Quo Vadis Aeronautics ??

Some Remarks from a European Scientific and Academic Viewpoint

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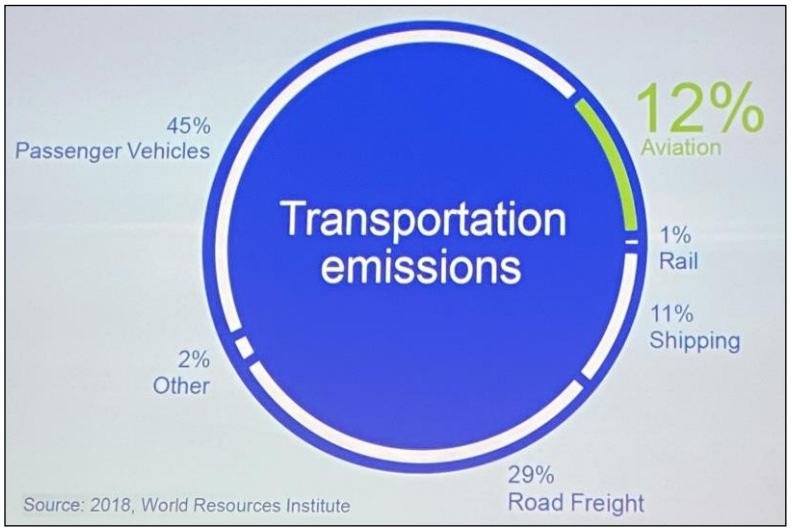
Content:

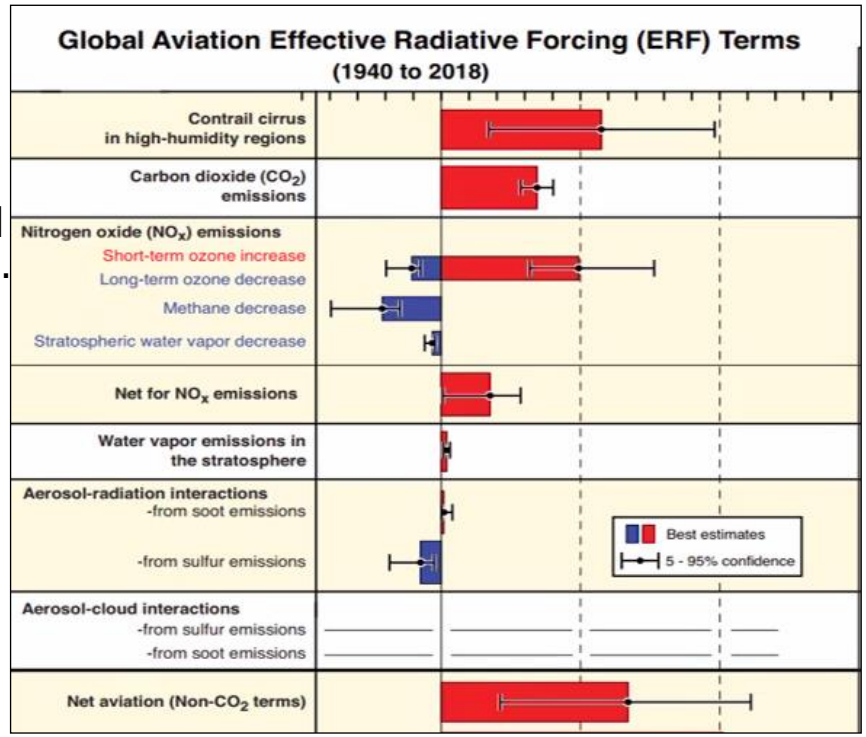
1. Introduction

Global Warming – A rising challenge for aviation

- Aviation emissions are about 12% of all global transport CO_2 emissions (2.8% of global CO_2).
- Non-CO_2-emissions of aviation contribute significantly to Effective Radial Forcing (ERF).
- Wide uncertainties exist about the impact; thus, more research is needed.
- Aviation will need to undertake measures.



