

## AVDASI-3: Sustainable Aviation & Ethics

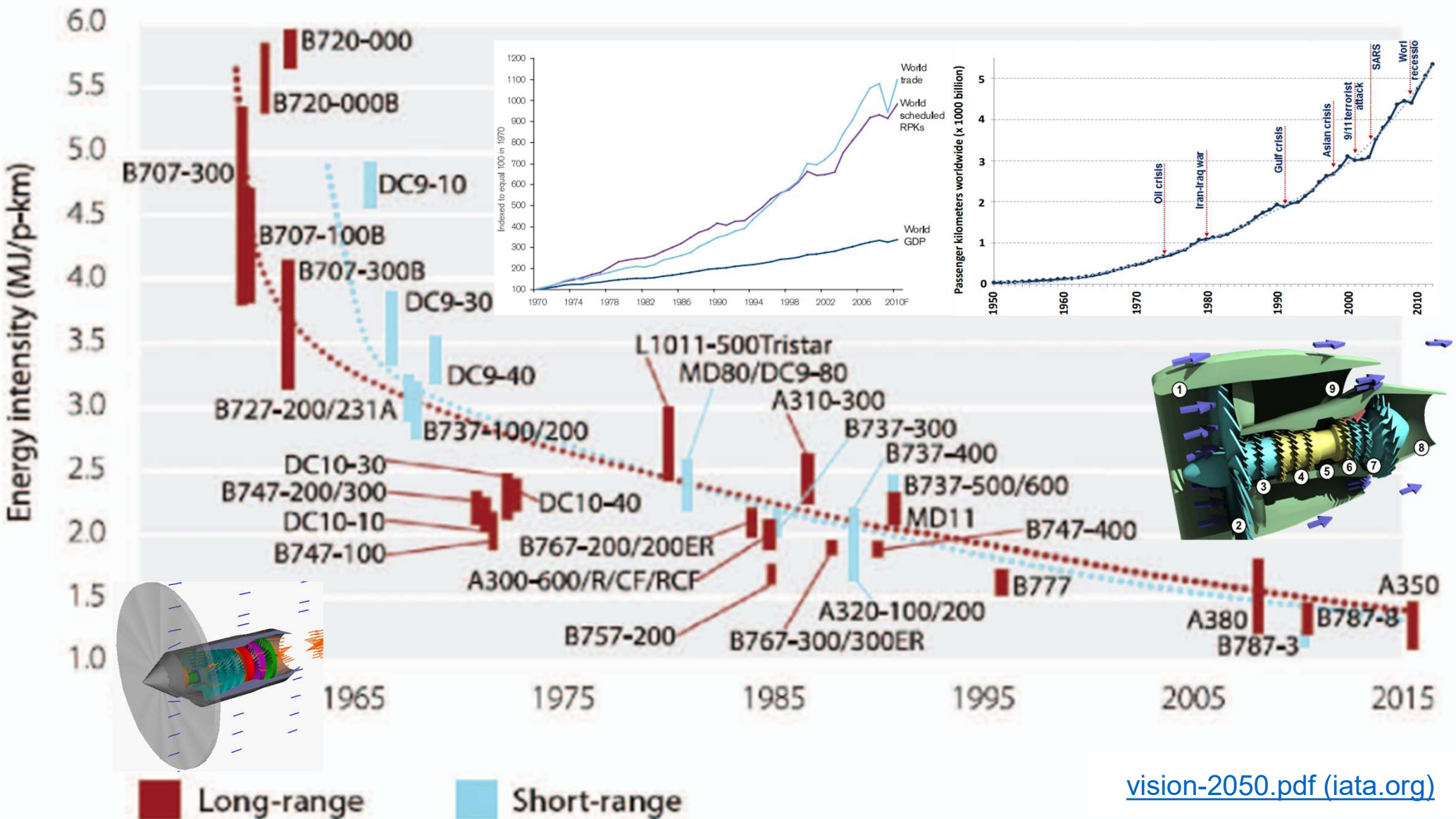
### Lecture-1: Types of environmental impacts & aviation's contributions

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# 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

