

AVDASI-3: Sustainable Aviation & Ethics

Lecture-1: Types of environmental impacts & aviation's contributions

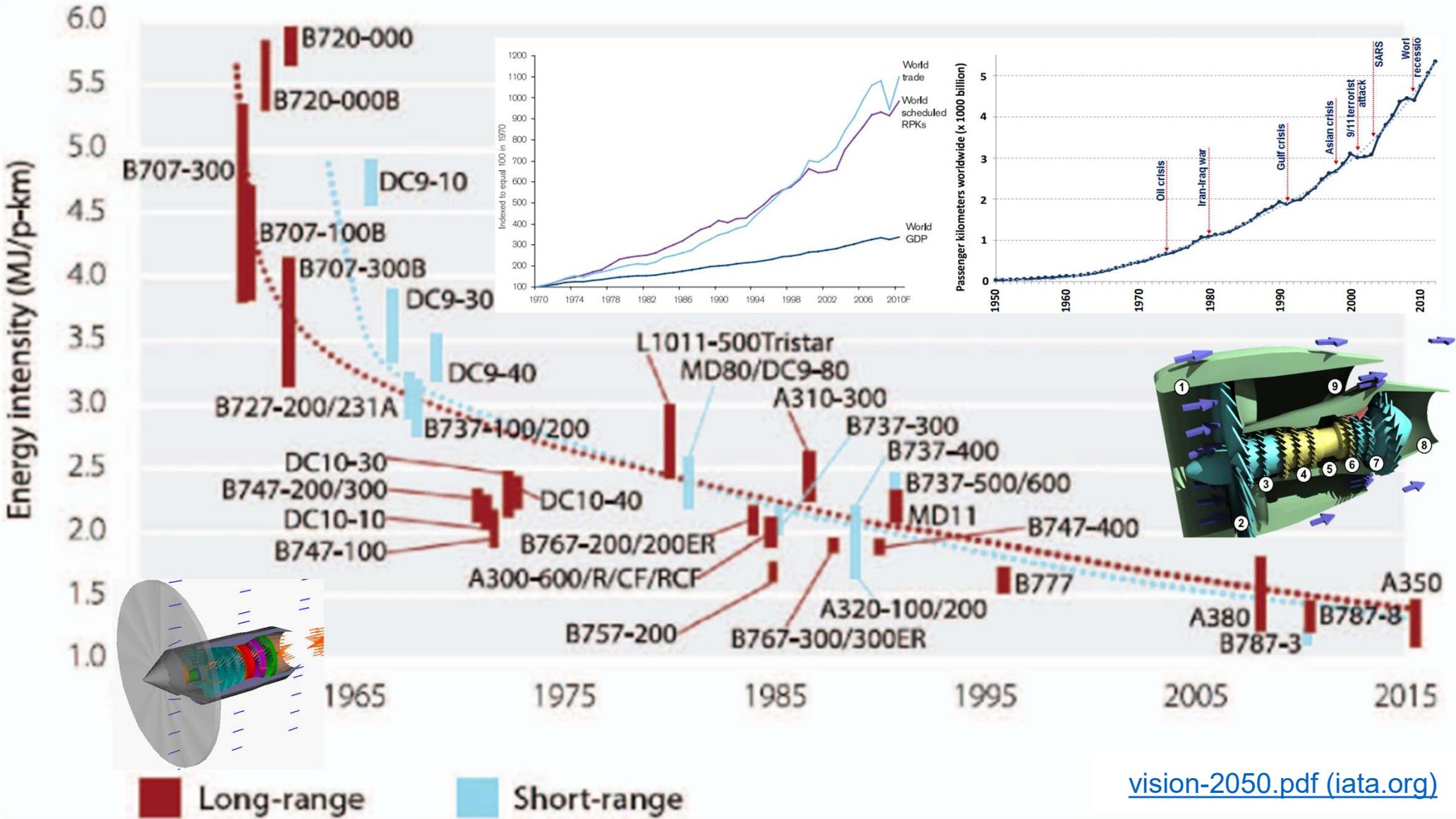
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Energy intensity (MJ/p-km)



