AERONET

Long-term Scenarios of Aviation and its Emissions

Is aviation on the way to sustainability?
A European project

Status - Report
after Workshop I on 17-18 October 2000 in Cologne, Germany

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Content

Summary

In March 2000 AERONET decided to take up the topic „Long-term Scenarios on Aviation and its Emissions“, initially with with 2-3 workshops in the 2000 and 2001 to produce a set of 2-4 qualitative scenarios including 2-3 constrained scenarios (with – as far as possible – some first quantification).

The results of the workshop period should be taken forward by a European study team to develop quantifications for the scenarios designed and to elaborate the details needed to achieve the objectives of the AERONET Scenario Project. The second stage could involve a pre-study, possibly financed by national sources, to firm up the outcomes of the workshops, to define concrete goals, contents and structures for the work of the study phase, and to invetigate models which can be used for quantification. The objectives and tasks developed in the pre-study should than be realized through a (main) study project, funded e.g. by the European Commission. The (preliminary) results of this work should be discussed in an open European review, finished by a European workshop. Using the inputs of these discussions, a final version should be produced until the end of the year 2003. These proposed steps towards complete scenarios will be considered further with key stakeholders and participants.

The final outcome of the AERONET Scenario Project should then be applied as information for the strategic planning of European stakeholders in aviation, as input for other European projects related to aviation and its emissions, and referred to the worldwide international community, especially to ICAO/CAEP, for further discussion.

The present Status Report describes the situation of the AERONET Scenario Project after the first workshop hold on 17-18 October 2000 in Cologne, Germany. The main objective of this workshop was the design of two extrem „backgound“/ environment scenarios for those fields and sectors which are known to influence the development of air transport demand and related emissions.

The participants of Workshop I were welcomed by Prof. Volker von Tein, Member of the Board of DLR and Winfried Dewes; AERONET. Roger Gardner and Alf Schmitt gave short overviews on the AERONET Thematic Network Project and the prime goals and the programme of the workshop. The following session set the scene with four invited overview reports on the long-term developments in the fields „economy and population“, „ecology“, „energy“ „total transport/mobilty“, sectors known to strongly influence air transport demand.

The group work, facilitated by a professional moderator, started with some background information on recent scenario work of the IPCC, and a report on the concepts and tools for the design of scenarios, a process which consists of up to eight phases or steps. During Workshop I the Steps 1 - 4 of the Scenario Techniques were performed by the workshop participants. (Later on it was decided to perform Step 5 : „Interpretation“ in the follow-up of Workshop I and Step 6 – 8 : „Consequence Analysis“, „Wild Card Analysis“, „Scenario Transfer“ at Workshop II.)

In the task analysis (Step 1), it was agreed by the plenary of Workshop that the subject of the scenarios is Aviation and its Emissions and the time horizon of the scenarios is the year 2050. (The situation for 2025 is also of interest as well as potential projections up to 2100.)

The first block of groupwork was related to the External Influence Analysis (Step 2 of the Scenario Process). For seven external fields and five more internal areas altogether 43 most important drivers and key factors were identified. In Step 3 (Projections) the groups were tasked to define for two extreme or boundary positions (A, B) for each descriptor and to nominate the reasons for the selected extreme developments. The next task (Step 4 of the Scenario Process– Clustering) was to assemble alternatives of the descriptors according to their consistency, so as to form logical and possible future scenarios structures and to select the most contrasting ones for interpretation.

At the end of the workshop, two clusters of the alternatives for the 43 descriptors from the 12 key external and internal fields influencing air tranport demand, defining scenarios A and B, were agreed.

Details of the work on Step 2 – Step 4 are given in the report.

A first proposal for the interpretation of the scenarios A and B designed during the workshop (Step 5 of the Scenario Process), was already given by the facilitators during the final round of discussions. After the workshop the facilitator, Mrs von Reibnitz, has elaborated comprehensive storylines for both scenarios A and B. The draft of the report was discussed by e-mail by the workshop participants. The modified versions of the scenario storylines are given in Annex 14 of this Status Report.

The workshop was closed with a discussion on first conclusions on the outcomes of the workshop and adequate next steps. The participants gave a positive response to the workshop, especially from the work within the groups. They felt that it was too early to access, whether the approach of the workshop to develop two extreme scenarios will eventually prove itself as an adequate way to design useful scenarios to support aviation stakeholders in the development of their long-term strategy. It was decided that this important issue should be discussed again during the preparation phase of Workshop II. The participants agreed that the Project is far from being complete. They agreed that a second workshop will be necessary and worthwhile, and this workshop should be held in early spring 2001. The Core Team took the responsibility to prepare the final report. Finally, thanks and much applause were given to the two facilitators for their professional work.

Other topics of the work in the follow up after Workshop I, for which the results are presented in this report are: a very first comparison of the AERONET Scenarios A and B designed during the workshop with the new IPCC Scenarios (SRES), first conclusions from the present status (mostly developed in e-mail-discussions), and actual plans for the preparation and performance of Workshop II and on further steps beyond Workshop II.

The prime result of these discussions is the proposal that the main objectives of the next workshop - which will be held on 19/20 March 2001 at the airport of Palma de Mallorca - should be the design of a set of 2-3 constrained scenarios of air transport demand and related emissions. The extreme Scenarios A and B, developed during Workshop I should be used as background/environment scenarios of those fields influencing air transport demand. A preliminary agenda for Workshop II will be distributed in early February and a final version will be prepared –including proposals from an e-mail discussion- will be send to possible participants in the workshop in the second half of February 2001.

The final version of this report was produced using the comments and ideas of the review on the draft, which was distributed in December 2000 among the participants of Workshop I.

1. Introduction

At the second meeting of the Steering Group on 2 March 2000 AERONET, a Thematic Network Project initiated and supported by the European Commission, it was decided to follow a joint proposal of the two AERONET Subgroups EDI and OTD and the German Scenario Circle to take up the topic „Long-term Scenarios on Aviation and its Emissions“ and to deal with this subject through a European AERONET workshop.

During the preparation phase for this workshop it became obvious that this complicated subject could not adequately been treated within one two-day-meeting.

The present view is that at least a second workshop will be necessary and after the workshop phase a project group should take up the task to elaborate a quantification of the qualitative scenarios commonly developed during the workshops.

This report presents the proceedings and achievements of the Workshop performed on 17-18 October 2000 in Cologne and - based on this analysis – offers a first draft for further planning to achieve the stated objectives of the AERONET Aviation Scenario Project.

2. Background and Objectives of the Long-term Scenario Project

Long-term scenarios on aviation and its emissions are important as input for long-term assessment of the impacts of these emissions on climate change, and on local (airport) air quality, and as basic information for long-term strategic planning in the field of air transport. However, so far, there is no comprehensive, realistic product at hand, especially one reflecting the European perspective.