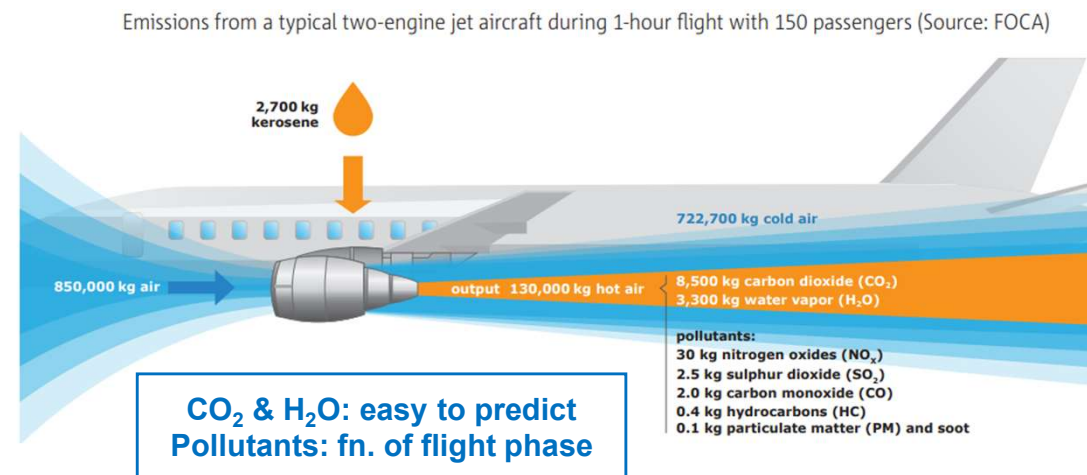
- ~ 2x every 15 years

- Aviation contributes ~ 2.5% of global CO<sub>2</sub> emission (pre-2020)

- Non-CO<sub>2</sub> effects (NO<sub>x</sub>, O<sub>3</sub>, contrails, sound etc.)