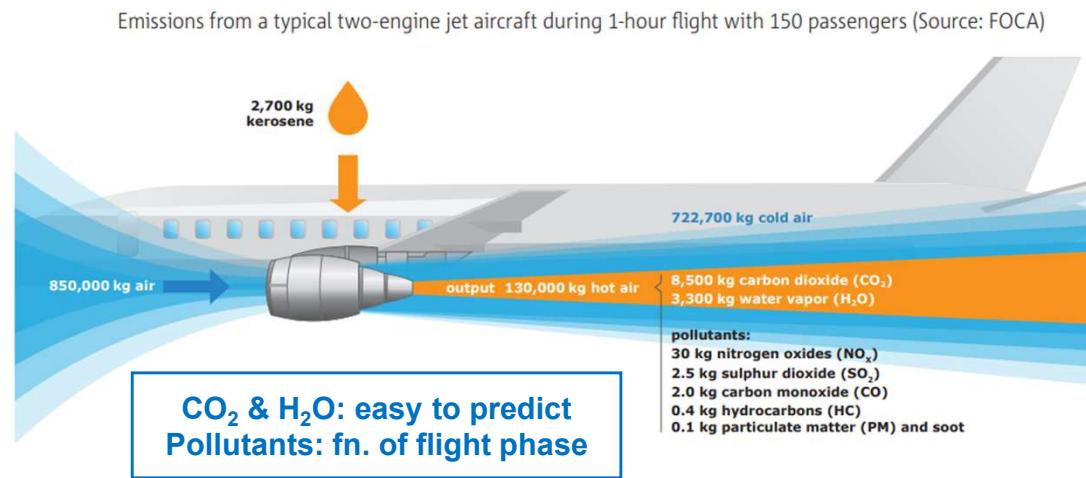
Some hard data about aviation

- How bad is aviation?
 - Current fuel consumption per pax-km is amazing
 - ~ 18L/100km/pax brought down to ~ 4L/100km/pax (equivalent to modern car)
 - Pax-km is too high & increasing exponentially
 - ~ 2x every 15 years
 - Aviation contributes ~ 2.5% of global CO₂ emission (pre-2020)
 - Non-CO₂ effects (NO_x, O₃, contrails, sound etc.)