Published in the year 1999, various scenario approaches for the possible development of global air traffic and related emissions until 2050 were developed and described in the report of the Intergovernmental Panel on Climate Change (IPCC) on „Aviation and the Global Atmosphere“. The key set of scenarios was developed for IPCC by FESG, an ICAO/CAEP working group, as a quantitative input – in form of emission inventories – for the calculation of the global impact of aircraft emissions on the atmosphere.

Common to all scenarios considered in the 1999 IPCC Special Report was the assumption of an unconstrained development of air traffic. With that, the whole range of alternative scenarios was excluded from further consideration.

Moreover, the ICAO/FESG scenarios are based on the GDP figures of the IPCC „background“ scenarios on the development of economy, population, energy, generated in 1992. However, recently (in the year 2000) the IPCC has published new background scenarios developed for its Special Report on „Emissions (ed.: of all anthropogenic sources) Scenarios” with new assumptions for developments in economic and population features. Before using the ICAO/FESG scenarios once again (e.g. as part of a complete set of scenarios), it would be appropriate to modify them to refer to the newest set of IPCC background scenarios.

Considering this situation, it seems to be obvious that if a sound base for the long-term strategic planning in aviation and the long-term assessment of its emissions is requested, it will be necessary to undertake a new effort to design a full set of long-term scenarios based on the best information presently available. With its European Long-term Scenario Project AERONET aims to do so.

The main objective of this project is the „design“ of a set of (up to four) scenarios of the long-term development of aviation and its emissions until the year 2050,

- for which the „no-restriction“ assumption of the scenarios available will no longer be a principal hypothesis, although it will be necessary to have as well one (or more) unconstrained „control“ scenario(s).
- which take into account the new „background“ scenarios from the IPCC on economy, population (and others), developed for the IPCC „Third Assessment Report“, and other recent information and results especially from ICAO/CAEP, industry, economic and air transport sources and various AERONET workshops in years 1999 and 2000,
- which can be used as basic input for atmospheric assessments, and in addition explicitly addresses topics which are critical for the long-term strategic planning in the field of air transport and can be applied as well to policy development work.

For each scenario development, it is proposed that the situation in the year 2025 should be described as well and - as far as possible – some consideration should be given to the need for information out to the 2100 time horizon.

The aim is to develop new state-of-the-art scenario information which can be:

- used by European stakeholders in the aviation system, including airports, ATM/ATC, aviation industry, policy makers, and other relevant European organisations for a better understanding of critical aspects of the challenge to obtain sustainability for the aviation system and for a definition of possible amelioration options to avoid „unwanted“ and support „acceptable“ future developments,
- referred to the worldwide international community, especially to ICAO/CAEP for further discussion, and
- used as basic information for the calculation of a new modified set of global emission inventories applying a new approach for inventory generation in conjunction with work being developed by the European Project AERO2K (recently approved) and for other actual and upcoming projects considering the projection of aviation.

3. Concept for the Performance of the Project

Due to the present understanding, 2-3 workshops will be necessary to achieve the qualitative objectives of the Scenario Project in an adequate manner.

Each of the 2-3 workshops will have three phases

(A) Preparation:
Actions preceding the workshop, preparing useful and necessary inputs;
(B) Performing the workshop:
Addressing the special objectives of each workshop
(C) Follow up after the workshop:
Working out a somewhat more detailed description of the results achieved during the workshop,
and producing a final report for each of the workshops.

After the workshop phase, a European study team (e.g. financed by the EU Commission) should develop - as far as reasonable –quantitative features for the qualitative scenarios, designed during the workshop, and elaborate the full details needed to achieve the objectives of the Scenario Project.

4. Preparation of Workshop I

To start the preparation of the workshop, an Organisation Team (Core Group) was formed which included five persons of different background, organisations and nations.

The Core Group has addressed the following topics:

Survey

The preparation phase of the first workshop was started with a survey. A draft for the agenda of the workshop was designed and a questionnaire was elaborated and sent to selected experts of the aviation community:

- to learn about the principal interest in the workshop and its basic ideas
- to ask for questions for the long-term development of aviation and its emissions which are assessed by the experts to be open and of major interest
- to collect additional proposals for topics which should be addressed at the workshop and
- to get information for a final agreement on the date and duration of the workshop.

The response to the survey was impressive: more than fifty people from all parts of the aviation community gave positive reactions and responses. Some of the experts agreed to act as advisory panel during the discussions in the preparation phase.

Date, duration and emphasis of Workshop I

Eventually, it was accepted that the (first) workshop should be held at 17/18 October in Cologne, Germany. A majority of the possible participants voted for a two-day workshop. During the discussions on the possible agenda of such a workshop it became obvious that it would be impossible to address the complete bundle of the objectives of the Scenario Project within a single workshop. Therefore, it was decided that a second workshop should follow the first one: Whereas the first one should concentrate on the *design* of a set of scenarios, emphasis of the second should lie on the *analysis of consequences* for the scenarios developed in Workshop I.

Facilitator for Workshop I

Taking into account the complexity of the task to design long-term scenarios during the short duration of a two-day workshop (even after the decision to split the work on the Scenario Project into two - or three - workshops), the Core Group decided to use the help of a professional facilitator. Eventually, the „Scenarios + Vision“ team, Lence, France was selected to act as a neutral moderator for the complex organisation of the workshop discussions.

Elaboration of a list of possible topics to be addressed by the workshop

Based on the analysis of the questionnaire and additions from members of the Core Group and others an „Open list of proposals for topics to be addresses by the AERONET workshop on long-term aviation scenarios“ was compiled and eventually agreed after the inclusion of modifications resulting from an e-mail discussion with the advisory panel experts and others. (See Annex 1.)

Agreement on key factors for the design of the scenarios

Next, the Core Group explored a set of the most important key fields and factors which largely may „explain“ the long-term development air transport demand and supply. The draft was distributed and discussed with the advisory panel of experts by e-mail.

Finally the results of these discussions were summarized in a paper which was then used as input information for the workshop. (See Annex 2.)

Distribution of further information relevant for the workshop

A couple of different additional relevant papers and information – predominantly dealing with explanations of the techniques to design scenarios and with critical aspects of the further development of the key fields and factors - were selected by the Core Group and distributed among the possible participants in the workshop.

Funding

The principal funding comes from AERONET. Workshop I was also sponsored by DLH, (German Lufthansa AG), DLR (German Aerospace Center) and EADS, Bremen which together took the responsibility for the financing of the moderator. DFS (German Air Navigation Services) provided the co-moderator.

Agenda for Workshop I

Including proposals from the facilitator, an Agenda was developed for Workshop I, which was a compromise between the wish to come as close as possible to a fulfilment of the extensive list of objectives of the Scenario Project and the necessity to accept the limitations for a two day activity. (See Annex 3.)

Formation of Working Groups for Workshop I

Finally, 39 persons (including speakers, facilitators, service people) enrolled for participation in Workshop I (see Annex 4, part 1).

Taking into account the special expertise of each of the participants, a proposal for the formation of seven Working Groups for the first day of the workshop was delivered by the Core Group. (See Annex 4, part 2.)

