

Supporting
European
Aviation



Eurocontrol ENV Briefing

IFATCA ENV working Group

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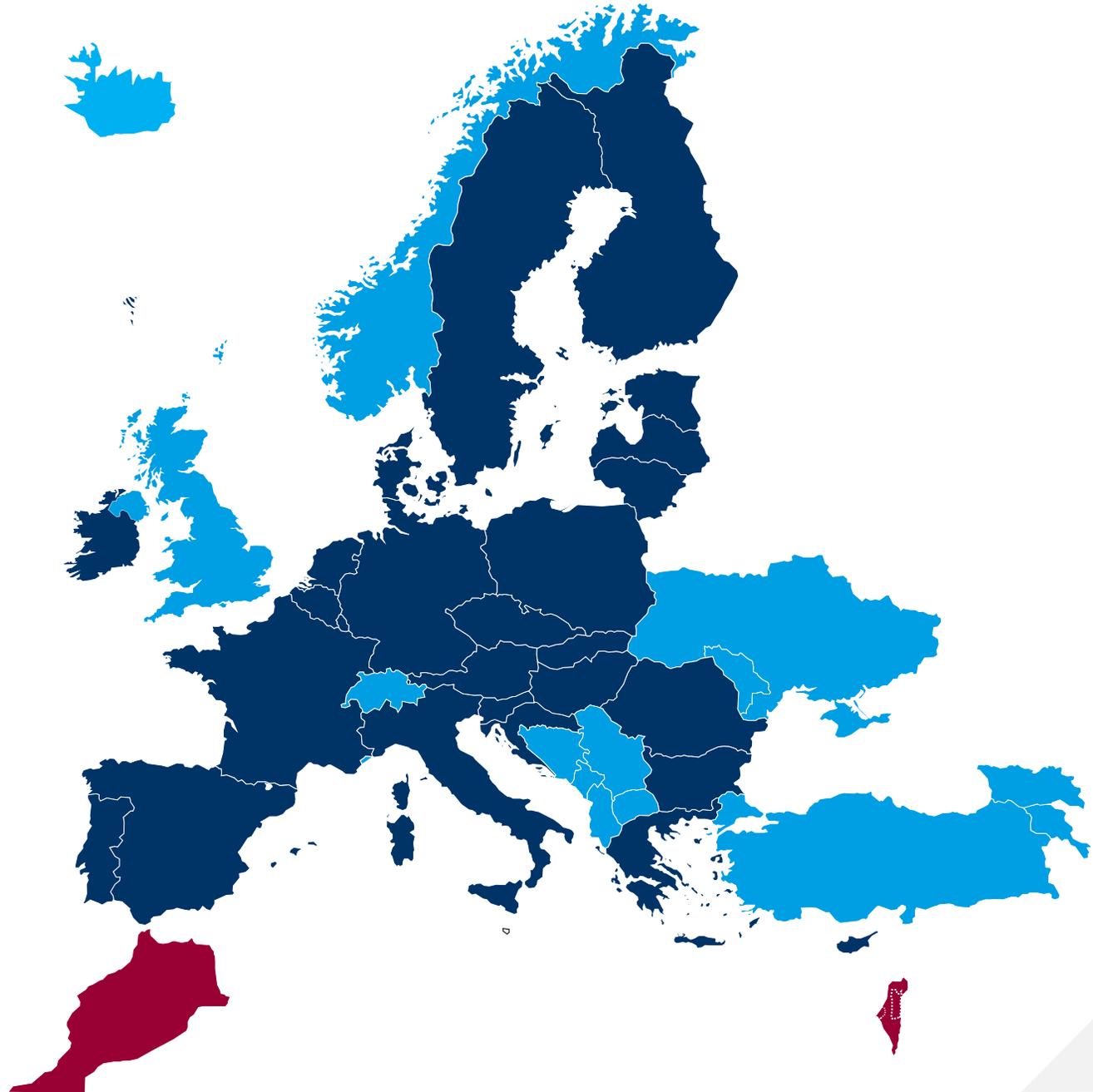
EUROCONTROL MEMBERS