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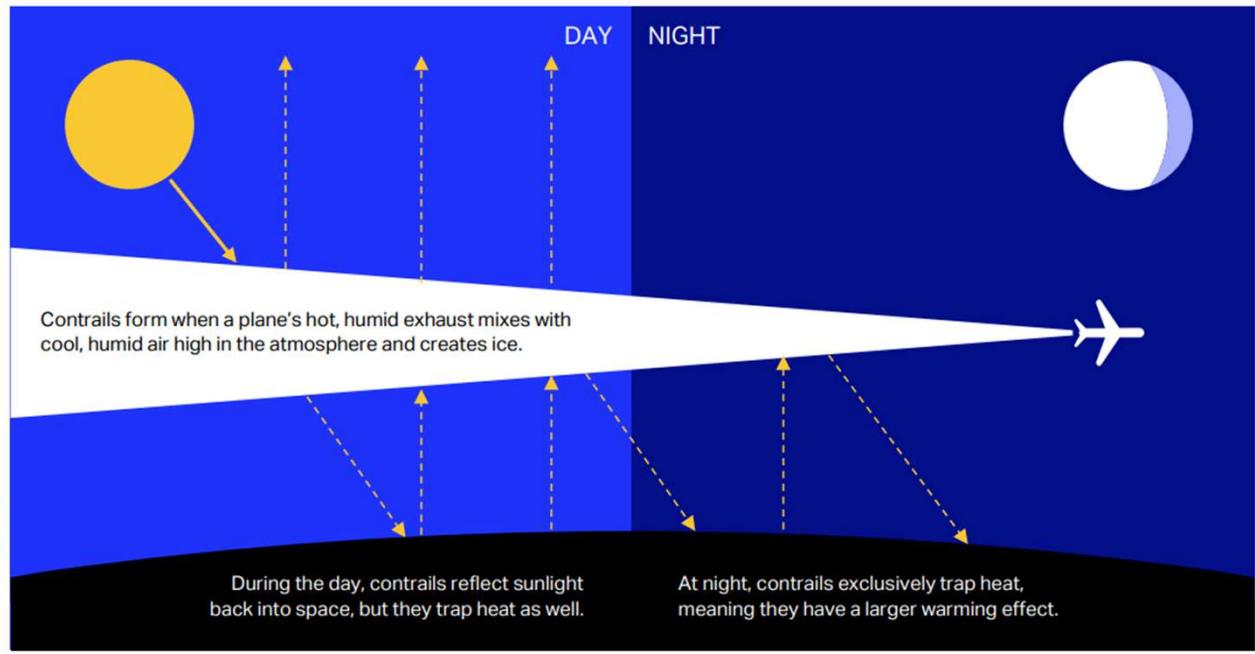
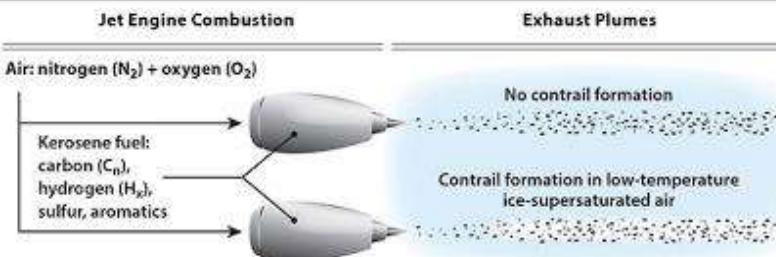
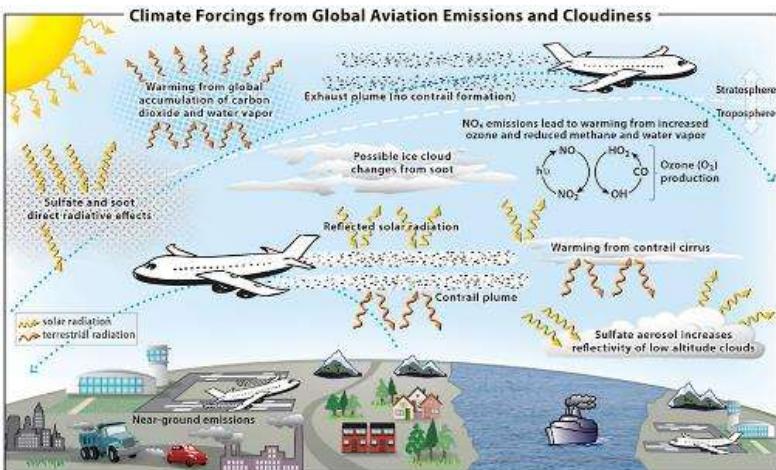
Environmental impacts of aviation

- Geo-spatial distribution
 - More in NH (EU & USA)
 - More @ high altitude
- Impacts of exhaust
 - CO₂ & H₂O: warming
 - NO_x & soot: warming
 - Contrails: warming
 - Sulphate aerosols: cooling
- Air quality index (conc. near surface)
 - Particulate matter
 - Fine particles (PM2.5) < 2.5μ dia
 - From NO_x, SO_x etc. (NH₃ from background)
 - Ozone
 - Toxic for humans & plants (oxidises tissues)
 - NO_x + HC reactions



[European Aviation Environmental Report 2016 -72dpi.pdf \(europa.eu\)](#)