Global CO_2 emissions by transport means *(Source: Boeing)*

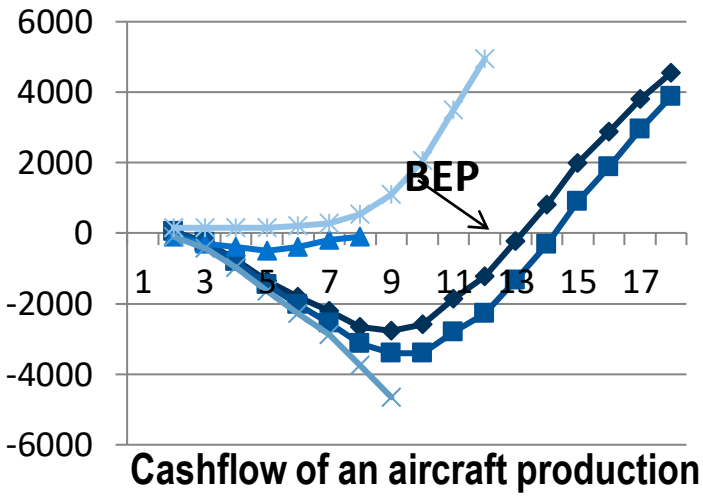


Source: Patrick Le Clerc, DLR

Contrail cirrus over Northern Atlantic *(Source: DLR/ NASA)*

Particularity of Aeronautics

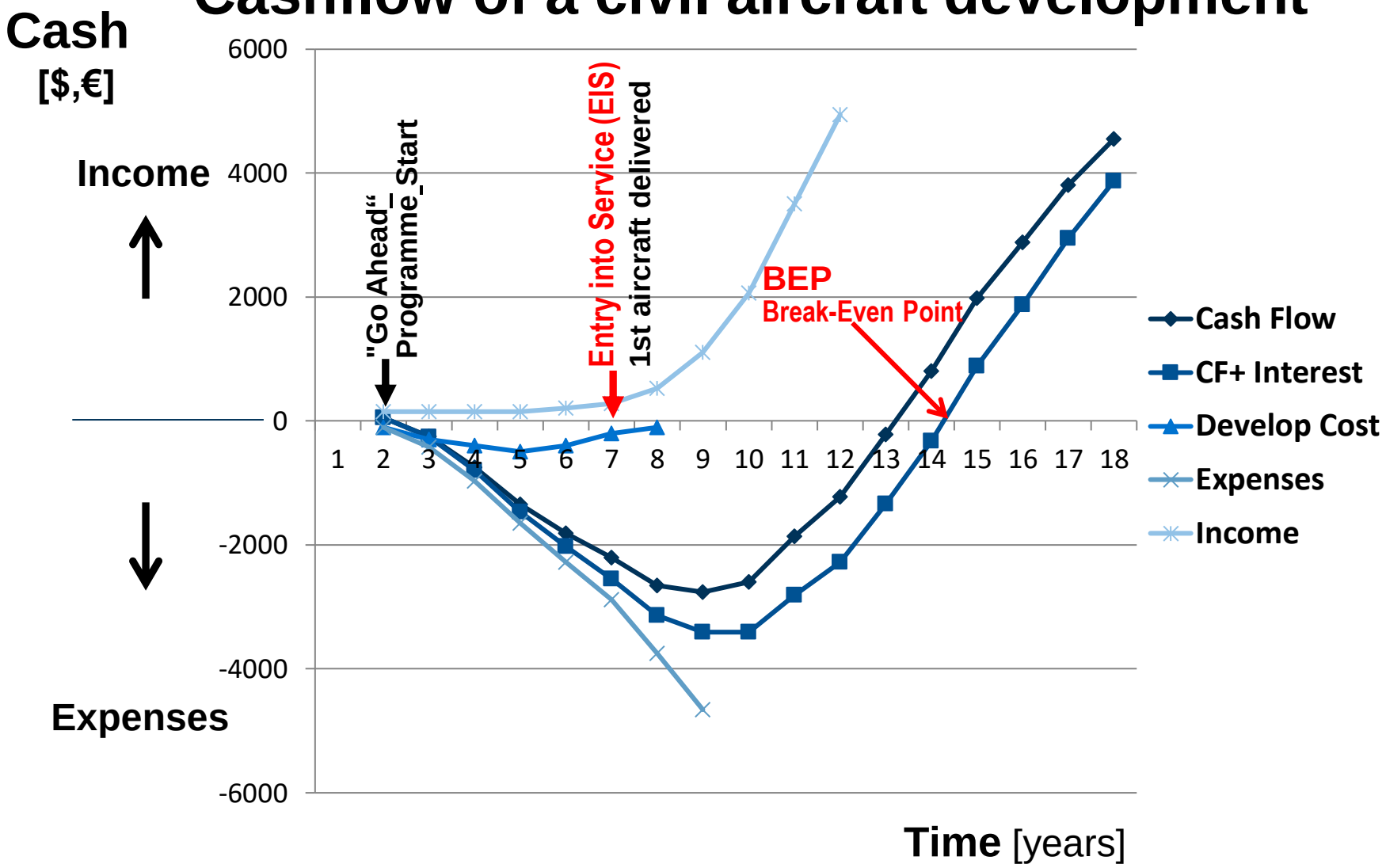
- Civil aircraft industry is not only a market driven business!
- To reach the financial breakeven of the cashflow for a new airliner takes typically **13 to 15 years** *(details in next slide).*
- The development costs of a new large aircraft (10+ billion €) can only be ensured by re-payable launch aid or guarantees by the Governments
- The high complexity and the challenging technologies of a modern civil aircraft require an excellent industrial team of **well educated engineers** for a successful product.