# Environmental impacts of aviation

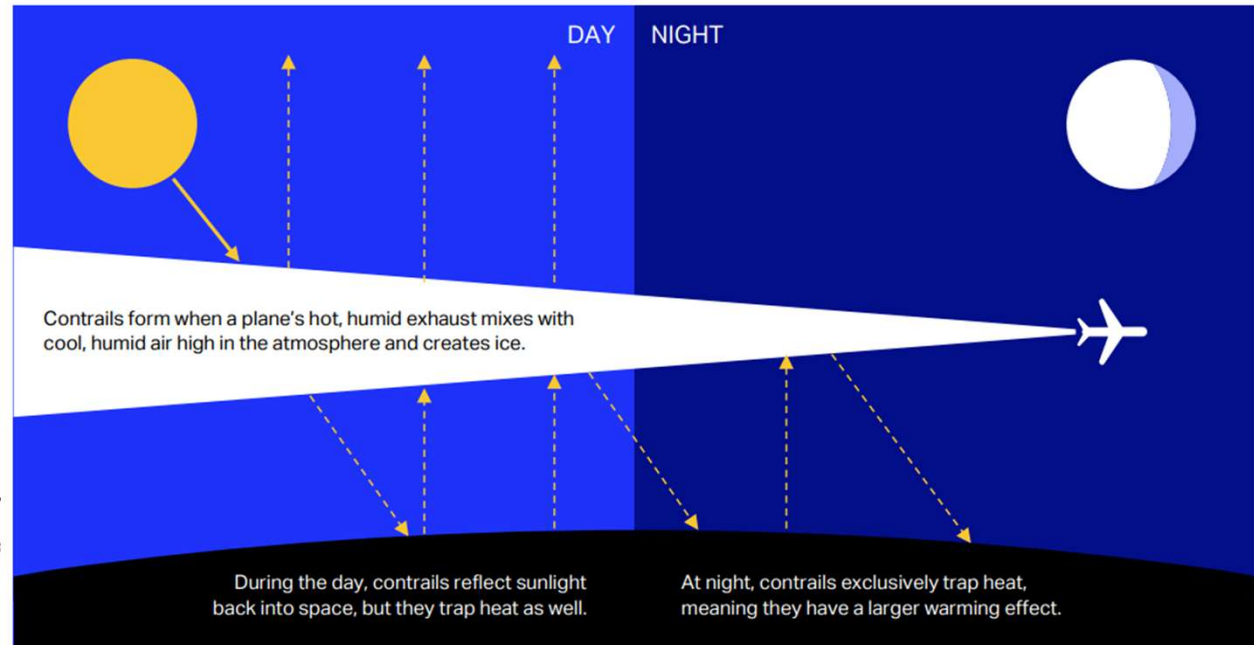
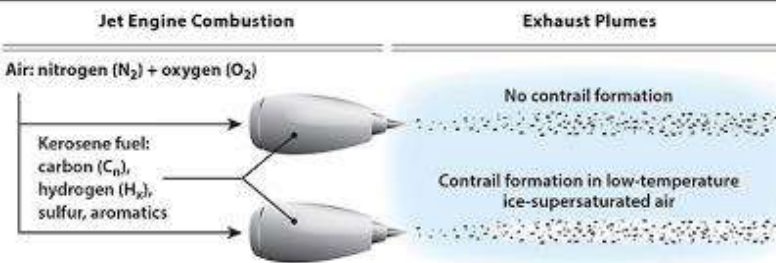
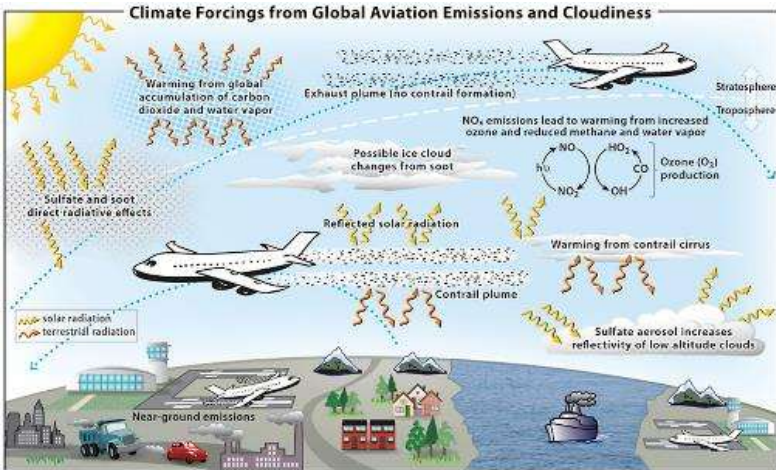
- Geo-spatial distribution
  - More in NH (EU & USA)
  - More @ high altitude
- Impacts of exhaust
  - CO<sub>2</sub> & H<sub>2</sub>O: warming
  - NO<sub>x</sub> & soot: warming
  - Contrails: warming
  - Sulphate aerosols: cooling
- Air quality index (conc. near surface)
  - Particulate matter
    - Fine particles (PM2.5) < 2.5μ dia
    - From NO<sub>x</sub>, SO<sub>x</sub> etc. (NH<sub>3</sub> from background)
  - Ozone
    - Toxic for humans & plants (oxidises tissues)
    - NO<sub>x</sub> + HC reactions



