clean Sky programme is to consider the economic value of the avoided carbon.

Taking into account the fleet replacement effect, a 30% improvement in CO_2 emissions is equivalent to a 1% per annum improvement over 20 years from the initial entry into service (EIS) date.

It is possible to put an economic figure on these benefits although there is a great deal of uncertainty as to the exact effects of global warming and the subsequent social impact.

Based on projections of aircraft emissions growth from the IPCC (1999) and using values of the social cost of carbon from a 2005 study carried out on behalf of the UK Government[11], estimates put the total amount of carbon avoided by Clean Sky at between 2 and 3 Bn tonnes with an economic value of around €700 Bn. (Lower Bound ~ €100Bn, Upper Bound ~ €2000 Bn).

2.7 Quantifying the economic benefit of Clean Sky

The output of the Clean Sky R&D programme will act as the catalyst for substantial investment in new generations of aircraft, engines and systems. The spillover benefits of this investment will benefit the whole European industrial and scientific base, enhancing productivity and competitiveness across a wide range of sectors and member states.

The evidence for wider economic benefits or 'spillovers' from R&D is compelling. While estimates vary on the extent to which these spillovers mean that the 'social' role of the return from R&D (i.e. the return to the economy as a whole) exceeds the private return to the company undertaking the investment, there is a clear consensus that it is substantial.

Estimating the value added opportunity open to the European Union

The industry has worked with Oxford Economic Forecasting to develop an estimate of the value generated by the European aeronautics sector in the creation of the generation of products that will be influenced by the Clean Sky programme.

This exercise attempted to quantify value added in respect of:

- The direct activities of the industrial primes
- The value sourced from the supply chain
- The wider economic benefit of aerospace R&D

The industry provided forecasts of potential sales and associated product costs across each market sector (widebody, narrowbody, regional, corporate and

[11] *The Social Costs of Carbon Review – Methodological Approaches for Using SCC Estimates in Policy Assessment", AEA Technology Report for DEFRA (UK Govt), December 2005.*

rotorcraft) at the product (aircraft) and system (airframe, engine, aircraft systems) level and estimates of what proportion of those costs would be sourced from firms located in the EU and how this would be distributed across the EU economies.

The R&D estimates are based on an assumption that the output from the Clean Sky programme will influence product development from 2010 to support an in service date of 2015. The market estimates were based on a single generation of new products, first entering into service between 2015 and 2025, the period over which technology developed under the JTI could be considered leading edge.

As a rule, “Business as Usual” estimates of market and programme share were assumed.

Estimates of the value opportunity related to Clean Sky

All numbers shown in 2006 prices using a risk free discount rate of 3.5%

Total (Global) Market Opportunity (all sectors 2015-2035)	**~ 1500 € billion**
Industry funded R&D performed in the EU in developing new products (2010-2030)	~ 100 € billion
Value created in the EU by the Aero Industry Primes *New product sales and related aftermarket between (2015-2035)*	~ 160 € billion
Value created in the EU by the Aero Industry Supply Chain *New product sales and related aftermarket between (2015-2035)*	~ 190 € billion
R&D spillover benefit to the EU (2010-2035)	~ 450 € billion
Total "Value Added" to the EU (2010-2035)	**~ 800 € billion**

The largest single contributor of value is the R&D spillover benefit which is more than 4 times as large as the total spending on R&D. While the R&D associated with aeronautics is concentrated in a small number of countries, the wider economic benefits are shared across the European Union as a whole.

The benefits will flow from the countries with an active aerospace industry throughout the European Union since, for example:

- The aerospace manufacturers source materials and other inputs from suppliers in other EU member states, and work with these suppliers to improve their processes, the quality of their output etc, benefiting all the suppliers' customers, including those in countries that are not sources of the R&D activity.
- Companies in the aerospace industry and its supply chain transfer knowledge and techniques developed by aerospace programmes to subsidiaries in other member states that are involved in other sectors (e.g. in supplying the motor vehicles sector in central Europe).

- Mobile skilled workers build up their human capital while involved in aerospace R&D, and then take that experience with them when they move to work in other positions in other countries.

The Econometric analysis carried out on behalf of the industry by OEF suggests that the spillovers across the European Union from aerospace R&D may be similar in scale to the social returns seen within the country in which that R&D is undertaken.