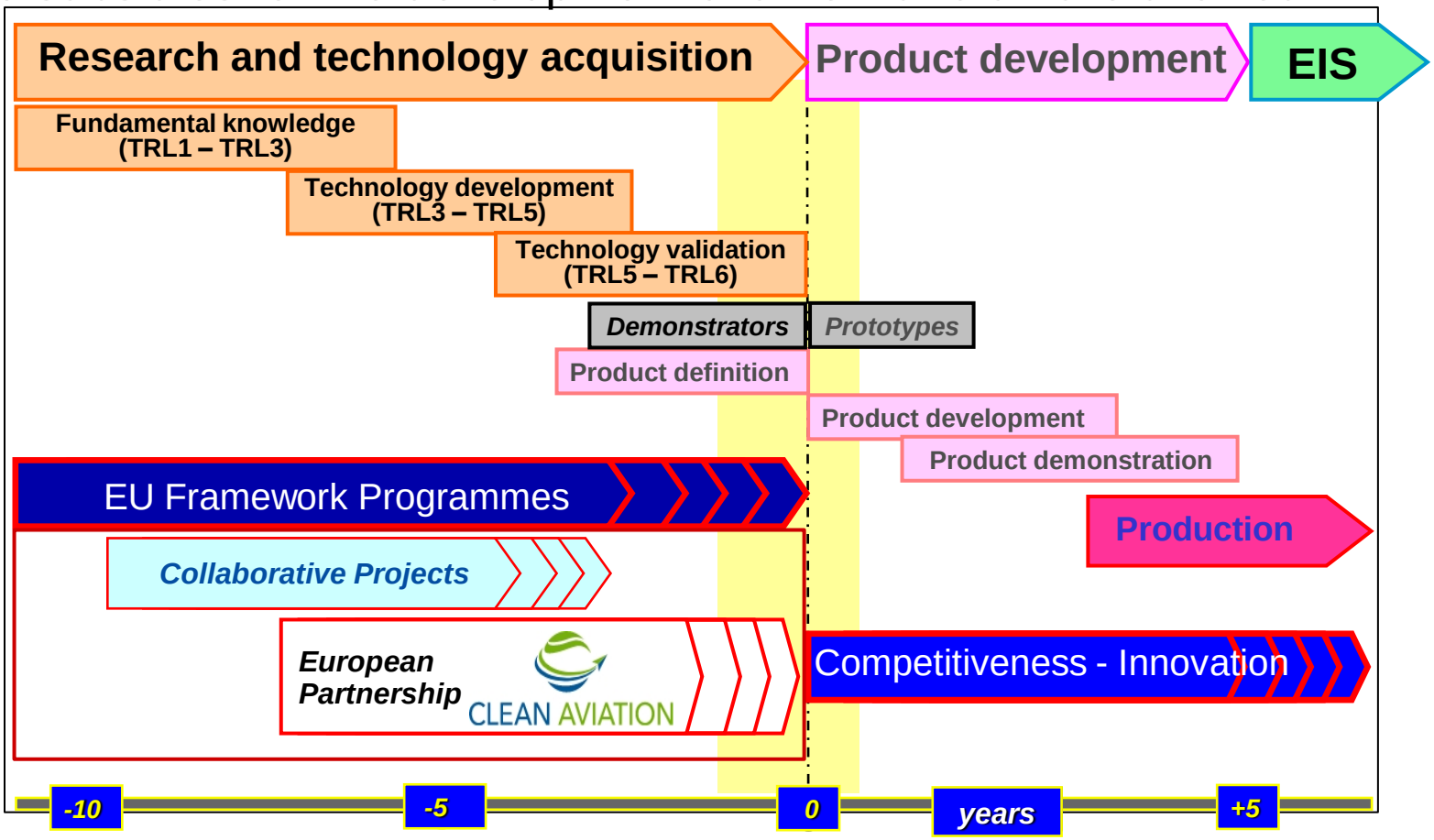
Cashflow of an aircraft production

- **The civil aircraft sector is a strategic industry for the USA and EU. It needs public back-up and risk-sharing support in technological developments.**

Cashflow of a civil aircraft development



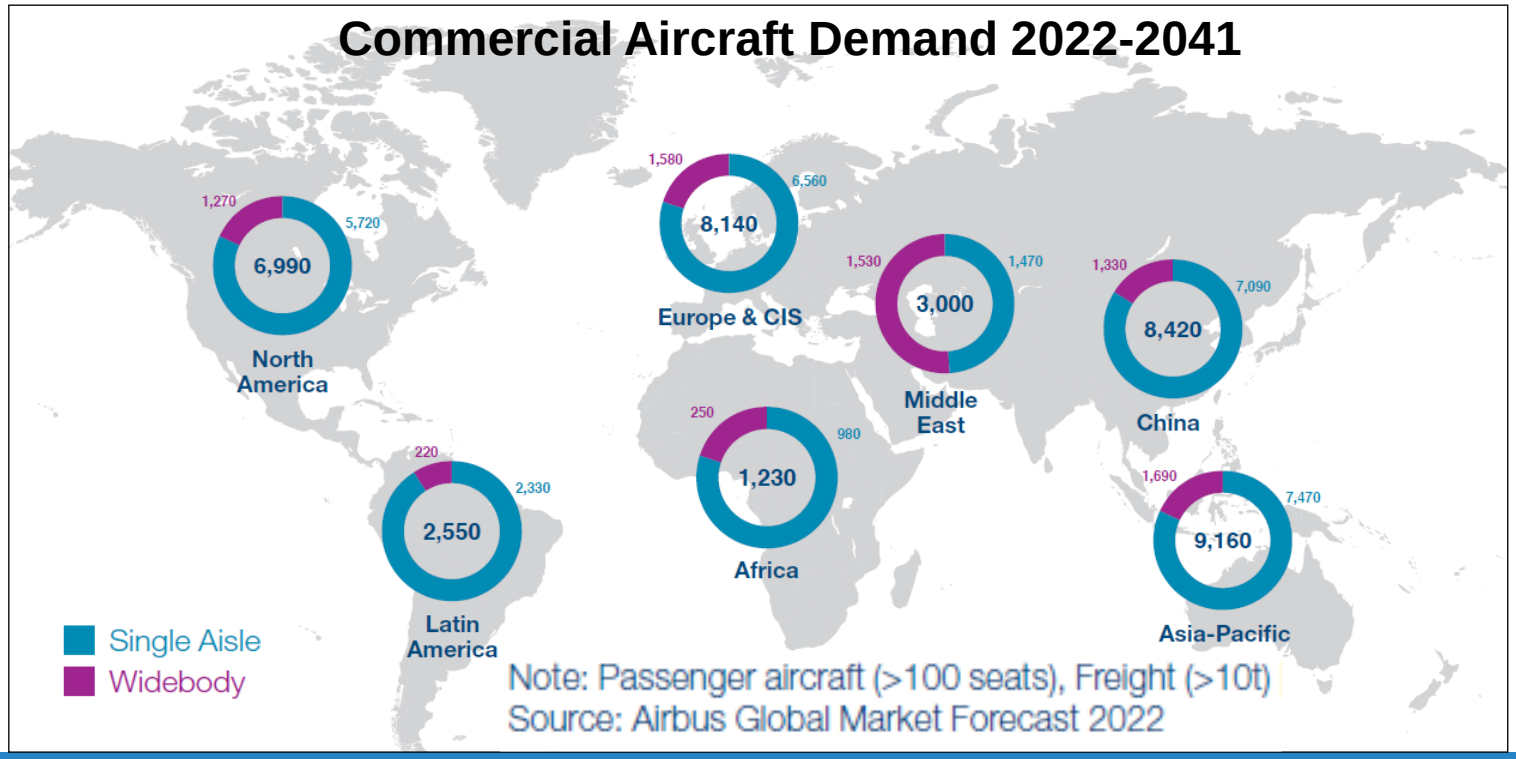
WTO and EU allow to support research and technology development
But no subsidies for the development of a new aircraft are allowed.