5. Performance of Workshop I

5.1 Introduction

Prof. Volker von Tein, Member of the Board of DLR and Winfried Dewes, AERONET, DLR welcomed the workshop participants.

Roger Gardner gave an overview on the AERONET Thematic Network Project.

Alf Schmitt gave a short presentation on the prime goals and the programme of the workshop (as resulting from ideas described in chapter 2 and 3).

Part (A) of the Workshop: Reports on Perspectives of Framesetting External Sectors

5.2 Invited Reports

In the first block of Workshop I, the morning session of Tuesday, 17 October 2000, invited reports were presented which gave overviews on the long-term developments of those external sectors which are known to define the frame for the development in air transport demand and supply. Outlooks on relevant global and European aspects were given concerning long-term developments in the field of:

- economy and population
- environment
- energy
- total transport / mobility

(A presentation on telecommunications, information and computer technology, originally planned as well, could not be realized.)

5.2.1 Long-term Perspectives in Economy and Population
(Konrad Haker, Prognos)

A report on recent scenarios concerning the demographic and economic development up to 2050 was presented, based on the actual IPCC Special Report on Emission Scenarios.

The following regions of the world were defined and considered:

OECD90
Western Europe, USA, Canada, Japan, Australia, New Zealand

REF (Countries undergoing economic reforms)
Central and Eastern Europe, Newly Independent States (CIS)

ASIA
China, India, Tigers, Other Asian Countries

ALM
Africa, Latin America, Middle East

In the following discussion, these definitions for the regions of the world were adopted for the whole workshop.

IPCC has designed four main Scenarios: A1, A2, B1, B2, called *SRES* (Special Report Emissions Scenarios).

These four scenario „families“ have respectively 17, 6, 9, 8 family members with small internal differences but a common qualitative family storyline.

Storyline for SRES A1

The main characteristic feature of A1 is a rapid and successful economic development in which regional income per capita converges – distinction between „poor“ and „rich“ countries tend to dissolve. Global population that peaks in mid-century and declines thereafter.

(*Ed.:* Others: Rapid introduction of new and efficient technologies. Environmental quality sacrificed in pursuit of personal wealth.)

Storyline for SRES A2

Main characteristics: Heterogeneous world. Relatively low and uneven economic development with less emphasis on interaction between regions, increasing income disparity between industrialized and developing countries of the world. Continuously increasing global population.

(*Ed.:* Others: Technological change more fragmented and relatively slow.)

Storyline for SRES B1

The B1 storyline describes a convergent world with the same global population that peaks in mid-century and declines thereafter, as in Scenario A1, but with rapid changes in economic structures towards a service and information economy. The emphasis is on global solutions to economic, social, and environmental sustainability, including improved equity, but without additional climate initiatives.

(*Ed.:* Others: Introduction of clean and resource-efficient technologies. Reduction in material intensity.)

Storyline for SRES B2

The characteristic feature of B2 can be described by a moderate economic development in general and only a slight decrease in international income differences. Emphasis on local solutions. Continuously increasing population at lower rate than A2.

(*Ed.:* Others: Less rapid and more diverse technological change than in A1 and B1.)

Compared to the IPCC scenarios of the year 1992 (the so-called *IS92* scenarios) the *SRES* scenarios show more optimistic prospects for the Developing Countries. E.g., compared to IS92a, which was a scenario with a medium economic development and with an annual GDP per capita in the year 2050 of 4,100 US$, SRES A1 shows a nearly fourfold increase in GDP per capita of 15,900 US$ and SRES B2 an almost twofold increase in GDP value of 8,100 US$ in the year 2050. Projections for population of the SRES2000 scenarios show lower figures than those for the IS92 scenarios.

Viewgraphs of the report on economy and population and a summary are attached in Annex 5.

5.2.2 Environmental Concerns of the Next Decades
(Wouter van Dieren, IMSA Amsterdam, member of the Club of Rome)

Main messages and thesis of the talk:

- The features of the curve for the development of CO2 during the last 160,000 years show clear evidence of a strong correlation of changes in CO2 concentration and changes in temperature.
- Changes in temperatures were connected, for example, with changes in the coast lines (shown for Italy.)
- CO2 concentration was at about 280 ppm / v at the beginning of the industrial revolution and has increased since then – obviously as a result of human activities - faster than ever before during the last 160,000 years to a present level (1993) of 353 ppm / v.
- The trend line for economic and insured losses for the period of the last fifty years up to now show an alarming increase in losses caused by climate-related catastrophes.
- There seems to be a wide gap between the probable world energy demand and the necessity for CO2 reduction.
- Aviation contributes to the change in climate, which is now globally agreed to be real, and the related effects.
- So far, aviation is only partly included (emissions from domestic air traffic) in the global effort to reduce greenhouse gases (especially the UN Convention on Climate Change and the Kyoto Protocol).
- With strong growth in aviation there is a danger that the further increase in added values from aviation stops and, in balance, internal and external costs begin to dominate.
- Without additional measures, aviation will not be a sustainable partner.
- Open Trading of emissions might be a feasible possibility to include aviation into the global effort to reduce CO2 and other greenhouse gases.

The viewgraphs of the report are given in Annex 6.

5.2.3 Energy Perspectives in the 21st Century.
(Gerd Eisenbeiß, DLR, Programme Director Energy and Transport)

Main conclusions from the report are:

- There has been an exponential increase of energy consumption during the last 1,000 years.
- Presently the per capita consumption of energy differs widely - from very small to about 14 t SKE - over regions and countries with a global average of about 2t SKE.
- In the future mankind will consume 5 to 10 times as much energy as earth resources spent during the whole history.
- If energy consumption will still be connected with large emissions of CO2, an extreme climate change will become certain.
- There is a hidden iceberg of unknown external (including social) costs of energy consumption.
- So far there are only weak forces to obtain sustainability.
- Based on the ratio of available reserves of energy and annual energy consumption, oil might be available for a further 44 years, natural gas for a further 64 years (=> hydrocarbons for 50 years?), coal for centuries. The availability of nuclear energy is primarily a question of acceptance, the availability of Renewable Energies (RE) a question of cost reduction (or increase in price level for energy unit.)
- The mid-point of the Hubbert curve, indicating that more than half of the sources have been exploited, has already been passed in 1975 for North America and between 1995 and 2000 for Eurasia, Latin America, Africa, Western Europe. For the middle East with 53% of world's oil reserves it will be passed in 2013.
- Important types of renewable supply options are
  - Solar Collectors and Solarthermal Power (solar belt only) with huge potential
  - Photovoltaics with a huge potential, if cheaper than now

  - Wind Energy with a huge potential in windy regions
  - Biomass, the use of which will be restricted to waste, as it will be still predominantly used for food (if no special plants can be cultivated, which can also be harvested on areas, infertile for food plants)
- The fuel problem for the transport sector will depend on if and when the hydrogen dream might become true. Present conclusions of the discussion on how to handle the transport energy problem in the next decades include the following theses:
  - Biomass will be not a reasonable solution, if not ... (see above);
  - Reduce oil and natural gas consumption in heat and power production and drive/fly with hydrocarbons carefree
  - Don't produce a gas with electricity produced from gas
  - H2 from reforming does not save energy or CO2, unless fuel cells are superior in wheel-to-wheel efficiency
  - Only cheap and clean Renewables (or nuclear energy!) redundantly supplying electricity can become a reasonable basis for H2

A summary (only in German) and the viewgraphs of the report are attached in Annex 7.