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



# The contrail conundrum



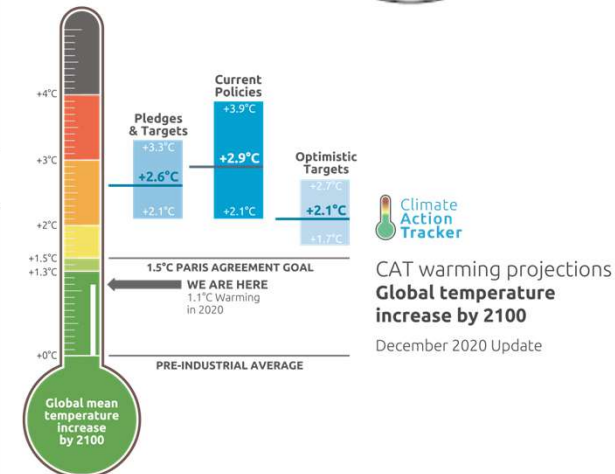
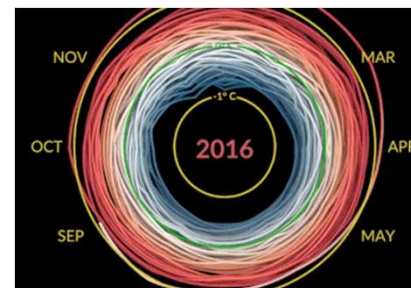
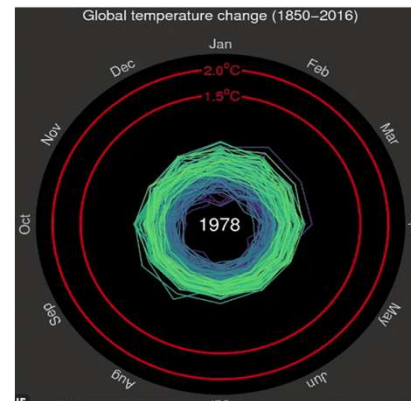
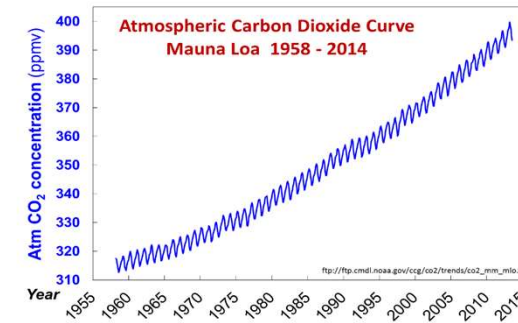
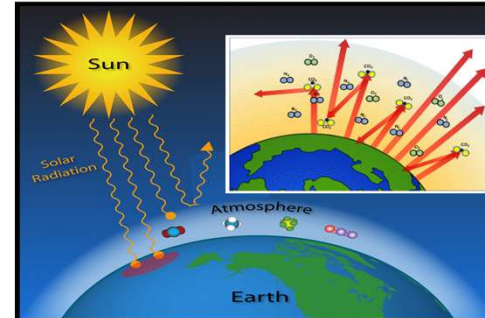
Conditions for reducing CO<sub>2</sub> vis-a-vis NO<sub>x</sub> & contrails are often contradictory

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Lee et. al.: <https://doi.org/10.1016/j.atmosenv.2020.117834>  
**IATA 2024 Report:** Aviation contrails and their climate effect

# The impacts

- **Climate change** (greenhouse effect)
  - $\text{NO}_x$ ,  $\text{H}_2\text{O}$ ,  $\text{CO}_2$ , aerosols from jet exhaust
  - Non- $\text{CO}_2$  effects >  $\text{CO}_2$  effects
  - **About 5%** from aviation industry
- **Air pollution**
  - CO and  $\text{CO}_2$  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
- $\text{N}_2$  cycle disruption due to  $\text{NO}_x$