WTO – World Trade Organisation
TRL – Technology Readiness Level
EIS - Entry into Service – aircraft in operation

2. Leading Countries in Aeronautics

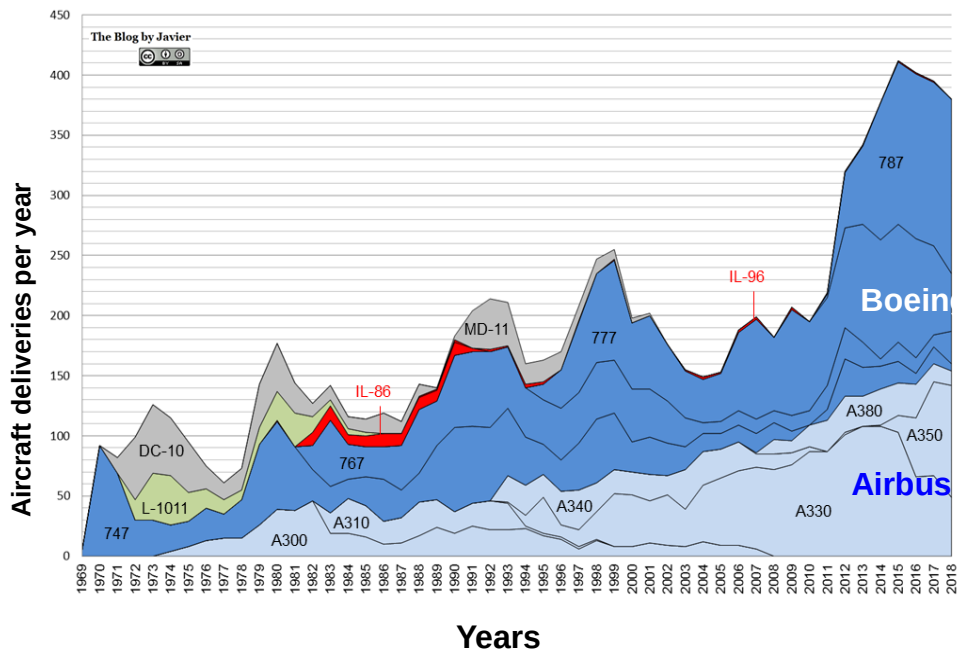
- **Leading Countries:** USA, EU, China, Russia, Brazil, UK, Canada, Japan etc.
- **Military strength:** USA, Russia, China, UK in the lead - less in Europe (France).
- **Civil aircraft:** Boeing and Airbus are today in a duopoly with fierce competition.
- **Future:** Actors from Brazil, China, Russia (?) and Japan may enter the market.
- **Global Market Forecast 2022-2041 of Airbus:** ~ 40.000 new passenger and freighter aircraft over the next 20 years (value: ~ 200 billion €)