2.8 Quantifying the "Additionality" of Clean Sky

The pivotal value of the Clean Sky programme is as an enabler that will both stimulate the development of new technology and accelerate its market introduction. In doing so Clean Sky would act as a catalyst, strongly influencing the timing, the rate and the magnitude of private investment.

One can illustrate how important Clean Sky is to the industry's medium and long-term competitiveness in respect of its ability to:

- **Increase the level of early R&D activity.**

  The high risk of failure inherent with the early stages of technology development discourages long-term private investment. The JTI will lower this risk through funding support and stimulating greater collaboration within the industry.

- **Shorten the time required to bring a new technology to market**

  Bringing forward the maturity of a new technology through the JTI will further stimulate development since the launch of a new program is often dependent on being able to deliver a significant enough benefit to justify the costs and risk of replacing an existing platform.

- **Stimulate R&D within the supply chain**

  Clean Sky's emphasis on demonstration will increase the involvement of the supply chain in technology development and thus raise the technical capability of Europe's industrial base.

The impact of the Clean Sky programme

The impact on value creation by the Clean Sky programme can be explored through considering potential scenarios.

- **Product competitiveness**

  The JTI can make a significant and critical difference in product competitiveness by ensuring that the technology a new product is based on is advanced enough to be competitive whilst being mature enough to be an acceptable risk.

Without this vitally important capability it is perfectly plausible to imagine a scenario where the competition achieve a small but significant performance advantage over the equivalent European product.

In the extremely competitive new aircraft market even a relatively small performance disadvantage can rapidly destroy market share and profitability.

- **Industrial base competitiveness**

  The greater participation of industrial partners from non-EU member states in new aircraft programmes has significant benefits for Europe’s aerospace sector through the opening up of new markets and the ability to share program risk.

  The ability to manage such relationships well is key to the industry’s long-term success if it is to maximize these potential business opportunities without compromising long-term competitive advantage.

  However it is also absolutely vital to maintain a leading technical position to avoid a shift in the balance of power between the high value “prime” position and that of any “risk sharing” partner.

  Research programs such as the JTI are of critical importance if Europe is to maintain a technical lead in aerospace technology. Evidence suggests that the risk of losing this position is both real and significant.

  Should there be a shift in such basic technical capability over time the overall work share and level of technical involvement will follow.

- **Programme timing**

  Activities such as the JTI are key to achieving a level of technical improvement sufficient to justify the launch of a new product development.

  In the event that the JTI is not funded and the significant performance improvements that Clean Sky is expected to deliver are not realised, the expected new aircraft development programmes will be delayed.

  Any such delay has serious implications in delivering fleet level environmental improvements due to the long lives of aircraft. Similarly as the spillover benefit is cumulative a reduction in R&D activity has a significant long-term impact.

Potential significance of the Clean Sky programme

An analysis in support of this submission has shown the following :

A/ the potential effect of a single uncompetitive product,

B/ and/or a delay in launching a major programme,

C/ and/or a shift in workshare

suggests that between 12 to 20 % (€100 Bn to €160 Bn) of the total value added generated by the European aero industry between 2010 and 2035 could be dependent on the leading edge technical capability delivered by Clean Sky.

2.9 Summary & conclusion

The air transport industry is vital to maintaining and developing Europe's industrial competitiveness, enhancing Europe's social mobility and is fundamental to the economic growth of the Union.

To preserve and enhance the economic benefits of air transport we must seek to address the environmental challenge without inhibiting traffic growth. This makes it essential that the availability of environmentally beneficial technologies is expanded and accelerated. EU and national government intervention is necessary and appropriate to correct the market failure inevitably associated with environmental pollution.

However, the stimulation of greater environmental research will also correct the market failure that exists in the general provision of R&D. Research and Development creates very high social returns in the wider economy that cannot be captured by the companies conducting such R&D. As a result, the level of R&D is less than the social optimum and the returns from intervention can be high.

The JTI offers a joint industry – EC mechanism that will set technological goals on a market and social basis and share the cost of acquisition. The approach will encourage greater coordination of research activities within the Union and thus offers the potential to raise the efficiency of European innovation.

Importantly, an emphasis on a co-ordinated technology programme is fully compatible with an environmental trading scheme as a further mechanism to improve the environment – indeed should air transport come within the scope of the ETS it will be vital that these two policy instruments evolve in close coordination.

The Clean Sky Joint Technology Initiative is an essential step towards a sustainable air transport system.