42 Member States
& 2 Comprehensive Agreement States

EUROCONTROL and EU

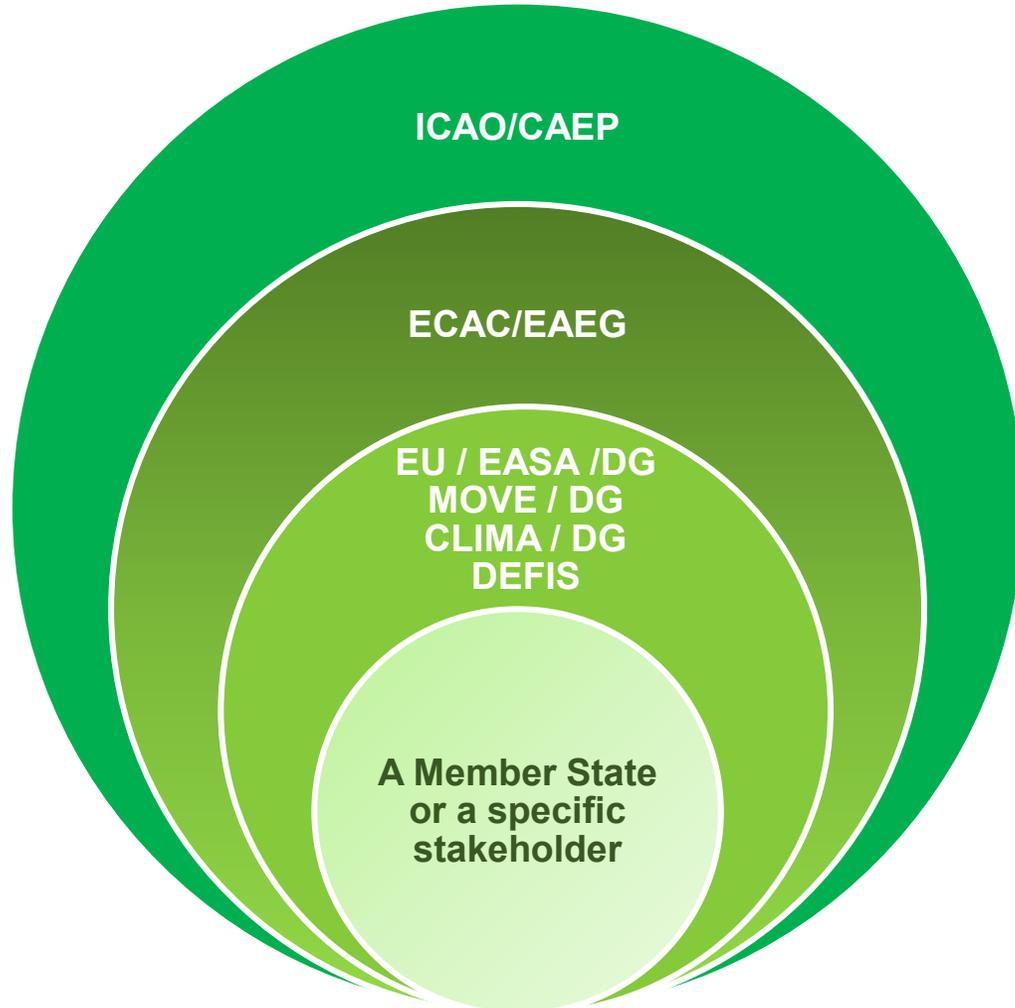
EUROCONTROL but not EU

**Two Comprehensive Agreement
States: Israel & Morocco**



The designations employed and the presentation of the material on maps in this presentation do not imply the expression of any opinion whatsoever on the part of EUROCONTROL concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.

Aviation Sustainability Unit: WHO ARE WE SUPPORTING?



ASU is the technical team providing data, expertise and tools for all stakeholders



Common ENV subjects such as:

- Climate Change Adaptation
- SAF & energy
- ENV performance assessments
- Non-CO₂

But different scope and objectives



Agenda

- **MRV and non-CO₂**

 *Monitoring, Reporting, Verification & climate effects beyond CO₂*

- **ENV Performance Metrics – AVENIR Working Group**

 *Measuring and aligning environmental performance*

- **Climate Change Adaptation – ECCAWG**

 *Building aviation resilience to climate change*

- **ANSP Carbon Footprint, CSRD, EU Taxonomy**

 *Sustainability reporting & regulatory compliance*

- **FlyingGreen Platform**

 *Supporting ATM for taking informed decisions*

- **Discussions**

Monitoring, Reporting, Verification & climate effects beyond CO₂

MRV AND NON-CO₂

Environmental Management Information Service (EMIS)

EUROPEAN ORGANISATION FOR THE SAFETY OF AIR NAVIGATION

EUROCONTROL

Measures of the Permanent Commission

MEASURE No.10/160

authorising the Agency to open negotiations and conclude agreements with one or more Contracting Parties, non-member States and International Organisations for supporting and improving their environmental policy in the field of aviation, including the establishment and the operation of an "ETS Support Facility"