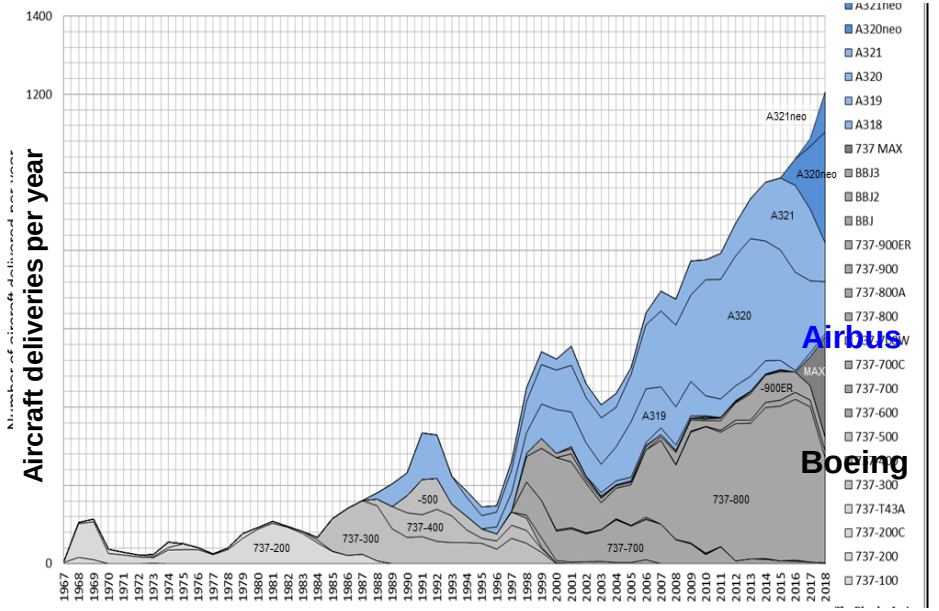
Leading Civil Aircraft Manufacturers

- Today only Boeing and Airbus have the capabilities and financial basis to build successfully large civil aircraft.
- This duopoly is operating in a fierce worldwide competition.
- Newcomers from China, Russia, Japan may enter the market in future.

Commercial widebody aircraft deliveries per year (1969 – 2018)



B737 vs A320 family deliveries per year (1967 – 2018)



Source: https://theblogbyjavier.com/

3. Airbus – A European Success Story

Airbus is a European success story!
From the creation in 1970 until today,
Airbus has started with three European partners the development of the Airbus A300, certified in 1974,
From 15 aircraft sold in 1975 (A300) to 611 aircraft delivered in 2021, this is an unbelievable success story of Europe's aviation!

A300 Prototype (1972)

A350-1000 Prototype (2016)

But this is not only an industrial success story, it is based on Governments' launch aid, the EU-research programmes, and on institutions as ACARE, EREA, EASN etc.**!**

The well established aeronautical network has supported this European success story!

4. European Aeronautical Research

The history of aeronautics research on European level

1973: GARTEUR - Group for Aeronautical Research & Technology in Europe

1988: EUROMART* study as rational for aeronautics research on EU level

1989: Specific Aeronautics Research in the 2nd EU Framework Programme

1993: CEAS “Confederation of European Aerospace Societies” started

1994: EREA founded; 11 European Research Establishments are cooperating

2000: High-level Group for the **Vision 2020** and **ACARE** established

2007: Clean Sky, SESAR** launched in 7th EU Research Framework Programme

2008: EASN: European Aeronautical Science Network (Academia network)

2011: **Europe’s Vision for Aviation ‘Flightpath 2050’** published

2016: Clean Sky 2 + SESAR 2 started within Horizon 2020

2022: Clean Aviation + SESAR 3 started within Horizon Europe

* EUROMART – European Cooperative Measures for Aeronautical Research and Technology

**SESAR – Single European Sky Air Traffic Management Research

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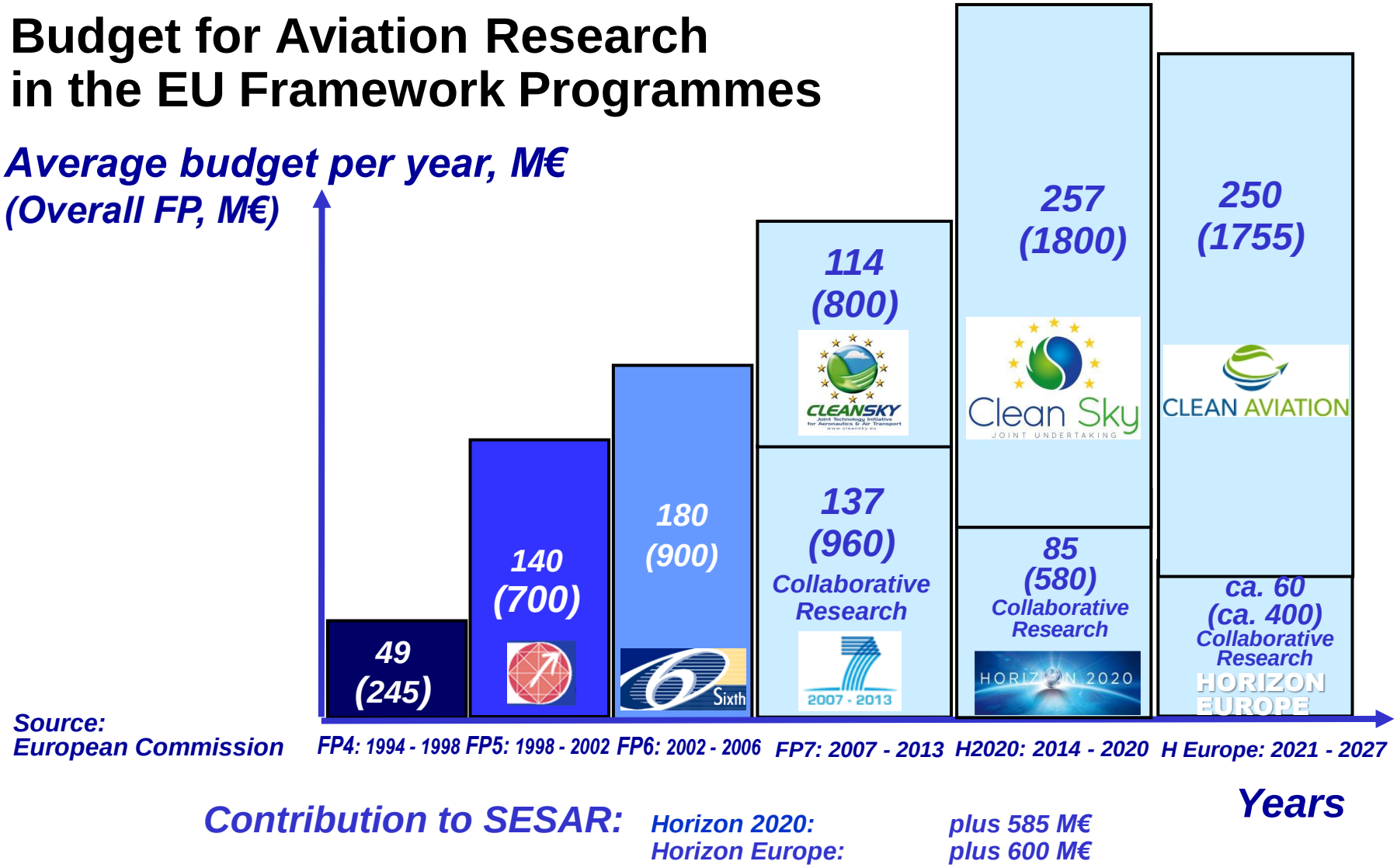
Budget for Aviation Research in the EU Framework Programmes