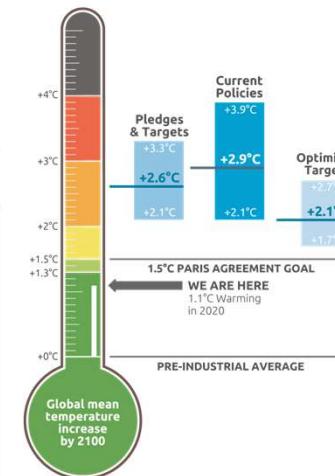
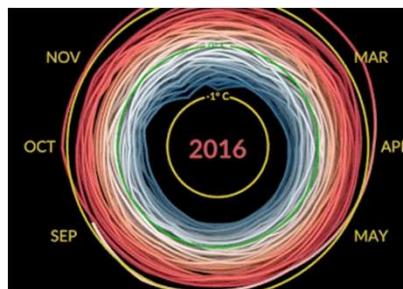
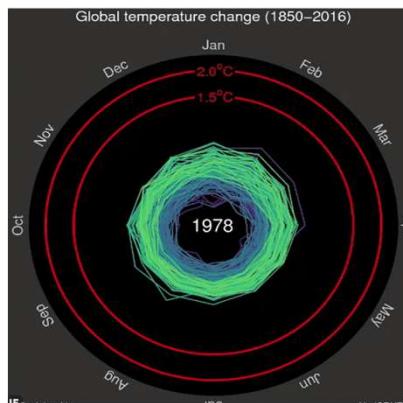
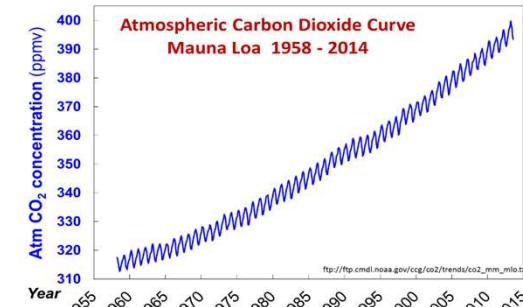
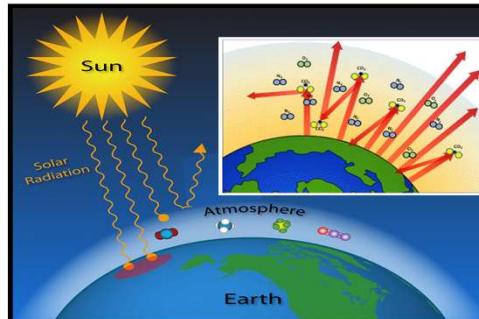
The contrail conundrum



The impacts

- Climate change (greenhouse effect)
 - NO_x, H₂O, CO₂, aerosols from jet exhaust
 - Non-CO₂ effects >CO₂ effects
 - **About 5% from aviation industry**
- Air pollution
 - CO and CO₂ from exhaust
 - Overall carbon footprint
 - Suspended impurities
 - **About 2% in EU from aviation industry**
- Noise pollution
 - Mainly T/O and landing
 - **About 3% (>55dB)** from aviation industry
- Ozone layer depletion
 - High altitude & super/hypersonic flights
- N₂ cycle disruption due to NO_x

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CAT warming projections
Global temperature
increase by 2100
December 2020 Update