Supporting states in the implementation of ETSS & CORSIA

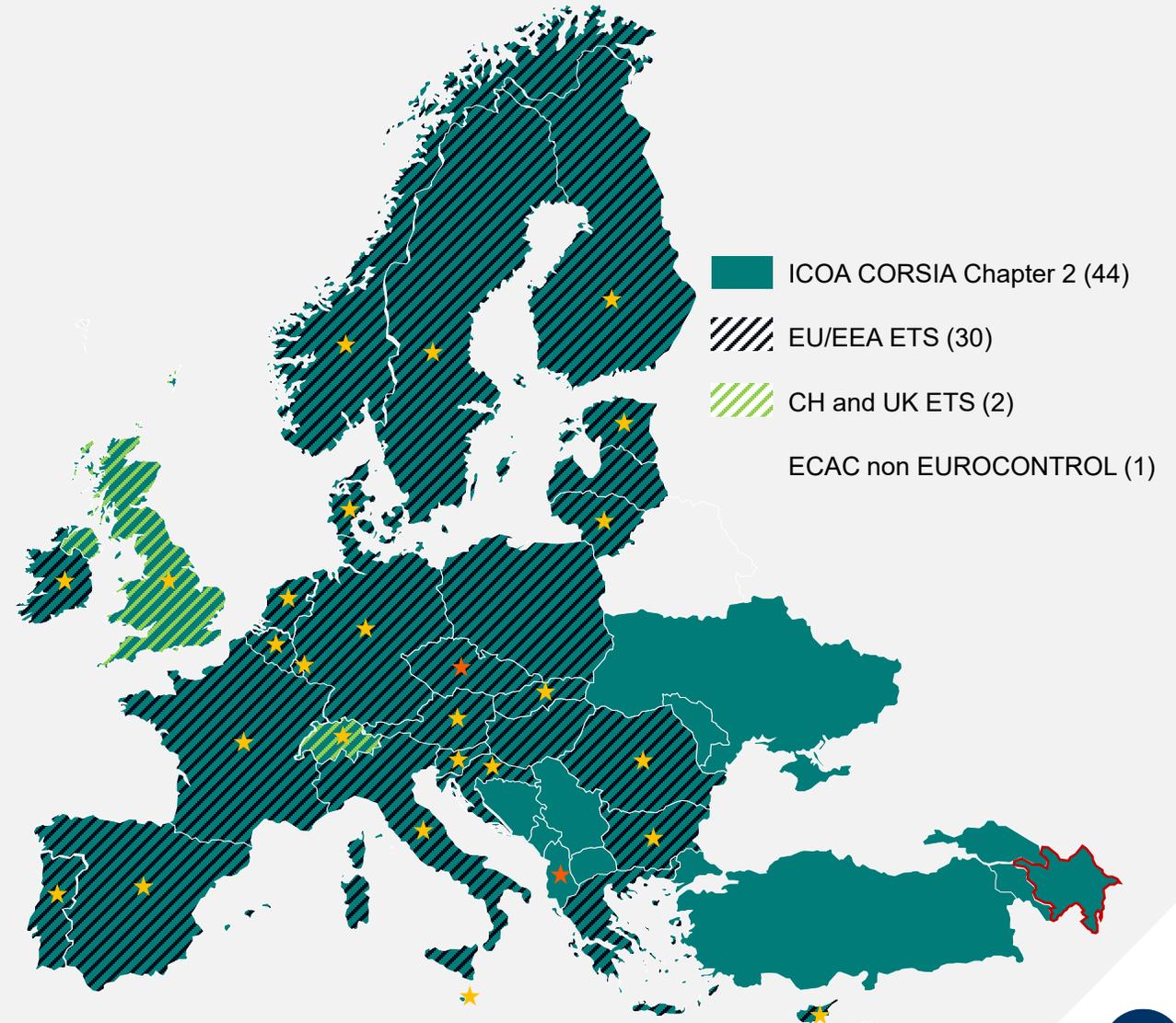
- ★ 28 states use EMIS (UPP)
- ★ 3 states use only the EMIS/CRT (free of charge)

Supporting aircraft operators

> 400 aircraft operators subscribed to the 2024 data (UPP)

Support to DG CLIMA

13th Cooperation agreement 2025 including NEATS (UPP)



EU-ETS extension to cover non-CO₂ aviation effects

2023 amendment of EU ETS Directive part of the 'Fit-for-55' package: added provisions addressing the non-CO₂ aviation effects on climate change:

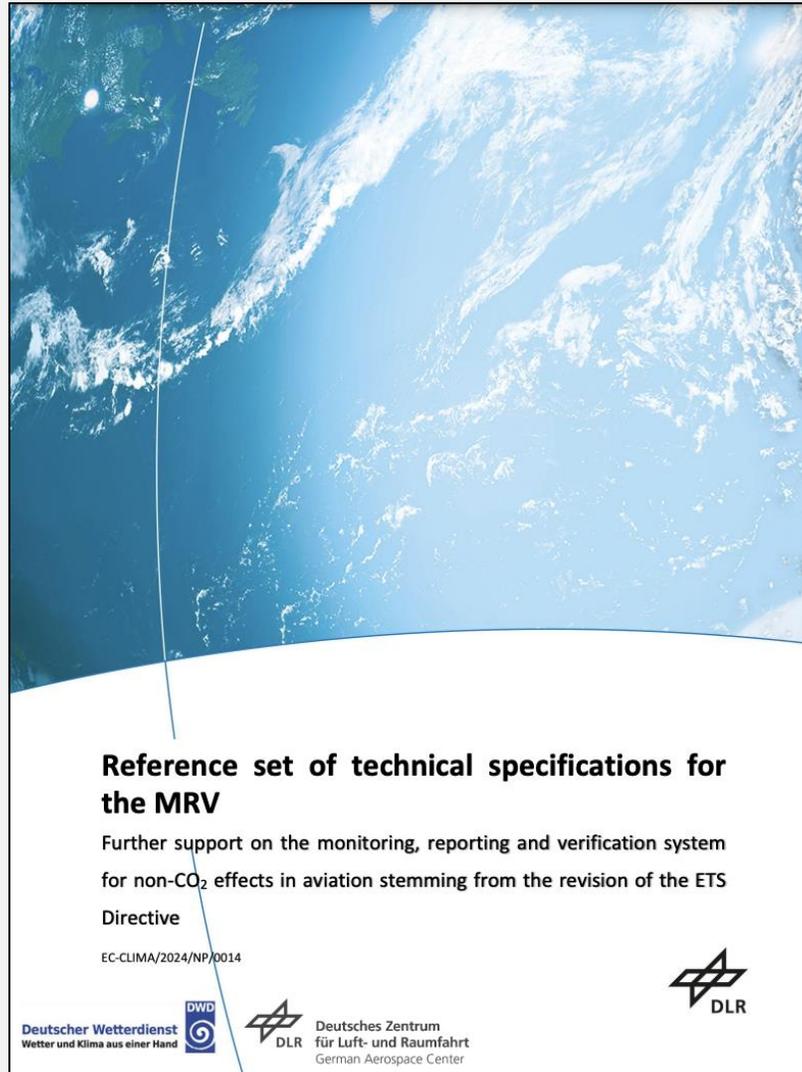
Commencing January 1st, 2025, aircraft operators under the purview of the EU ETS will have the added responsibility of monitoring and reporting their non-CO₂ effects, which encompass soot particles, water vapour, nitrous oxides (NO_x) and oxidised sulphur species. The European Commission is launching a new IT tool called the Non-CO₂ Aviation Effects Tracking System (NEATS) to automatise the monitoring and reporting process.