5.2.4 Future Mobility Patterns and Scenarios of the Long-term Development in Transport (Volker Schmid, Univ. of Stuttgart (speaker) and Reinhart Kühne, Univ. of Stuttgart and DLR)

A historical description of traffic patterns was given to understand the features of the present transportation network and to be able to assess plans for future development.

The long-term development in infrastructure of canals, networks of rail, roads, air transport show a lot of similarities: slow starting, a maximum of growth and finally saturation. If these historical features will be similar in the future, a maximum growth in air traffic within the upcoming ten to twenty years can be deduced.

Over time, the increase in transport speed was one of the most important driving forces resulting in a world of shrinking distances where a larger territorial range could be covered by an individual, and average distances per day and per traveller grow exponentially. Each new transport mode has increased the average range of an individual by about one order of magnitude.

Structural changes of society and economic bursts accompany the steps toward the new transportation technologies. The increases of passenger mileage and goods load mileage are strongly related to GDP (or to GDP per capita). Since 1750 or so, the real gross national product growth has accelerated when new transportation systems were being deployed. Installation of canals, implementation of railroad networks and rail transit in the big metropolitan areas, and finally the invention of automobiles and their dissemination as a ubiquitous transportation means have produced economic growth cycles.

The relationship between discontinuities in the long-term evolution of growth of infrastructure and long-term rates of technical, economic and social changes are clearly discernible. These historical discontinuities show patterns with 55-year-intervals.

If this development continues into the future we appear to be amid a period of structural discontinuity characterized by saturation in the expansion of an old development paradigm and the transition towards a new development path.

This development path is identified by the communication and media experts as a networking to a new artificial environment, lifting transportation to a new level of quality and service. The central thesis is: "Technology develops from a prosthesis park and product assembly into a completely networked, artificial, intelligent environment."

Transportation has been shown to be a central power house of national economies. Obviously, a reduction of the power of expansion in this sector would lead to a lasting effect upon the future process of economic development, provided it would not be compensated. Such a compensation might be generated by the linkage between information- and communication technology and transportation resulting in a more qualitative growth in road and air transport honored by the market.

The viewgraphs of the report are given in Annex 8.

5.2.5 Panel discussion on the four reports

A number of the principal points were clarified and some corrections were offered. (For example, it could be made clear that subsonic aviation does not contribute to ozone depletion.)

Part (2) of the Workshop: Group Work on the Design of Scenarios

5.3 Discussion on Key Factors and their Projections

In the afternoon session of Tuesday, the 30 participants of the Scenario Workshop started the group work on scenarios, facilitated by a moderator and a co-moderator.

As an introduction, some background information was given.

5.3.1 Short Report on the long-term scenarios of the IPCC Special Report on „Aviation and the Global Atmosphere“ by Alf Schmitt (1) and some general remarks on „Civil Aviation Growth and Emissions Scenarios" from Peter Newton, presented by Robert Falk (2).

(1)
In the IPCC Special Report, all worldwide available reviewed projections to the year 2050 are reported. All these scenarios assume an unconstrained development of transport demand.

The FESG Traffic Projections were prepared for IPCC and were used as key scenarios, applied as main input for the calculations of the impacts of emissions from aviation on the atmosphere.

Approach and underlying assumptions of the FESG scenarios were described. GDP is the dominant „explaining“ factor in the formula for the global modelling of air transport demand.

The three FESG scenarios are based on the three IPCC „background“ scenarios on GDP, generated in 1992 (called IS92a, IS92c, IS92e). As IPCC has recently developed new background scenarios on GDP (and other key features) for its Special Report on „Emissions *(ed.: of all sources)* Scenarios“, called SRES, it would be necessary to update the FESG scenarios assumptions on GDP fitting to the actual IPCC scenario figures, if it is planned to use the scenarios for purposes of the AERONET Scenario Project, e.g. as unconstrained „control“ scenarios for those designed during the workshop(s).

(For some more details see Annex 9.)

(2)
In summary, for the design of useful long-term projections one should keep in mind that scenarios

- are easy to develop, but should be used carefully
- assumptions must be creative, but also realistic
- should reflect changes from known baseline

- must explore the boundaries
- must be credible
- must cover global and local concerns
- must be policy relevant

(Complete viewgraphs of the report of Peter Newton are attached in Annex 10)

5.3.2 Concepts and tools for the design of scenarios by Ute von Reibnitz

The moderator welcomed the participants of the workshop. As a first tuning for a creative, open minded thinking, desirable for the design of long-term scenarios, the moderator showed a video-film which should give an imagination of scenes and impressions of possible future worlds.

The moderator explained the main features of the proposed Scenario Techniques or Process and how they work. The hallmark of the Scenario Process is to create alternatives in case of uncertainty and to assemble them into highly consistent scenarios. Because nobody knows what the exact outcome of the future will be, contrasting future situations have to be taken into account. Scenario Techniques link these scenarios to the present situation of the community for which the scenarios were developed, including existing goals, strategies and questions to be solved. They help to design strategies to seize future opportunities and to reduce or even turn eventual threats into opportunities.

Scenario Techniques consist of up to eight phases or steps:

Step 1 - Task Analysis

Defining the subject of the scenarios and special characteristics like the time horizon of the scenarios

Step 2 – External Influence Analysis

Analysis of external influence areas, their interrelationship and the driving and driven forces of the systems

Step 3 – Projections

Anticipation of future developments of the influencing factors, in case of uncertainties of alternative projections

Step 4 - Clustering Alternatives

Alternatives are assembled according to their consistency, so as to form logical and possible future scenario structures and to select the most contrasting ones for interpretation.

Step 5 - Scenario Interpretation

Description and visualisation of the scenarios in an imaginative way, analysis of the system dynamics and changes in the future

Step 6 - Consequence Analysis

Identification of future opportunities and threats within the different scenarios and development of action items which maximise opportunities and turn risks into opportunities.

Step 7 - Wild Card Analysis

Analysis of possible disruptive events, so called wild cards, and their effects on the subject under study, in order to develop preventive measures to reduce the worst effects of these events and pre-define reactions.

Step 8 - Scenario Transfer

If possible, design of a master guideline and a new, sustainable vision which can be successfully realized under the different scenarios.

(For more details and two case studies see Annex 11.)

5.3.3 Task Analysis

The subject of the scenarios is: Aviation and its emissions. The agreed time horizon of the scenarios is the year 2050. (The situation in the year 2025 is also of interest as well as potential projections up to 2100.)