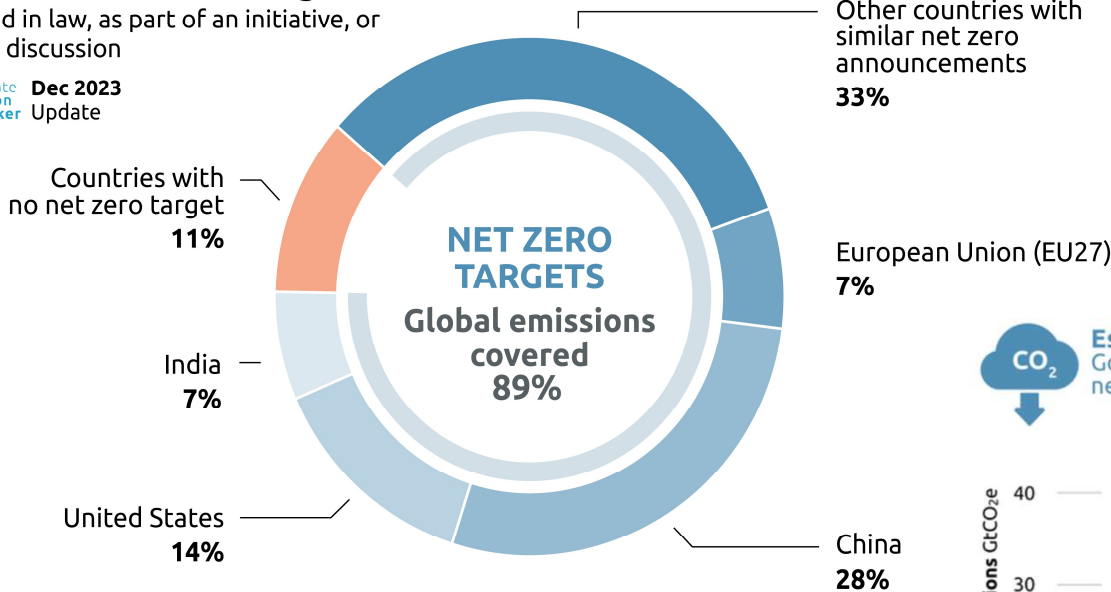


# Net-zero climate action tracker

## Net zero emissions target announcements

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

Climate Action Tracker  
Dec 2023 Update



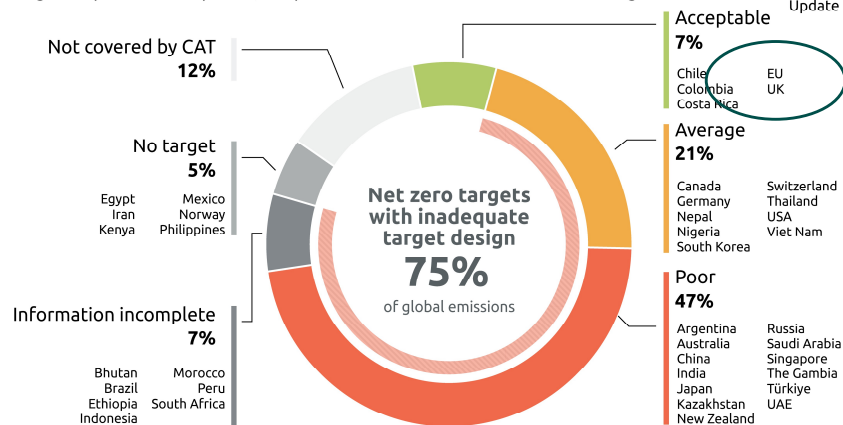
Net zero targets are key for reducing global CO<sub>2</sub> and other greenhouse gas emissions to net-zero around 2050 and 2070 resp. This is necessary to keep to the Paris Agreement's 1.5°C temp. limit.

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## Net zero target design - mostly inadequate to date

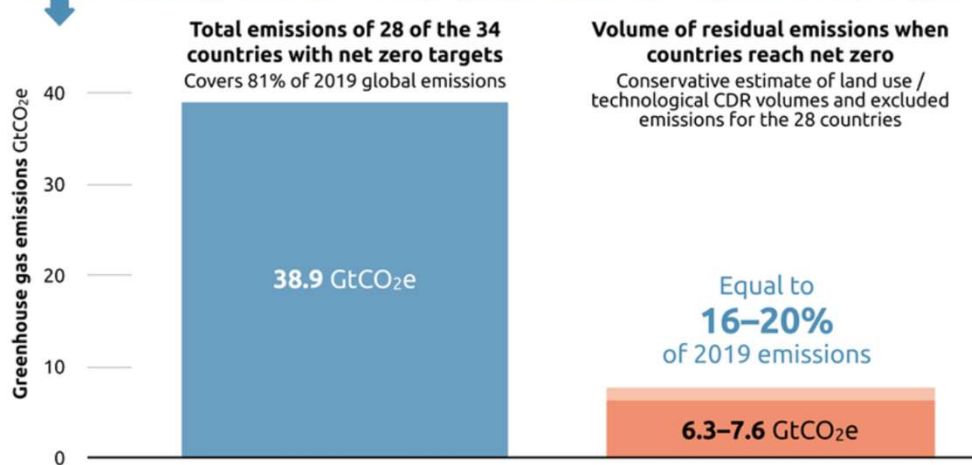
Quality of net zero targets by percentage of global emissions evaluated using the CAT's design blueprint for transparent, comprehensive and robust national net zero targets

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



# Jet, set, go...

## Rating the comprehensiveness of national net zero target design



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





# Thank you

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