Contribution to SESAR: Horizon 2020: plus 585 M€
Horizon Europe: plus 600 M€

5. ACARE - Advisory Council for Aviation Research & Innovation in Europe

- Vision and mobilisation in Europe
- Involvement of all European aviation stakeholders
- Implementation of ***Vision 2020*** and ***Flightpath 2050*** through the ***Strategic Research and Innovation Agenda (SRIA)*** and its updates

Key Goals of Vision 2020

- 50% cut in CO_2 emissions per passenger/km
- 80% cut in NOx emissions
- Halving perceived aircraft noise
- Five-fold reduction in accidents
- Air Traffic System capable of handling 16 million flights a year
- 99% of all flights within 15 min. of timetable

ACARE Members

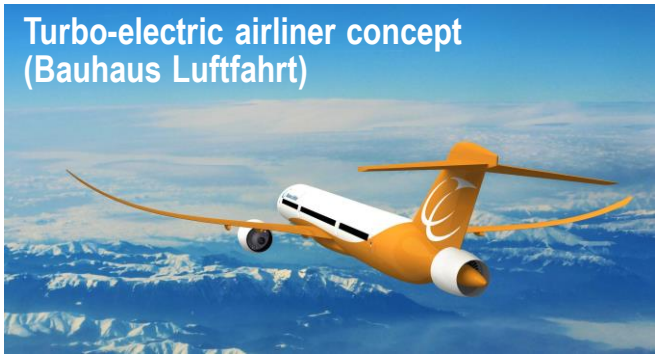
- 27 Member States
- European Commission
- Manufacturing Industry
- Airlines
- Airports
- Air Navigation
- Eurocontrol
- Research Centres
- Universities
- Energy
- Regulators

=> The ACARE goals can only be achieved with sufficient activities and support!

6. Research & Technology Supply Chain in Aeronautics

Aeronautics products need a research and technology supply chain:

1. **Aircraft Manufacturing Industry (OEM):** Overall design, definition of main technology needs and drivers; design and manufacturing concepts, components and systems architecture, maintenance concepts, etc.
2. **Industrial Suppliers:** System-, structure-, component design, development + production; cost and quality driven.
3. **SMEs**: Fast prototyping + testing of components, material and systems; innovation and cost driven.



4. **Research and Technology Organisations:** (CIRA, DLR, INTA, NLR, ONERA, VZLU, …) – Large scale testing and validation (flight physics, structures, propulsion), material developments, system control architectures, technology maturation, tools, new concepts.
5. **Universities: Education + qualification of young engineers for industry and research!** Upstream research support in nearly all technology areas; innovative concepts, low cost research, however creating "**Out of the Box**"-ideas.

7. Importance of Qualified Education in Aeronautics

Numerous technical Universities in Europe are performing the **qualification of young engineers in Aeronautics** by education and research activities.

This qualification requires the cooperation between industry and academia. Different ways of cooperation are possible:

- Internships in industry (4 weeks to 6 months),
- Master or PhD thesis in cooperation with industry (at campus or in industry),
- Master or PhD thesis as part of a joint research programme between industry and university (best solution).

Without highly skilled people, a complex product like an aircraft will not be possible.

Industry does not always recognize the academic effort and support as a necessary investment in the future, as industrial decision makers are often financially driven.

TU Delft: Flying V concept

8. Clean Aviation – The European Partnership for Aviation

The goals of the predecessors Clean Sky and Clean Sky 2 are basically in line with Vision 2020 and Flightpath 2050

Goals of Vision 2020 - Clean Sky (CS) *(2008 – 2016)*

- 50% reduction in carbon dioxide (CO_2) emissions.
- 80% reduction in mono-nitrogen oxides (NO_x) emissions.
- Noise reduction for flying aircraft by 50%.
- Mitigate the environmental impact of the lifecycle of aircraft and related products.

=> Several open calls have been launched with a 25% contribution to SMEs

=> Major demonstrators have been realized like BLADE, Ultrafan, etc.

Goals of Flightpath 2050 - Clean Sky 2 (CS2) *(2014 – 2023)*

- 75% reduction in carbon dioxide (CO_2) emissions.
- 90% reduction in mono-nitrogen oxides (NO_x).
- Noise reduction of flying aircraft of 65%.
- Mitigate the environmental impact by designing aircraft to be recyclable.

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Clean Aviation is a European Partnership within ***Horizon Europe.***

The European Commission changed its objectives to “Impact to greening”.