5.3.4 Selection of Key Factors

During the preparation phase a list of key fields and factors affecting the long-term development in aviation and its emissions were collated. After an e-mail discussion with the possible participants a Workshop Version of this list was produced (see Annex 2) and now distributed as a starting support for the groupwork on key factors.

For the discussions within the Groups, the list of topics/questions of interest, collected during the preparation phase, (see Annex 1) was distributed among the participants at the workshop.

Of special interest were factors / topics which are assumed to be most essential / critical for the design of the scenarios on air transport demand. E.g. in the discussions of the different Working Groups some emphasis went to the question to what extent air transport demand will be decreased by one of the following reasons:

- increase in fuel prices
- policy regulations and regulatory restrictions
- restrictions caused by scarcity of infrastructure

As a start for the discussions within the Groups, the following main fields of influence for air transport demand were agreed on by the plenary:

External fields

- Demography
- Macroeconomics
- Energy/Resources
- Social Trends/Mobility Patterns
- Ecology
- Non-Transport Technologies
- Policy/Regulations

Internal areas (for traffic and air traffic)

- Transport (in general)

- Transport/Air Transport Technologies
- Aviation Effects on Ecology
- Aviation Supply Side
- Special System Aspects of Aviation

Scenario subject

- Air Transport Demand

In the first round of the discussion of the Working Groups, the key factors of the *external areas* (in addition to those of the Aviation Supply Side) were regarded. The task was to select the most important key factors of those fields which would be used as descriptors for the design of the scenarios.

In order to perform the work, eventually six groups (A-G, no Group F) were formed out of the participants of the workshop, each with 4-6 experts and each group (besides Group A) „responsible“ for one field of influence:

Group A: Demography, Macroeconomics
Group B: Social Trends/Mobility Pattern
Group C: Policy/Regulations
Group D: Non-Transport Technologies
Group E: Supply Side of Aviation
Group G: Energy (Energy for aviation included)

Reflecting the results from Tuesday, within the morning session of Wednesday, 18 October, the plenary discussed the question, whether additional descriptors from the external areas should be added, to be able to design even more comprehensive pictures of the future.

During the afternoon session the descriptors for the regarded *internal fields* were selected by working groups, with slight changes compared to the composition, originally proposed (see Annex 4, part 2). Members of Group C from Tuesday morning were distributed among the other groups. The responsibilities for the remaining five Groups were as follows.

Group A: Ecology, Aviation Effects on Ecology
Group B: Transport
Group D: Aviation Technology
Group E: Supply Side of Aviation (Round 2)
Group G: Special System Aspects of Aviation

The complete list of descriptors, selected by the workshop, contents 43 dominant factors from twelve key areas. (Air transport demand as the central subject of the scenario project will depend on the outcome of the scenarios designed during the workshop).

The selected 43 descriptors were then used for the next steps of the scenario design process (and will be described in the following chapters).

5.3.5 Projections for the Selected Descriptors until 2050

The second step during the afternoon session of Tuesday, 17 October was the elaboration of projections for 2050 for the selected descriptors of the external influencing areas.

The task was given, to search for two extreme alternatives (A, B) for each descriptor and to nominate the reasons for the selected extreme developments. (At a later stage, intermediate

scenarios might be developed. The initial goal was to limit the range of credible future developments.)

The number of different alternative projections looked for is arbitrary. Depending on the number of different scenarios which are to be designed, one could look also for more then two contrasting projections. Furthermore, the long-term developments of some descriptors can be unambiguous, resulting in *one* common agreed projection for the time horizon considered. For Workshop I the number of alternative projections to be nominated was restricted to two, because the aim of Workshop I was the design of a set of two extreme scenarios.

During the afternoon session of the Working Groups on Wednesday, 18 October, the Groups discussed the projections of the additional dominant factors, identified in the panel discussion on Wednesday morning, and – in the same round – the long-term developments of the dominant factors from the internal influencing fields.

The resulting alternatives of the descriptors and the elaborated reasons for these developments are reported in the following chapter.

5.4 Clustering (Descriptor) Alternatives to Scenarios

The task of this step of the scenario design is to assemble alternatives of the descriptors according to their consistency, so as to form logical and possible future scenario structures and select the most contrasting ones for interpretation.

In the morning of Wednesday, 18 October the moderators presented a first proposal of two consistent scenarios A and B.

Surprisingly often one of the alternative projections fitted obviously better to one of the scenarios than to the contrasting scenario. However, the projections for some of the selected descriptors fit to both scenarios or would not be in discrepancy to the clusters found for the bundle of projections from another descriptor. Therefore, in principle, more than two consistent scenarios can be designed. As an example, of the long-term developments for the descriptors nominated in this workshop, the alternative B for the projections of ICT – namely a strong increase in importance of these new technologies – could consistently fit to both clustered scenarios. But, here, as in other cases, the decision was made, not to split the original cluster / scenario B into two branches.

The extent to which consistency or non-consistency has to be regarded, depends on the importance of such a differentiation for the subject of the scenario design.

At the end of the workshop, two clusters of the alternatives for the 43 descriptors from the 12 key external and internal fields influencing air transport demand, defining scenarios A and B, were agreed on. These clusters A and B are described below, together with the reasons found by the Working Groups for the selected alternative projections to 2050:

<u>Demography</u>

- Fertility

Alternative A: slightly decreasing
Reasons: religion, slow increase in income

Alternative B: strongly decreasing
Reasons: high income, policy measures

- Mortality

Alternative A: slightly decreasing
Reasons: slow increase in income, some regions: too little food, environmental impacts

Alternative B: strongly decreasing
Reasons: high income, improvements in medicine & hygiene

- Education

Alternative A: for the masses
Reasons: Long-term benefit, more social equality

Alternative B: for an elite
Reasons: short-term profitability, economically driven: need for highly educated professional class + workers, political view

Macroeconomics

- GDP

Alternative A: low growth (ca. 1% p.a., nearly stagnation)
Reasons: regulation, change in way of life, problems from environmental effects

Alternative B: impressive growth (ca. 4% p.a.)
Reasons: economic focus, globalisation, no energy problems, strong urbanisation

- Globalisation

Alternative A: no increase
Reasons: nationalism, (political) instabilities

Alternative B: increase to total
Reasons: profit thinking, communication

- Economic centers

Alternative A: dispersion
Reasons: strong political co-operation, low disparities

Alternatives B: concentration
Reasons: few strong political centers, only three currencies: Dollar, Euro, Yen, large disparities

Ecology

- Climate Change

Alternative A: large change
Reasons: lack of awareness and/or no effective actions, climatologists have underestimated the effects

Alternative B: little change compared to today
Reasons: climatologists have overestimated the effects; or: a large climate change is avoided by high awareness and effective actions

Effects of Emissions from Aviation on Ecology

- Noise effects

Alternative A: noise is a major problem
Reasons:
- speed of technology development and implementation is slow
- sensitivity of population increases
- high growth rates for traffic

