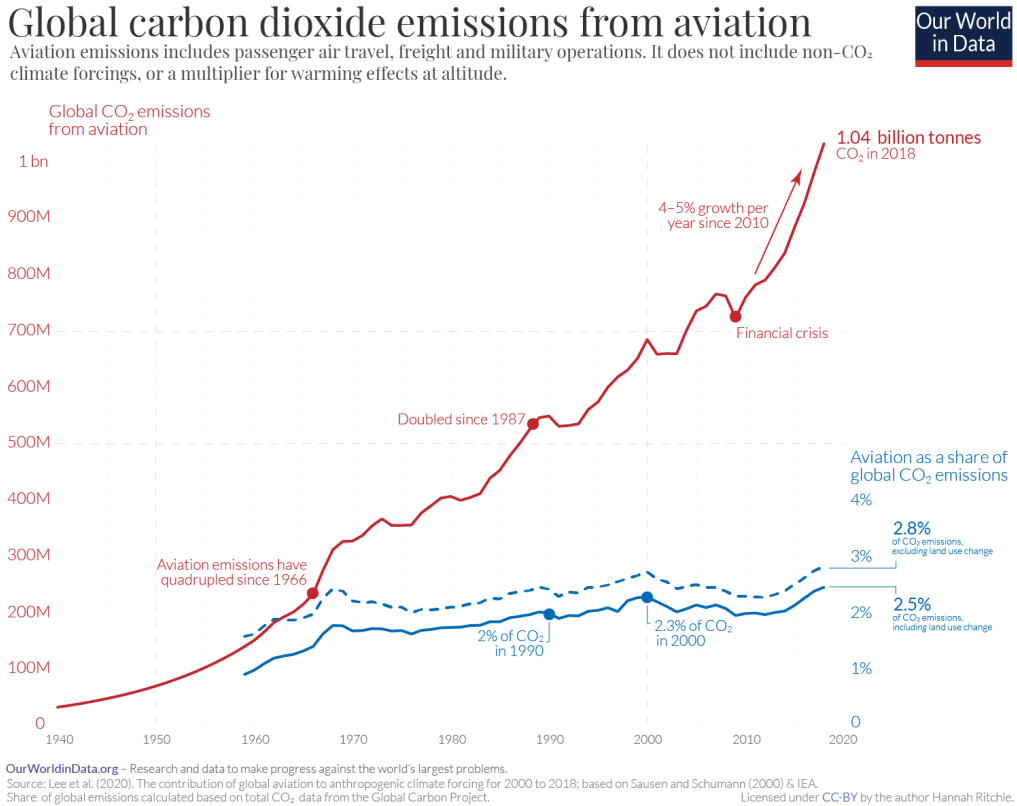
Dedicated to innovation in aerospace

Consolidating and stepping up aviation's climate ambition: a comprehensive definition of a climate neutral air transport system

Bram Peerlings & Ligeia Paletti – ECATS 2023

We have a problem…



'Today', aviation contributes

~ 2.5%

of anthropogenic CO_2 (2018)

~ 3.5%

of anthropogenic global warming (2000 – 2018)

By 2050, aviation could be responsible for

~ 25%

of anthropogenic CO_2

Lee et al. (2020), Our World In Data.org

There's increasing high-level agreement about the goal

Official Journal **L 243**

of the European Union

English edition | Legislation | Volume 64, 9 July 2021

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REGULATIONS

* **Regulation (EU) 2021/1119 of the European Parliament and of the Council of 30 June 2021 establishing the framework for achieving climate neutrality and amending Regulations (EC) No 401/2009 and (EU) 2018/1999 ('European Climate Law')** 1

CarbonBrief, NLR, Official Journal of the European Union

But… how to get there?

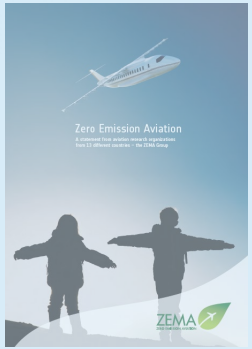
1. **Agree** what it is exactly where we need to get to
2. **Make a plan** that gets us there
3. **Execute the plan** and ensure nothing falls between the cracks

However: aviation – currently – is struggling with this

1. Goals are often poorly defined
2. Quantified targets are often missing
3. Nobody is keeping track of the overall picture

Goals are often poorly defined

Dedicated to innovation in aerospace



“We want sustainable aviation”

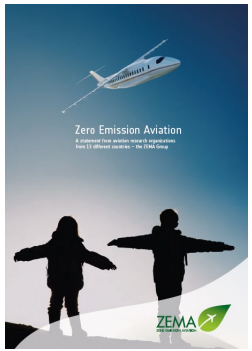
DLR, NLR, Duurzame Luchtvaarttafel, Destination 2050, A4A, Euronews, Clean Aviation, AZEA, ACARE, ZEMA, ACI World, IATA, ATAG, ICAO