The new goal is the “Green Deal” of the European Union!

- Clean Aviation activities should be **impact driven!**
- This is targeted as an industry research programme with fixed timing to deliver new products for:
  - Hybrid-Electric Regional Aircraft *(Entry into service: 2035)*
  - Short-Medium-Range Aircraft *(Entry into service: 2035)*
  - Long-Range Aircraft (LH_2-based) *(Entry into service: 2050)*

These new targets are well understood and clear!

However, that means now:

Concentration on product maturation with no specific share for upstream academia activities! Reduced research for the development of “long-term ideas”.

The Vision of Clean Aviation for 2050

The **ultimate objective** is to reach net-zero greenhouse gas emissions, and to enable a climate-neutral aviation system in Europe by **2050**!

Key thrusts have been identified:

Technologies	*Application*	*Fuel burn*	*EIS*
- Hybrid electric & full electric architect.	Regional aircraft	- 50%	2035
- Ultra-efficient aircraft architectures	Short/med. range aircr.	- 30%	2035
- Disruptive technologies to enable hydrogen-powered aircraft	Long-range aircraft + business jets	tbd.	2040

Clean Aviation follows the objectives of its predesessors Clean Sky 1 + 2. Its new strategic research and innovation agenda (SRIA) aims to set out the overall trajectory to achieve the vision.
All aeronautical partners contributed to this vision!

CLEAN AVIATION

Everything looks fine! ***=> However, . . .***

Implementation of the Vision of Clean Aviation

- The vision of Clean Aviation (CA) is outlined by all stakeholders in the SRIA.
- The horizon for CA is 2035 – 2050 (i.e. 13 to 28 years from today).
- The evaluation criteria for project proposals are “Excellence”, “Impact” and “Implementation” with “Impact” now as the most important criteria.
- This reduces the quota for SME or university participation considerably.
- To ensure major output the proposals must have already a fairly high TRL level (TRL 3 – TRL 4) to be selected.
- Upstream research of universities (thematic topics) will no longer be funded.

This causes a major concern that leads to questions:

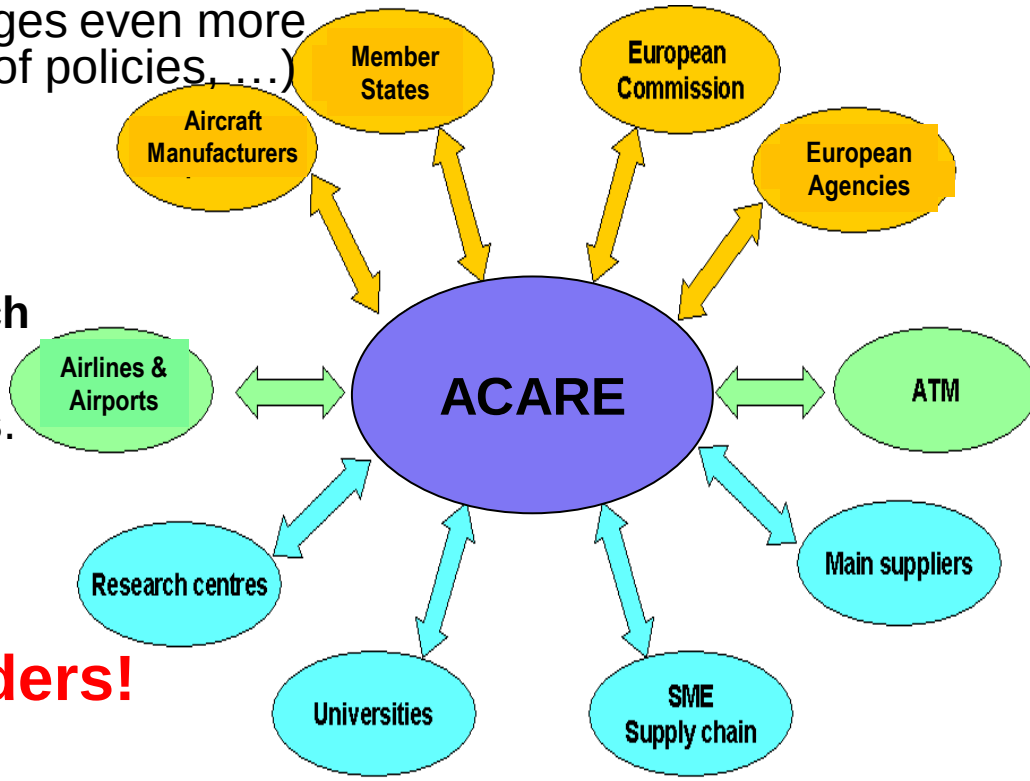
- Where the innovative upstream academic research will be funded, needed for technology developments of aviation products in 2035 and onwards?
- Why the successful cooperation of the entire aeronautical technology supply chain in Europe should no longer be used?
- Are innovative ideas of universities with reasonable small budget research not anymore needed for the support of industry strategies?
- Should university research, essential for the education of skilled engineers, not be linked with industrial technology developments for future aviation products?

9. ACARE in 2022 – What is the Future?

The ACARE Chair Team has issued **Europe‘s Vision for Sustainable Aviation „Fly the Green Deal“**.

- The ACARE Chair Team has finished its mandate.
- A new ACARE Chair Team was appointed in 2022.
- ACARE need to tackle future challenges even more (Global warming, pandemic, change of policies, …)
- Some big players consider acting outside ACARE.