Alternative B: noise is a minor problem
Reasons:
- high speed of technology development and implementation into fleets
- technology R&D programmes on the way
- NGOs + governmental actions
- lower traffic growth rates

- Effects from gaseous emissions from subsonic aircraft at cruise altitudes

Alternative A: major problems
Reasons:
- effects on climate change underestimated today
- measures insufficient
- high traffic growth

Alternative B: minor problems
Reasons:
- effects on climate change overestimated today
- high level of reduction measures
- low traffic growth

- Effects from gaseous emissions from supersonic aircraft

Alternative A: no problems
Reasons: no supersonic fleet or small fleet of supersonic aircraft

Alternative B: no problem
Reasons: Large fleet of supersonics, but low environmental effects

- Effects from aircraft emissions on local air quality

Alternative A: health problems
Reasons: proved effects from aircraft emissions originating at airports, high growth in traffic, ineffective measures to mitigate abundances, low improvement in engine technologies with respect to related emissions

Alternative B: no problems
Reasons: effects from aircraft emissions are shown to be lower than those from other sources, low air traffic, improvements in engine technology, effective regulations and Market Based Options to reduce effects

Social Trends / Mobility Pattern

- Quality of life

Alternative A: spiritual + sustainable life style

Reasons: religion, „money doesn't make happy", „be responsible for yourself + others", healthy environment => healthy people, reduced resources

Alternative B: hedonism
Reasons: materialistic aspects dominant, consumption is in: „you are what you consume"

- Working pattern

Alternative A: locally oriented
Reasons: tribalism (home feeling), cost + convenience, income constraints, ICT brings the world together

Alternative B: highly (physical) interactive on a global level
Reasons: face to face contact wanted, resource availability, exploiting global markets

- Leisure behaviour

Alternative A: stay local
Reasons: more ICT, relatively less: speed + ease, leisure time, affordability, curiosity + search for adventures, availability + capacity, new destinations

Alternative B: shrinking world
Reasons: relatively more: speed + ease, leisure time, affordability, curiosity + search for adventure, availability + capacity, new (global) destinations

- Business behaviour

Alternative A: regionally orientated
Reasons: more ICT, relatively less/low: new markets, labour mobility, just-in-time production, spatial specialisation

Alternative B: globally orientated
Reasons: relatively more/high: new markets, labour mobility, just-in-time production, spatial specialisation

- Society structure

Alternative A: cohesive, bonding
Reasons: high importance of family bonds, strongly related to religion and national culture, more ICT

Alternative B: fragmented
Reasons: lower importance: of family bonds, religion, national culture

- Mobility needs of society

Alternative A/B: virtual
Reasons:
- society's mobility pattern completely changed => dramatic ecological problems + dramatic health problems (causal links!)
- new ICT (new multimedia/ cyber dimension), substitute travelling, AT is only the exception (very expensive; internalisation of costs...)
- new behaviour patterns: paradigm shift, „virtual encounter is better than a real one" (in business + leisure)

Alternative B/A: high physical mobility

Reasons:

- increased World Trade
- AT perceived as clean, efficient, less polluting than other transport modes (new energies, new engines, new aerodynamic principles)
- new airspace + distance navigation systems
- effort of all AT industry partners to become sustainable
- life style / leisure focus on real travel, adventure

Regulations

- Regulation of emissions

Alternative A: stricter regulations
Reasons: emissions damage to environment is evident

Alternative B: legislation follows technology
Reasons: economic factors, competition, growth, science proves that emissions have a minor impact

- Regulation of operations

Alternative A: stricter (no short distance flights, no „contrail“ flights)
Reasons: stricter policy to avoid impact on environment

Alternative B: none
Reasons: no need for or no agreement on actions (Remark: added after workshop)

- Curtailing demand

Alternative A: stricter (no leisure flights)
Reasons: cut down on aviation emissions (Remark: added after workshop)

Alternative B: none (Remark: added after workshop)
Reasons: no need for or no agreement on actions (Remark: added after workshop)

- Levies

Alternative A: stricter (make flying less affordable)
Reasons: cut down on aviation emissions (Remark: added after workshop)

Alternative B: none (Remark: added after workshop)
Reasons: no need for or no agreement on actions (Remark added after workshop)

Energy / Resources

- Energy mix

Alternative A: mainly today's sources
Reasons: reliance on fossil hydrocarbons, no incentives to develop Renewables, no legislative pressure

Alternative B: wide range
Reasons: hydrocarbons available, fusion technology mature (safe, efficient..), electrical energy cheap + everywhere

- Availability of energy resources for aviation

Alternative A: not available
Reasons:
- fuel is a scarce resource – aviation loses out
- regional political restrictions

Alternative B: available
fuel is no scarce resource, new oil sources, preference for aviation

- Raw materials

Alternative A: bottleneck and high prices
Reasons: critical raw materials run out or are no longer economically producible; recycling requirements restrict choice of materials, expensive energy also increases material/recycling costs, complex production processes, recycling processes make materials expensive

Alternative B: no constraints
Reasons:
- main materials are available and cheap
- there is enough cheap energy to extract raw materials and process them
  if some raw materials become scarce a cheap replacement is invented
- new materials offer superior characteristics

<u>Non-Transport Technologies</u>

- Telecommunication, information technologies

Alternative A: will not grow significantly / obsolete
Reasons:
- price for licenses (UMTS)
- electro smog
- change in mind of consumers

Alternative B: will grow significantly / dominant
Reasons:
- money can be made
- fast, easy, cheap
- possibilities
- e- commerce
- outsourcing
- 24 h development
- news
- entertainment

- E-commerce

Alternative A: will not grow / obsolete
Reasons: no personal experience, transport cost, security

Alternative B: will grow significantly / dominant
Reasons: reduced cost, comfortable, fast, wide range of selection

- Virtual Reality

Alternative A: will not grow / obsolete

Reasons: impersonal (more in favour of family contacts), technology cannot replace real impressions

Alternative B: will grow significantly / dominant
Reasons: travel will be more expensive, fast + save, optimal service, possibility to make money, CO2-budget

- Bioscience

Alternative A: moderate growth
Reasons: problems of ethical acceptance, long-term risks

Alternative B: rapid growth
Reasons: money can be made, enhance quality of life, ensures food production

- Robotics

Alternative A: moderate grow
Reasons: low labour rates, social problems

Alternative B: rapid growth
Reasons: replace routine and dangerous work + jobs; fast + cheap + precise, reduction of production costs

<u>AT Technologies</u>

- Airframe / Engine technology

Alternative A: conservative concepts
- no acceptance of alternative concepts
- low research level
- industry is not healthy
- technology limits

Alternative B: revolutionary concepts
- new materials
- alternative configuration
- huge research effort
- healthy industry
- fuel price high, but fuel supply secured

- CNS/ATM

Alternative A: stagnation / fragmented systems (=> congestion)
Reasons: local (national) interests, low investment