New Cooperation agreement with DG CLIMA to support the operation of the non-CO₂ monitoring, reporting and verification (MRV) framework, and the development and operation of **NEATS** – an IT tool for non-CO₂ aviation effects tracking system

NEATS to be developed by ASU:

- develop and deliver the complete NEATS free-of-charge for access and for use by the users, capable to calculate **CO₂e per flight for in/out-bound flights to/from EEA** taking place from 1st January 2025 where such are selected by the aircraft operators, on top of intra-EEA flights
- develop NEATS in a way to embed automatically the mandatory coverage by the MRV from 1st January 2027 of in/out-bound flights to/from EEA, on top of the intra-EEA coverage;
- develop NEATS in a way to cover flights covered by the Switzerland (Swiss) ETS, including in/outbound flights to/from Switzerland;

Non-Co2 Monitoring, Reporting and Verifying (MRV) Framework and EUROCONTROL's NEATS Platform



- ❑ **Purpose: Quantify, track the full climate footprint of aviation**—going beyond CO₂. Reported as **CO₂-equivalent (CO₂e)** across 20/50/100-year Global Warming Potentials (GWPs)

- ❑ **Launch & Scope**
 - Effective **January 1, 2025**, initially covering flights between EEA airports—and EEA-Switzerland/UK routes.

- ❑ **Calculation Methods**
 - **Method C (Default):** Weather-based modelling (**CoCiP/aCCF**) with **BADA/BFFM2** performance data.
 - **Method D:** A simplified, climatology-based option for smaller emitters (**AirClim**)

- ❑ **NEATS IT Platform:** The “Non-CO₂ Aviation Effects Tracking System” from EUROCONTROL automates data flows—integrating flight trajectories, meteorology, aircraft/fuel data to generate MRV-ready outputs

Staggered Implementation Timeline for NEATS IT Tool



First Version – Official launch on 30 September 2025

- Secure User Management
 - User focal points
- Upload of flight data and trajectory
 - Syntax checks for uploaded files

Second Release – Q4/2025

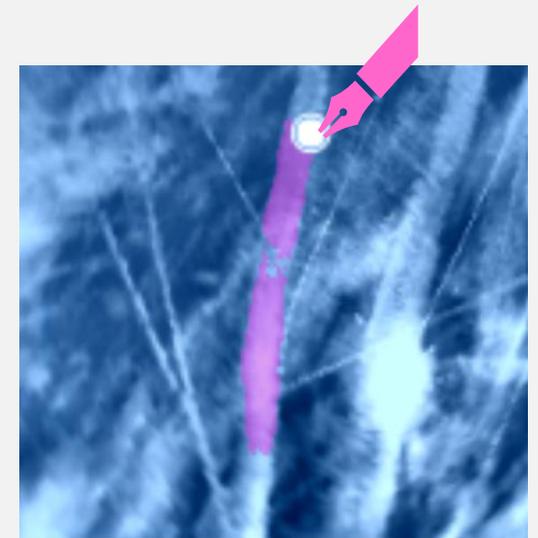
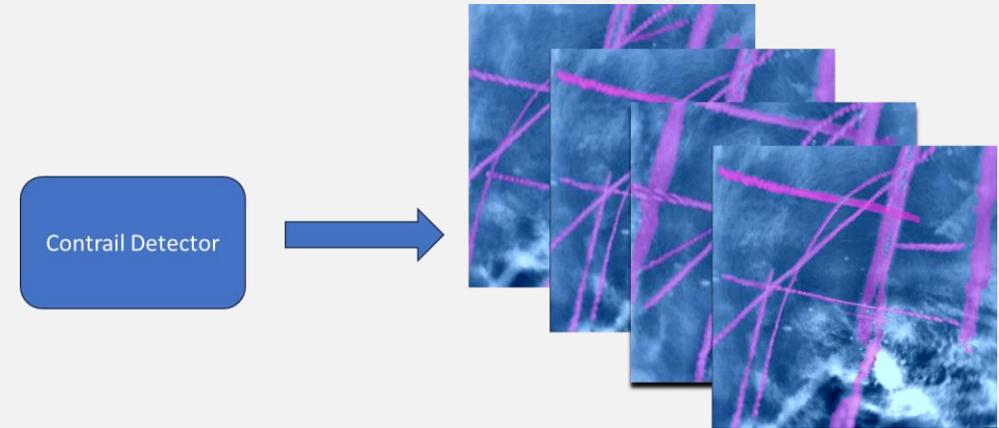
- Computation of non-CO₂ aviation effect values