For flights departing…

… worldwide

ATAG
AIR TRANSPORT ACTION GROUP

ICAO



IATA

ACI
AIRPORTS COUNCIL INTERNATIONAL

… from our continent

DESTINATION 2050

CLEAN AVIATION

ACARE

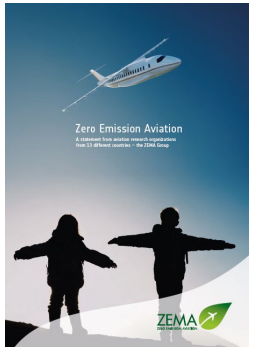
Airlines for America®
We Connect the World

Alliance for Zero-Emission Aviation
PREPARING EUROPE FOR HYDROGEN & ELECTRIC FLIGHT

… from our country

By having flights that are…

… zero emission



Alliance for **Zero-Emission Aviation**

PREPARING EUROPE FOR HYDROGEN & ELECTRIC FLIGHT

… climate neutral

ACARE

CLEAN AVIATION

… net-zero CO_2

DESTINATION 2050

Airlines for America®
We Connect the World

IATA

ICAO

ATAG
AIR TRANSPORT ACTION GROUP

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Taking into account…

… in-flight emissions

DESTINATION 2050

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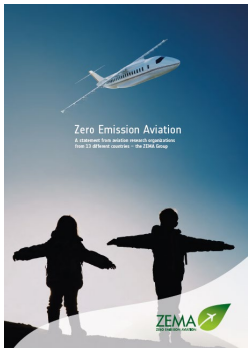
PREPARING EUROPE FOR HYDROGEN & ELECTRIC FLIGHT

CLEAN AVIATION

… the full life cycle



“We want climate-neutral aviation”

An example: Fly the Green Deal

The specific, overarching goals of the Vision are to:

- By 2050, achieve **climate neutral**[1] aviation based on validated and globally accepted tools and models, in the full

Article 2

Climate-neutrality objective

1. Union-wide greenhouse gas emissions and removals regulated in Union law shall be balanced within the Union at the latest by 2050, thus reducing emissions to net zero by that date, and the Union shall aim to achieve negative emissions thereafter.

The GHGs to be covered are:

Carbon dioxide (CO_2)

Methane (CH_4)

Nitrous Oxide (N_2O)

Sulphur hexafluoride (SF_6)

Nitrogen trifluoride (NF_3)

Hydrofluorocarbons (HFCs):

Perfluorocarbons (PFCs):

- By 2050 new technologies, fuels and operational procedures reduce the climate impact of CO_2 and non-CO_2 effects of all intra-EU flights and those departing the EU by 90% relative to the year 2000.

yet

no non-CO_2 climate effects

We need a universal definition

We need a universal definition

Climate-neutral aviation

Type of aviation of which the climate impact of all carbon dioxide and non-carbon dioxide effects is balanced

✓ Consistent with IPCC definition on climate neutrality

✓ Explicitly includes non-CO_2 effects

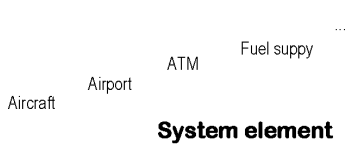
However, still unclear with respect to:

- Scope and system boundaries “Breadth”
- Temporal scale “Depth”

Breadth: scope and system boundaries

Aviation can be defined as

- “the activities surrounding mechanical flight and the aircraft industry”
- “the activity of flying aircraft, or of designing, producing, and keeping them in good condition”



Wikipedia, Cambridge dictionary

Depth: temporal scale

Whether historical emissions are dealt with determines aviation's total cumulative contribution to global warming

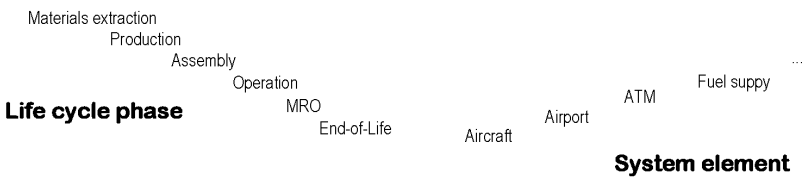
"Climate neutral" with respect to:

- Beginning of time?
- Compared to a 1.5˚C warmed world?
- Compared to forcing in (e.g.) 2050?