Alternative B: central regulation, new concepts
Reasons:
- IT
- reduced cost, time, impacts on the environment by optimized routings
- optimisation of capacity
- optimum pricing system for early equipage
- cross-border co-operation and service provision

- Airport design

Alternative A: denied / classic concepts
Reasons: no acceptance of new airports (politicians, passengers), no traffic growth

Alternative B: new concept
Reasons:
- new aircraft concepts
- increase in efficiency / capacity
- less noise, emissions
- more countryside + high speed links
- effects of better accommodation of General Aviation at airports on design

- Alternative transport modes

Alternative A: no substitution
Reasons: costs are too high, no real effect on environment, lack of comfort and attractiveness

Alternative B: significant substitution
Reasons: policy support, network effects, city centers, demand characteristics, cost

- Alternative fuels

Alternative A: no alternative fuels available
Reasons: no need for alternative fuels, no success in technology (Remark: added after the workshop)

Alternative B: H2
Reasons: production / use of H2 without CO2 emissions possible

<u>Transport (business, freight, private, military)</u>
Directly dependent on
- development of population
- GDP per capita
- world trade development
- life style
- travel time + cost budgets

Indirectly dependent on
- technology
- regulations
- infrastructure
- supply side

- Travel time

Factors
- time values
- pressured lives
- convenience
- free up leisure time
- cost pressure / sensitivities
- availability

Alternative A: misery
Reasons: features of factors result in small travel time budget (Remark: added after the workshop)

Alternative B: paradise
Reasons: features of factors result in large travel time budget (Remark: added after the workshop)

- Travel costs

Factors
- income

- cost of provision
- taxes / levies /charges
- competition

Alternative A: misery
Reasons: features of factors result in small travel cost budgets (Remark: added after the workshop)

Alternative B: paradise
Reasons: features of factors result in large travel cost budgets (Remark: added after the workshop)

- Infrastructure (demand related)

Factors
- optimisation
- expansion / contraction
- safety
- privatisation
- public acceptability
- ICT

Alternative A: misery
Reasons: features of factors result in bad infrastructure conditions (Remark: added after the workshop)

Alternative B: paradise
Reasons: features of factors result in effective networks of infrastructure (Remark: added after the workshop)

- Modal split

Factors
- intermodality
- connectivity
- specialisation
- integration
- new modes
- ICT

Alternative A: misery
Reasons: features of influencing factors lead to an inefficient, non-sustainable transport system (Remark: added after the workshop)

Alternative B: paradise
Reasons: features of influencing factors lead to an efficient, sustainable transport system (Remark: added after the workshop)

<u>Aviation Supply Side</u>

- Infrastructure –supply side aspects
  (includes airport/runway and airspace capacity, airport access, personnel, airport entertainment)

Alternative A: constrained
Reasons:
- ATM improvement failure
- stringencies (noise, emissions)
- pressure from „NGO ‘s“, regulations from governments
- increased costs and ticket price due to high fuel price and CO2 budgets
- less welfare due to water / food problems

- more comfort needs
- air traffic demand too high

Alternative B: non-constrained
Reasons:
- new CNS/ATM + improved A/C technology for sustainability
- new efficient, high performance airports and airspace
- new tools for slot planning process
- intermodality (tubes)
- European hubs, EU airlines
- low level of environmental regulations
- no impacts on airport neighbourhood
- airport + airspace integration
- airspace expanded by „Free Route“, Free Flight“ (RVSM, FUA)
- airport access improved
- no funding problems (high GDP)
- harmonization of airspace for civil and military flights

- Aircraft (includes new concepts, special inflight „entertainment“, avionics, performance, operating economies)

Alternative A. 2000 Technology / small improvements
Reasons:
- technology improvements failure, pressure from regulators
- low demand

Alternative B: High Tech
Reasons:
- new concepts (supersonic + new bizjets for business travel; very large A/C for leisure trips, airships)
- improvements in performance and operating economies
- high demand
- low level of environmental regulations

Special System Effects

- Noise

Alternative A: limitations and gradual improvements / slightly reduced
Reasons: cost of development of noise reduction technologies, current technology already near technical limit, demand insufficient to warrant technology efforts

Alternative B: silent aircraft / significantly reduced
Reasons: cost no object, driven by scarcity in environmental capacity

- Emissions

Alternative A: gradual improvements / slightly reduced
Reasons: cost of development of noise reduction technologies, current technology already near technical limit, demand insufficient to warrant technology efforts

Alternative B: significant change / significantly reduced
Reasons: new technology (new engines, new aircraft, new fuels), costs no problem, driven by scarcity in environmental capacity

Remarks: For emissions: local vs. global rules (drivers: local population, climate change)

- Safety

Alternative A: hazards are accepted
(Reasons: not given)

Alternative B: high level of safety, all is well
(Reasons: not given)

5.5 Scenario Interpretation

This step of the scenario design consists of a description and visualisation of the scenarios in an imaginative way and an analysis of the system dynamics and changes in the future.

A first proposal for such interpretations of scenarios A and B - at that time restricted to the projections of the dominant factors of external influencing fields – was already given during the workshop, developed from the facilitators during the final round of discussions of the Working Groups.

In Annex 12, these proposals are attached as a photo protocol .

A complete interpretation of the scenarios has not been developed at the workshop.

However, the facilitator , Mrs von Reibnitz, has written comprehensive storylines for both scenarios A and B during the follow up of the workshop (see following chapter).

5.6 First conclusions

After the five Working Groups had finished their brainwork on alternative projections up to 2050 for additional dominant factors of the external influencing areas (nominated by the plenary during the morning session of Wednesday, 18 October) and for the descriptors of the internal fields and after the presentation of the findings to the plenary, a discussion started on first impressions of the workshop participants

- (1) on the outcomes of the workshop
- (2) what might be adequate further steps.

(1)
The participants gave a positive response to the workshop, especially from the work within the groups.

Some felt, that the time for the discussion in the group work was perhaps too short but, it was also agreed that some time pressure must be there, to be effective in the group work.

The objectives of the AERONET Scenario Project were discussed again to be able to compare the defined goals with the workshop results.

There was a general agreement, that the available long-term scenarios are insufficient, mainly because they comprise only unconstrained projections. Therefore, if aviation scenarios are wanted, the need was seen, also to develop constrained scenarios to design a full range of possible and logical scenarios for the year 2050. In addition, it was agreed on that IPCC/FESG unconstrained scenarios should be modified, before they could be used as „control“ unconstrained scenarios for the set of scenarios developed by the AERONET Scenario Project.

The participants felt that it was to early to assess, whether the approach of the workshop to develop two extreme scenarios will eventually prove itself as an adequate way to design useful

scenarios from which hints for aviation stakeholders for their long-term strategy can be deduced, before being able to reflect the outcomes of the workshop more intensively during the follow up-phase and without having performed the missing steps of the Scenario Design Process during a second workshop. It was decided, that this important issue should be discussed again during the preparation phase of a possible Workshop II. The participants agreed that, anyway, much is still to do, and, so far, the Project is far away from being complete. The participants agreed that a second workshop will be necessary and worthwhile.