Third Release – End 2025

- Generation of annual non-CO₂ aviation effects report

AI Central Building Block for Contrail Research: Contrail Detection

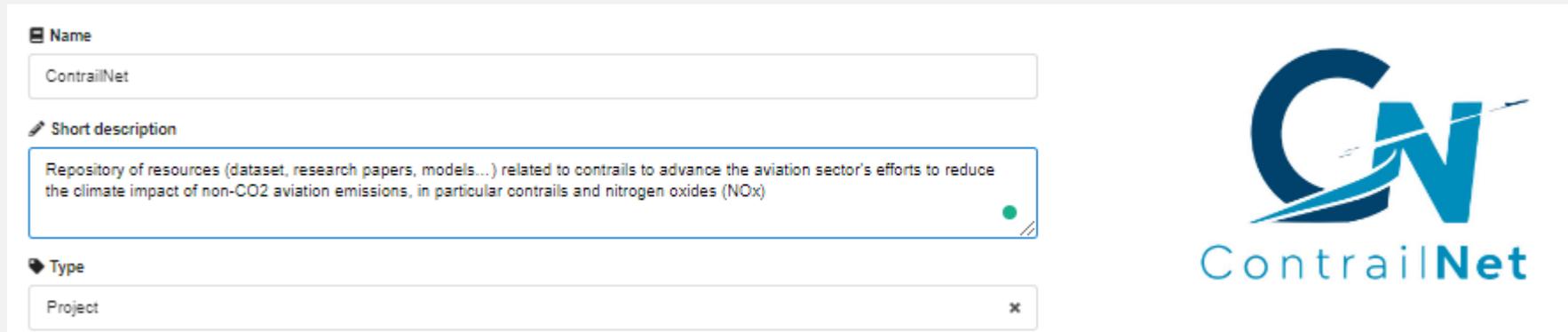
- ❑ Artificial intelligence enables **large-scale pattern recognition** (almost) without expert knowledge:
 - ✓ For contrail science: **contrail detection on remote sensors**
- ❑ To build and validate such AI algorithms, **large datasets** of (usually) **human-labelled patterns** are required.
 - ✓ “Human Labelling Campaigns” are needed for Contrails detection



ContrailNet: Stimulating Contrail Research by Sharing Data

Common portal (Zenodo) for contrail research data to stimulate collaborative contrail research

- **Pillar 1**: Store and/or link to **high quality raw data samples on contrail observations**, validated and **labelled by experts**
- **Pillar 2**: Propose a common/**generic format** and a **storage dataset for all models** used to predict/monitor contrails (AI-based or physical-based).



The image shows a screenshot of a Zenodo repository entry for 'ContrailNet' and the project's logo. The screenshot includes the following fields:

- Name:** ContrailNet
- Short description:** Repository of resources (dataset, research papers, models...) related to contrails to advance the aviation sector's efforts to reduce the climate impact of non-CO2 aviation emissions, in particular contrails and nitrogen oxides (NOx)
- Type:** Project

The logo for ContrailNet features a stylized 'CN' in blue with a white swoosh, and the text 'ContrailNet' below it.

Ongoing Research in SESAR

Further research on non-CO2 impact is currently performed under the SESAR framework

❑ CICONIA

- Develop **reliable weather forecasts** to support sustainable aviation.
- Assess **operational options for flight planning**, through **simulations and trials**.

❑ CONCERTO

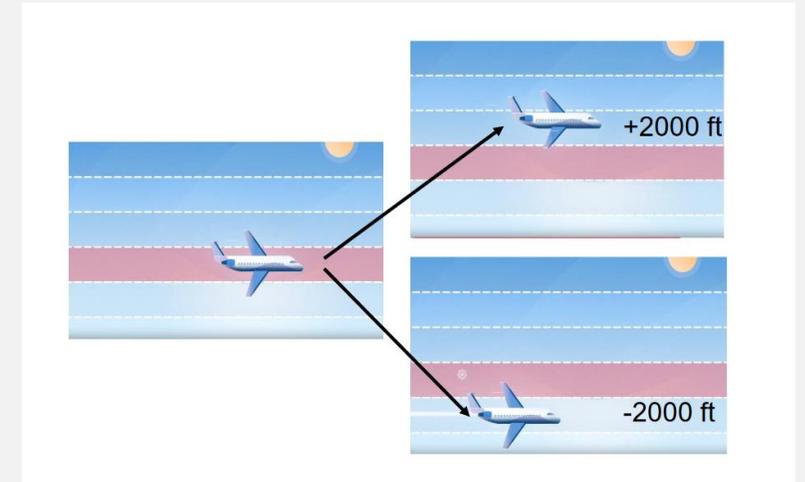
- Reach **TRL6 for processes and tools** enabling more **eco-friendly trajectories** without major changes to legacy systems
- Develop and integrate non-CO2 metrics into **flight planning systems**