Climate impact of aircraft operational activity today

Climate impact of aircraft operational activity 15 years ago

Climate impact of airport maintenance (MRO) activity today



Based on Brazzola et al. (2021)

A refined definition

Climate-neutral air transport system

> *Air transport system of which the climate impact of all its greenhouse gases and other non-carbon dioxide effects throughout the entire life-cycle of each element of the system is balanced*

- Clarifies that ‘aviation’ is the total ‘air transport system’
- Includes other greenhouse gases, emitted during e.g. production
- Explicitly includes life-cycle phases and system elements

Quantified targets are often missing

ACARE's quantified targets do not 'add up' to the vision

- Not in the original vision of climate neutral aviation,
  and not in the updated definition of climate neutral aviation

1. By 2050, in-sector measures (e.g. new technologies, ~~fuels~~ energy carriers and operational ~~procedures~~ measures) result in ~~net zero CO_2 emissions~~ a 90% (or larger) reduction in life-cycle greenhouse gas emissions and non-CO_2 climate impacts (due to, but not limited to NO_x and non-volatile particulate matter (nvPM) emissions and ~~warming~~ contrail cirrus) ~~for all intra-EU flights and those departing the EU~~ across the European air transport system, relative to the baseline
2. By 2050, any remaining climate forcers (including life-cycle CO_2, NO_x and nvPM emissions, and contrail cirrus) from emissions from 2050 onwards are neutralised.
3. By 2050, remaining non-CO_2 climate forcers (including NO_x and nvPM emissions and contrail cirrus, excluding CO_2 emissions) from emissions prior to 2050 are neutralised.

Setting quantified targets that are aligned

Current

By 2050

- Net-zero CO_2
- 90% reduction in NO_X v. 2000
- 90% reduction in nvPM v. 2000
- 90% reduction in warming contrail cirrus v. 2000

- No targets for addressing non-mitigated non-CO_2 effects

Required for climate-neutral ATS

By 2050:

- ≥ 90% reduction in life-cycle GHGs
- ≥ 90% reduction in NO_X
- ≥ 90% reduction in nvPM
- ≥ 90% reduction in ~~warming~~ contrail cirrus

- Any remaining climate forcers from emissions in 2050 are neutralised
- Any remaining non-CO_2 climate forcers from emissions < 2050 are neutralised

Nobody is keeping track

No-one can do this alone

- “Easy shooting” at all aforementioned organisations and targets: no single actor or stakeholder has a large enough span of control

- However, we should make sure that all individual initiatives “add up” to the overarching goal – a climate-neutral air transport system

- ICAO and ACARE seem well-positioned
    1. ACARE to start, fitting with higher European ambition level
    2. ICAO to take-over (in due time), guaranteeing global (UN) alignment

Summarizing…

- Goal: a climate neutral air transport system

  Air transport system of which the climate impact of all its greenhouse gases and other non-carbon dioxide effects throughout the entire life-cycle of each element of the system is balanced

- Targets (for 2050):
  - ≥ 90% reduction in all climate forces, across the life cycle, across the air transport system
  - Complete neutralisation of remaining climate forcers

- Keeping track:
  - ACARE
  - ICAO

Thank you for your attention!

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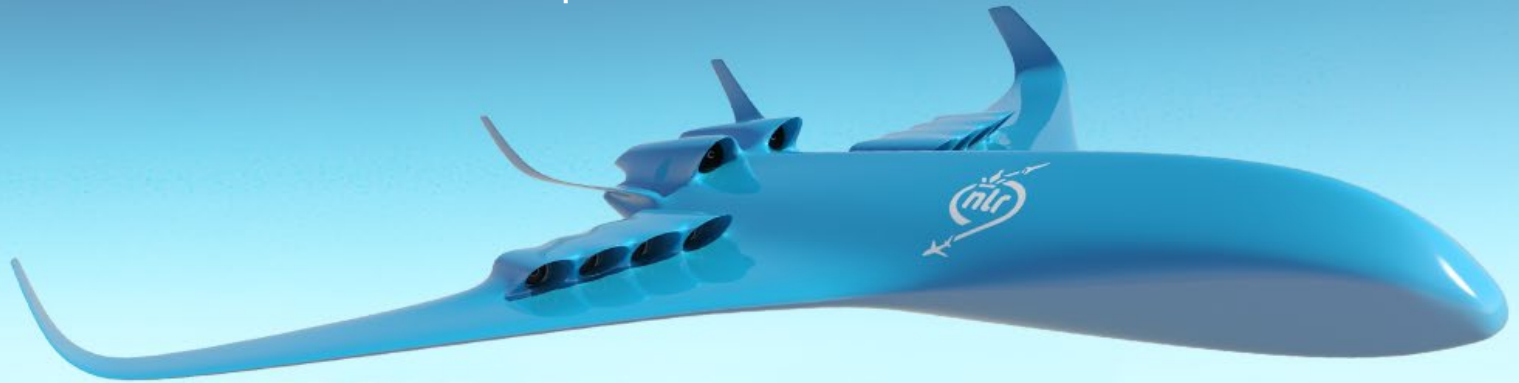
Dedicated to innovation in aerospace

Fully engaged

NLR - Netherlands Aerospace Centre



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