This workshop should be held in early spring of 2001, to make sure that the momentum from Workshop I could be used for the further steps to reach the objectives of the Scenario Project. At the best, all participants in the October-2000-Workshop should be as well part of the workshop team of Workshop II in 2001.

(2)
At the end of the workshop the participants discussed the content of the follow up of the workshop. It was agreed that a final report on the workshop should be made available as a draft per e-mail to the participants and then be modified using the comments from the participants. The facilitator , Mrs von Reibnitz, took the task to draft an interpretation of the two scenarios A and B, to be added to the draft final report for discussions. The Core Team took the responsibility to prepare the final report. Finally, thanks and much applause were given to the two facilitators for their professional work.

6. Follow up after Workshop I

6.1 More Detailed and Pronounced Storylines of the two Scenarios Designed during Workshop I

As planned, Mrs von Reibnitz drafted storylines for the two scenarios A and B.

The participants of the Workshop were asked to review and to comment these creative and comprehensive interpretations by e-mail, having in mind, e.g., the summarized characteristics which should be taken into account for the design of useful long-term projections, described in chapter 5.3.1.

The modified storylines for the scenarios A and B are attached as Annex 14.

6.2 Comparison with new IPCC Scenarios (SRES)

There are many good reasons to use the comprehensive work done by the writing team of IPCC for its Special Report on Emission Scenarios, published in spring 2000 for the purposes of the AERONET Scenario Project.

This might be especially true for those parts of the SRE Scenarios which address the fields of long-term developments in macroeconomics and population (not saying that other parts should be neglected). Below are some very first results of a first comparison of the AERONET Scenario clusters of alternatives, the Scenarios A and B (elaborated during the workshop) and their narrative interpretation (drafted after the workshop by Mrs von Reibnitz) with the IPCC/SRES:

- IPCC has decided to end up with a set of four scenario families (each with some members with internal quantitative differences, but a common qualitative storyline. The main arguments to develop *four* scenarios are:

    - there should be more than two storylines, to help to illustrate that the future depends on many different underlying dynamics
    - the number of scenarios should be even to help to avoid the impression that there is a „central“ or a „most likely“ case

- the number of scenarios should be no larger than four to not complicate the process by too many alternatives.

- The key fields and factors used for the IPCC / SRES are quite similar to those developed for the AERONET Scenario Project and used for the Scenario WORKSHOP I. One difference: IPCC has included „Agriculture“ / „Land – Use“, too.

- SRES A1 and B1 show a very high respectively high growth in GDP, combined with a relatively low growth in population, which makes them comparable to the AERONET Scenario B. SRES A2 and B2 show a medium growth in GDP. There is no IPCC scenario with a stagnation or very small increase in GDP as in AERONET Scenario A.

- Because SRES A1 shows very large energy use, high resource availability and a rapid technology change it might be regarded as the one closest to AERONET Scenario B. (SRES B1 shows low energy use and resource availability and an only medium pace in technology change.)

- SRES B2 might be regarded as closest to AERONET Scenario A, because it is orientated to social equity, focuses on local and regional levels and shows less rapid and more diverse change in technology.

- A major difference of SRES A1 compared to AERONET Scenario B is that in the A1 storyline a high growth in GDP is combined with a substantial reduction in regional differences and a general convergence among regions also with respect to cultural and social aspects.

6.3 Some conclusions from the present status

With Workshop I a start was made by European experts to develop a set of scenarios for the long-term development of aviation and its emissions which does not exclude constrained projections, takes into account the newest state of the art in the design of long-term scenarios for the world and eventually can be used as basic information for the long-term strategic planning of stakeholders in aviation.

After the workshop, the participants agreed that it is worthwhile to continue.

Taking into account the experiences of Workshop I and keeping in mind what are the goals of the AERONET Scenario Project it has to be decided early during the preparation phase for the next AERONET scenario workshop, whether

- (a) steps 6 – 8 (see 5.3.2) and other, so far missing parts of the Scenario Design Process, should be performed in Workshop II using the two Scenarios A and B, developed during Workshop I and interpreted in the follow up and then to decide whether an iteration will be necessary to reach the objectives of the AERONET Scenario Project

or

- (b) to start with Workshop II with an iteration of steps 2-5 (see 5.3.2), using a modified approach for the selection of scenarios to be designed, and end up with two (or more) modified scenarios by performing steps 6-8 of the design process with these newly developed scenarios.

Clearly there is a wish to move constructively forward from the ground work laid down at the first workshop and avoid any duplication of work. To the extent necessary, it is appropriate to qualify and develop the bounding scenarios so that these can be used within the process of defining the proposed four scenarios. Which are taken forward to the point of quantification. If the result of this

decision will be case (a), it has to be decided, whether the quality of step 5 of the scenario design process, the scenario interpretation, can be assessed as satisfactory for the upcoming work or a team of 6-8 experts should meet in short time and make further efforts to achieve the needed level of maturity for the scenario interpretation.

The next workshop should again be facilitated by a moderator.

7. Preparation of Workshop II

To prepare the next workshop in March 2001 the following main steps have to be performed, most of them as a result of e-mail discussions on proposals, developed from a new Core Group taking into account the experiences of the facilitator:

- Nominate an organisation team (Core Group) for the next workshop
- Decide on the question, whether the scenarios A and B, developed during Workshop I, should be as base for the work in Workshop II
- If yes for the last question, decide, whether step 5 of the scenario design process, „Interpretation of Scenarios (A, B) needs more depth and thus more work
- If yes for the last question, organize a meeting of 6-8 experts to perform the work and utilize the outcomes of the meeting
- Draft a proposal on how the IPCC/SRES can be included in the AERONET Scenario Project
- Draft a proposal on how the IPCC/IS92 can be used for purposes of the AERONET Scenario Project
- Agree on the details of the programme of Workshop II and on an Agenda.
- Organize a suitable participation of experts for Workshop II and the performance of the workshop
- Collect and distribute information which might be useful for the next workshop
- Realize additional agreed ideas from possible participants
- AOB

A preliminary agenda for Workshop II will be distributed in early February.

8. Planning of further steps

As has been agreed that the first part of the AERONET Project is to design a set of scenarios for the long-term development of aviation and its emissions, which can be used as basic information for the long-term strategic planning of stakeholders in aviation should be a series of 2-3 workshop.

The outcome of this work should be qualitative storylines for a set of scenarios and – as far as possible – some first quantification. This work should be finished in 2001.

The results of the workshop period should be taken up by a European study team to develop quantification for the scenarios designed by the workshops and to elaborate the details needed to achieve the objectives of the AERONET Scenario Project. This work should be done in 2002.

To be able to realize this plan, a group of appropriate interested European experts should form a team which should elaborate a proposal for the European Commission to be submitted in March 2001. The content and detailed work structure of the main study should be defined within a pre-study which also should complete and finalize the (qualitative) outcomes of the workshop period to ensure that the objectives of this phase will be achieved.