❑ E-CONTRAILS

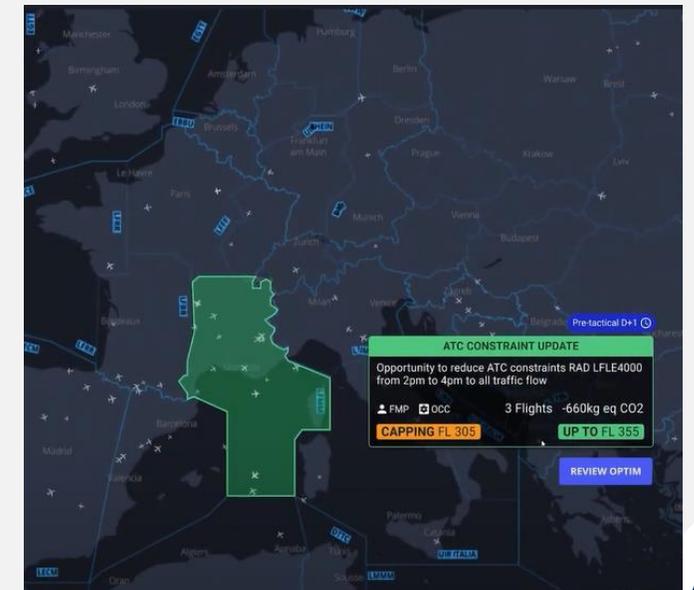
- Leverage **satellite data and artificial intelligence** to improve understanding and prediction of contrail formation.
- Develop remote sensing algorithms for **contrail detection** and quantify radiative forcing using **predictive AI models**.

❑ AEROPLANE

- Contrails/Cirrus clouds **interaction** effects
- Quantify **effects of climate change on aviation operations**



Source: MUAC Contrail Prevention Trial 2021, Lokman, 2022



Source: Thales, 2022

Measuring and aligning environmental performance

ENV PERFORMANCE METRICS AVENIR WORKING GROUP

The Big Picture – Why is it so complex ?

Let's start by the beginning...
what is a green trajectory?

Is it the shortest distance?

Is it the fuel-optimised trajectory?

Is it the climate-optimised trajectory?