➢ **There is a risk, that the joint approach of Europe’s aviation stakeholders is diluted after twenty successful years.**



=> Europe needs ACARE with all Aviation Stakeholders!

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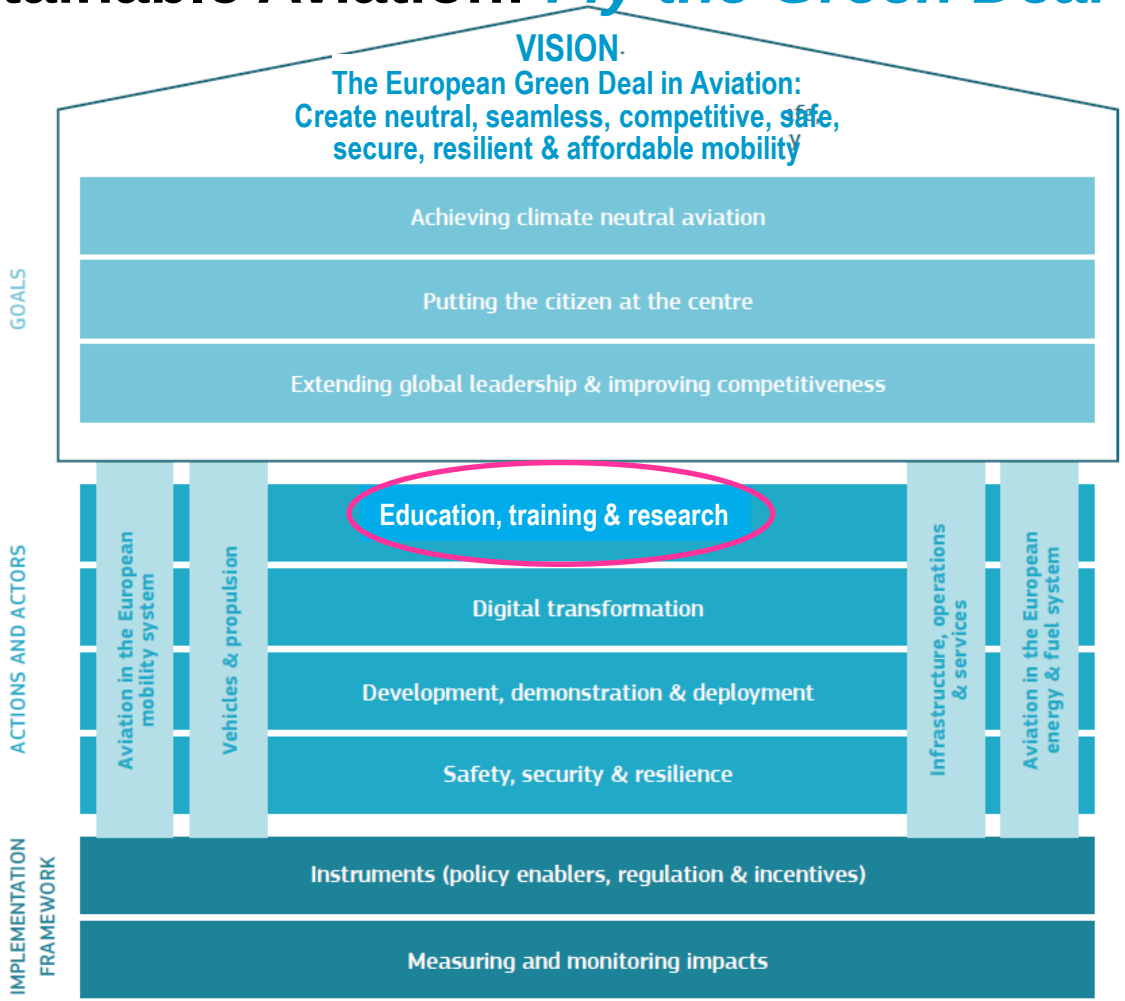
ACARE handed over to European Commission and EU Member States in 2022:

Europe‘s Vision for Sustainable Aviation: *Fly the Green Deal*



10. Conclusions

1. Europe's aeronautics industry has achieved a strong position on the global aviation market, which needs to be ensured in future.
2. The goal of becoming CO_2-neutral by 2050 represents a huge challenge to the entire aviation community.
3. Universities and their academic research can contribute novel ideas and innovative concepts for meeting these goals
4. Over the last 30 years, Europe has established an excellent network for aeronautical research involving all stakeholders incl. universities.
5. ACARE represents a unique institutions of all aviation stakeholder. It can provide strategic guidance on technology needs for achieving Europe's Vision goals (e.g. by its SRIA).
6. Aeronautical research will need also in future a continuous public support on European and national level.
7. An academic network upgrading education and innovative research in entire Europe, has been established during the last decades and strengthened by students and scientists exchange and cooperation in research by joint projects.

Recommendations

- In the research domain, „Excellence“ should be the dominant evaluation criteria for project proposals.
- Upstream innovative technologies with low TRL level should be included in Clean Aviation with a fixed percentage.
- The research cooperation between industrial and university partners should be established in the basic rules of Clean Aviation for ensuring qualified research training practise for the next generation of aeronautical engineers.
- ACARE has proven to be an excellent instrument for Europe‘s aviation community. It should continue with all stakeholders and enhanced perspectives. The European Commission should support the ACARE activities in a sustainable way.
- Universities play a key role in education of future engineers and contribute to important and innovative upstream research. Both must be performed in close link with industry.

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