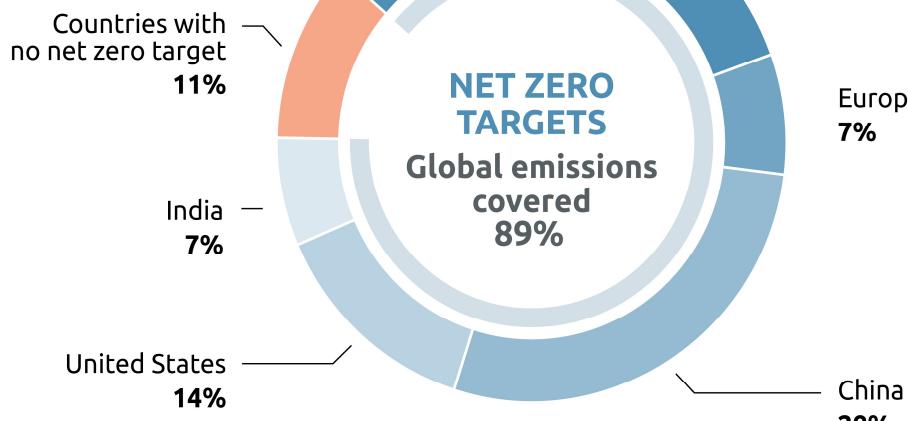
Net-zero climate action tracker

Net zero emissions target announcements

Agreed in law, as part of an initiative, or under discussion



Dec 2023
Update



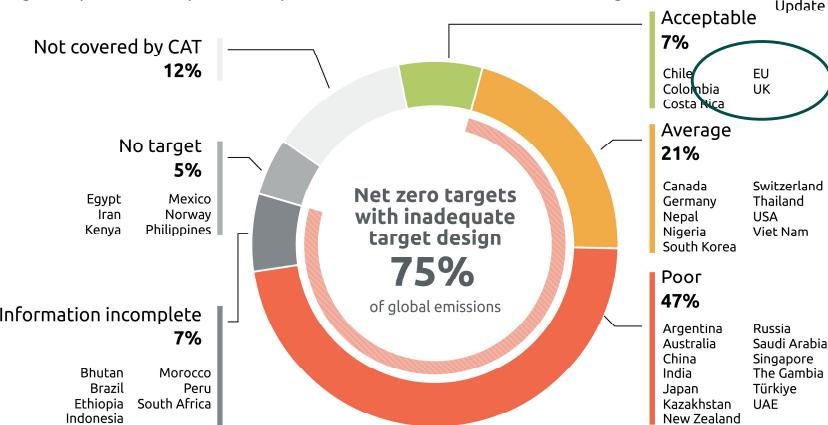
Net zero targets are key for reducing global CO₂ and other greenhouse gas emissions to net-zero around 2050 and 2070 resp. This is necessary to keep to the Paris Agreement's 1.5°C temp. limit.

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Net zero target design - mostly inadequate to date

Quality of net zero targets by percentage of global emissions evaluated using the CAT's design blueprint for transparent, comprehensive and robust national net zero targets

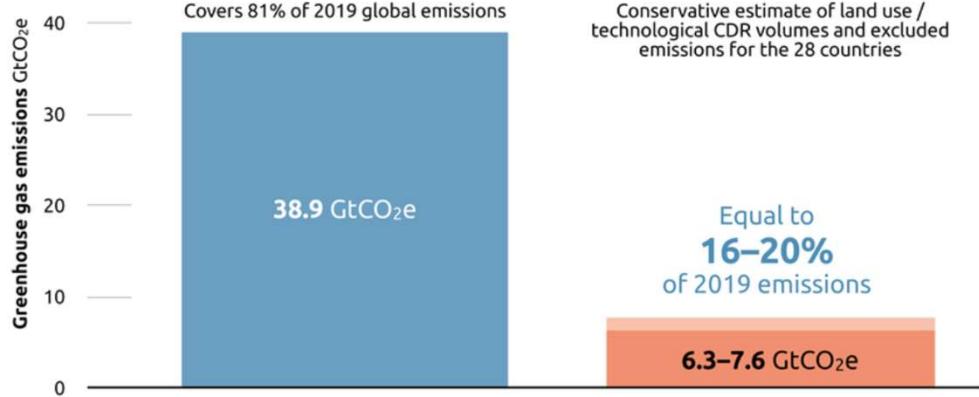
Climate Action Tracker
Dec 2023 Update



Estimating the residual emissions for when countries reach net zero
Governments either don't have complete coverage of all their emissions in their net zero plans and/or are relying on carbon dioxide removal to meet their goals



Total emissions of 28 of the 34 countries with net zero targets
Covers 81% of 2019 global emissions



Jet, set, go...

Rating the comprehensiveness of national net zero target design

Climate Action Tracker Dec 2023 Update

Country Rating

		Net zero target design elements									
		1 Target year	2 Emissions coverage	3 International aviation and shipping	4 Reductions or removals outside of own border	5 Legal status	6 Separate reduction & removal targets	7 Review process	8 Carbon dioxide removal	9 Comprehensive planning	10 Clarity on fairness of target
European Union	ACCEPTABLE	2050	✓	⊖	✓	✓	✗	✓	✓	✓	✗
United Kingdom	ACCEPTABLE	2050	✓	✓	⊖	✓	✗	✓	✓	⊖	⊖
United States	AVERAGE	2050	✓	✗	✗	⊖	✗	⊖	✓	⊖	✗

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- Effects on industry
- Effects on academia

Building blocks for sustainable aviation

Turboprops /
turbofans
trends

Alternate
fuels

Alternate
energy
carriers

Aero-
dynamics

Configs.

Materials

Man-log /
supply
chains

ATC / ATM

Ground
ops.

Improved propulsion
systems

Novel aircraft
designs

Sustainable
structures

Efficient
Operations
Management

Aircraft & systems design

New policies &
regulations etc.

Aviation industry

Thank you

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