Persistent
contrails

SOMETIMES



Aviation
Induced
Cloudiness

SOMETIMES



Warming
effect



<https://airlawgroup.com/aircraft-noise-in-air-law/>



How to prioritise ? Metrics Matter

CO₂

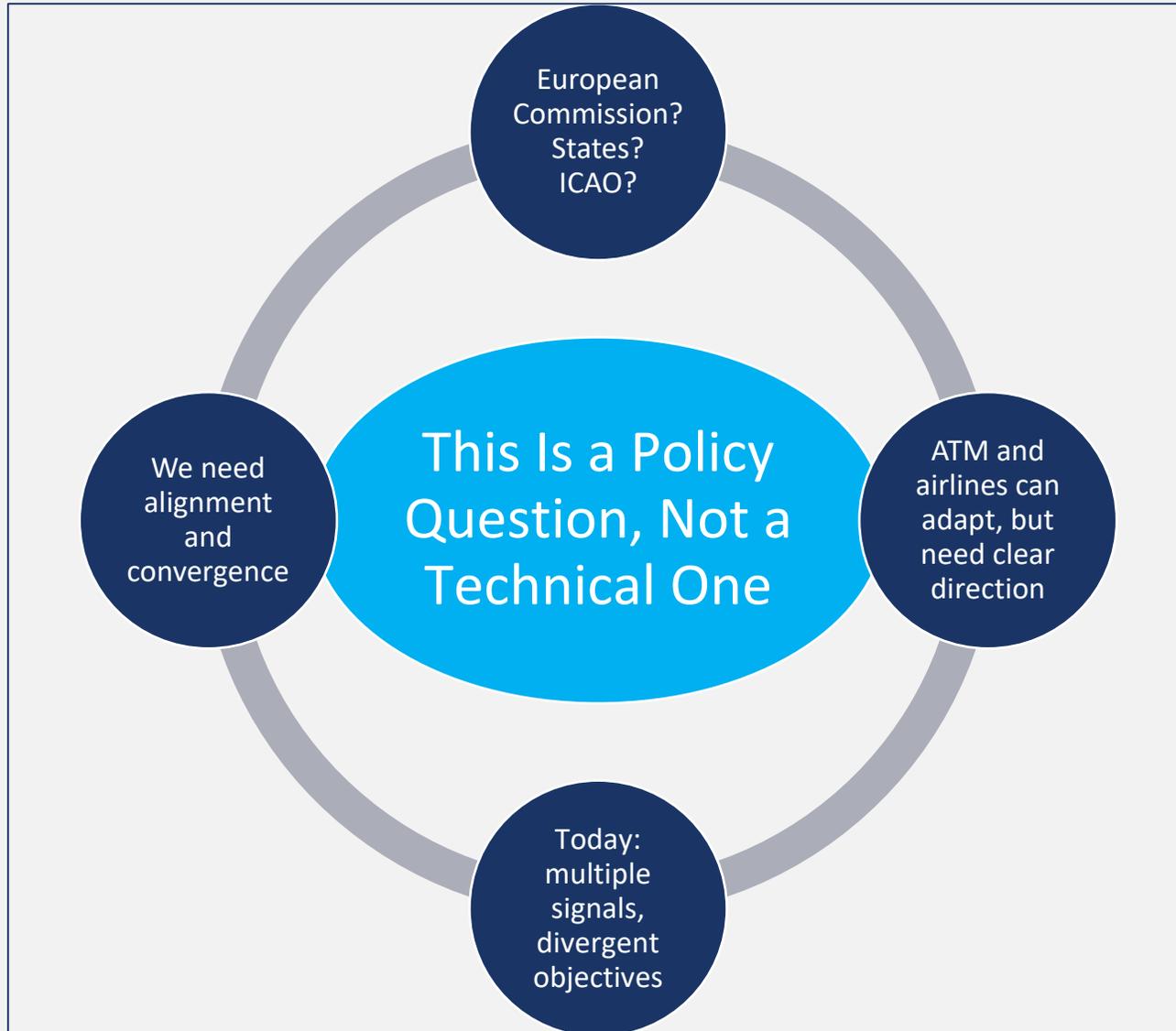


What Should We
Measure and
Prioritise?

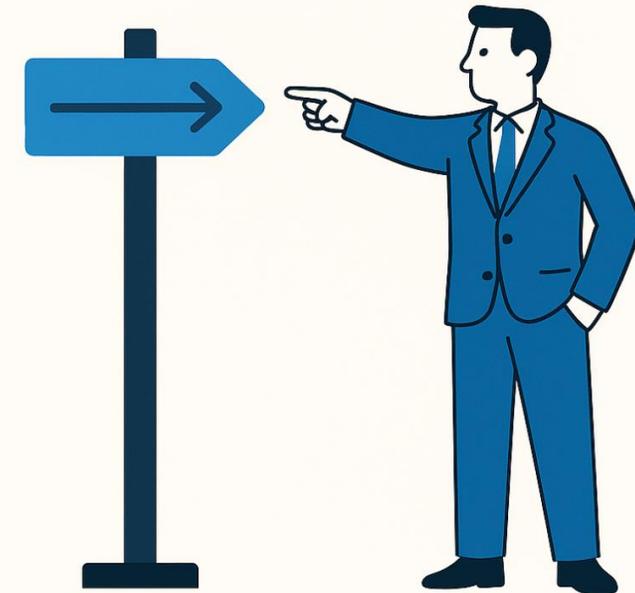


- CO₂? Contrails? Noise? Air quality?
- Metrics must align with policy goals for all stakeholders
- Without prioritisation → risk of contradictory strategies
- Network versus local performance and benefits

Who Should Decide?



WHO SHOULD DECIDE?



AVENIR

- **AVENIR = AViation ENvironmental Reporting**
- Working Group: **technical experts** – European ANSPs, EASA, EUROCONTROL.
- Under EASA-EUROCONTROL Joint Work Programme (JWP)

- Objective: **develop proposals on how ATM/ANS providers can increase environmental transparency and demonstrate efforts to support aviation's climate objectives**

- **By ANSPs, for ANSPs**

- Timeline:
 - OCT 2020 – JAN 2023: ATM/ANS Environmental Transparency Working Group – deliverables
 - APR 2023 – JUN 2025: AVENIR – Mandate 1 – deliverables
 - JUL 2025 – JUN 2028: AVENIR – Mandate 2

ATM/ANS Environmental Performance – Key Takeaways

Why this matters

- Support EU Green Deal, ICAO LTAG & Destination 2050.
- ANSPs need robust, transparent indicators to measure and improve their contribution.

Findings

- No single indicator fully captures ANSP environmental performance.
- Current indicators (KEA, CCO/CDO, ASMA, TXOT, XFB, 3Di) have **gaps**: often proxies (time/distance) not directly CO₂/fuel burn.
- **Gate-to-gate view is missing**; most indicators focus on isolated flight phases.
- Fuel burn / CO₂ indicators should be prioritised, but better airline data access is needed.

Strategic Recommendations

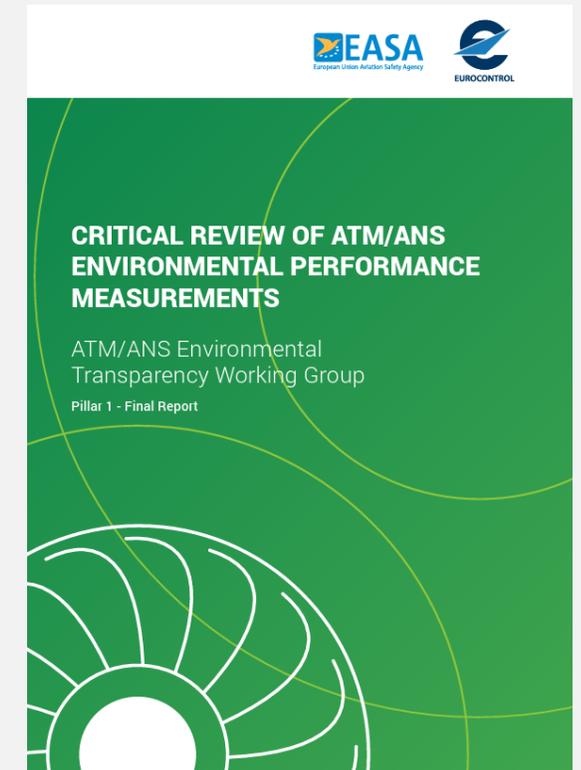
- Use a **set of indicators**, adapted by phase of flight.
- Engage with **airlines & manufacturers** to define fuel-optimal trajectories.
- Align KEA & ASMA indicators for consistency.
- Address **interdependencies**: CO₂, non-CO₂, noise, local air quality, capacity & safety.

Technical Recommendations

- Improve/expand current indicators (KEA local vs network, ASMA, TXOT).
- Incorporate **weather & MET data** (esp. wind).
- Develop/test new concepts (KEO fuel burn, Acropole ML-based indicators).
- Further develop EUROCONTROL TMA indicators & Excess Fuel Burn (XFB).

Bottom line

ANSPs must adopt a **portfolio of robust, CO₂-linked indicators** and collaborate across stakeholders to improve transparency, disclosure & environmental performance.



<https://www.eurocontrol.int/sites/default/files/2023-01/eurocontrol-atm-ans-env-performance-measurements.pdf>

AVENIR WG – Key Deliverables (2023–2025)



Pillar 1 – Indicators (Transparency)

Developed new & refined environmental indicators
Foundation for ANSP accountability in CO₂ performance.



Pillar 2 – Tools & Best Practice

Catalogue of 30+ tools & dashboards, endorsed by ANSPs.
Framework for measuring impacts of technologies & procedures;
repository for best practices.



Pillar 3 – Non-CO₂

Contrail mitigation explored as major short-term climate lever.
Synthesised results of MUAC/BeCoM/SESAR trials.
Recommendations for ANSP role, capacity impacts, and future regulation.



→ Together, the three pillars provide the first integrated framework for ANSPs to measure, report, and enhance environmental performance.



AVENIR WG – Pillar 1: Advancing ATM Environmental Transparency

Objectives

- Develop/refine **environmental indicators** to measure ANSP contributions to flight efficiency & CO₂ reduction.
- Establish **methods** to assess inefficiencies across flight phases.
- Update/reassess existing indicators using common evaluation criteria.

Key Outcomes

1. New Indicators

1. **Horizontal Time Trajectories Indicator** → time-based proxy for fuel burn/CO₂, six reference trajectories.
2. **Vertical Flight Levels Indicator** → time spent at suboptimal levels during cruise.

2. New Methods

1. **HFE En-route Assessment** → compares filed vs optimal cruise distances by city pair.
2. **CDO/CCO Assessment** → refined non-binary climb/descent indicators with CO₂ linkage.

3. Update of Existing Indicators

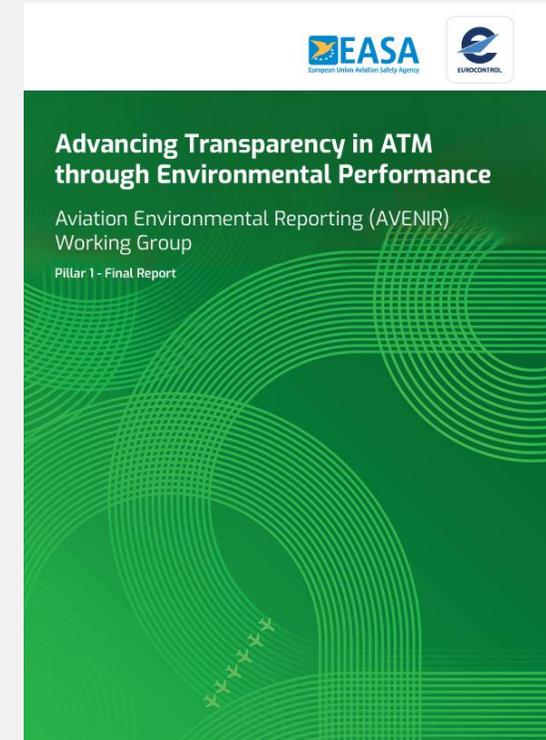
1. Progress on **ASMA, TXOT/TXIT, 3Di, KEO, TMA indicators, Acropole**.
2. Emphasis on **fuel burn & CO₂-linked metrics** aligned with EU Green Deal & ICAO LTAG.

Strategic Recommendations

- Use a **portfolio of indicators** – no single “perfect” metric exists.
- Involve **airspace users & manufacturers** to define optimal trajectories.
- Address **interdependencies**: CO₂, non-CO₂, noise, air quality, capacity & safety.
- Expand framework to include **non-CO₂ impacts** (contrails, NO_x, CIF).
- Enhance **accountability allocation** across ANSPs, AUs, Network.

Bottom line

AVENIR Pillar 1 advances a **transparent, multi-indicator framework** for ATM environmental performance, prioritising **CO₂-linked metrics**, while paving the way for **non-CO₂ integration** and stronger stakeholder engagement.



<https://www.eurocontrol.int/sites/default/files/2025-09/avenir-wg-pillar-1-final-report.pdf>

AVENIR WG – Pillar 2: Tools, Dashboards & Best Practices

Purpose

- Help ANSPs enhancing environmental performance through technological and procedural improvements
- Provide a **Catalogue of Tools & Dashboards** with concrete use cases.

Key Findings

- No “one-size-fits-all” tool → ANSPs rely on **different tools/dashboards for different flight phases**.
- Tools often depend on **proxies**, not real fuel burn data.
- **Dashboards are essential** for monitoring CO₂, noise, fuel burn, and supporting decision-making.
- Interdependencies (CO₂ vs noise vs capacity) must be continuously managed, especially near airports.

Catalogue Outcomes

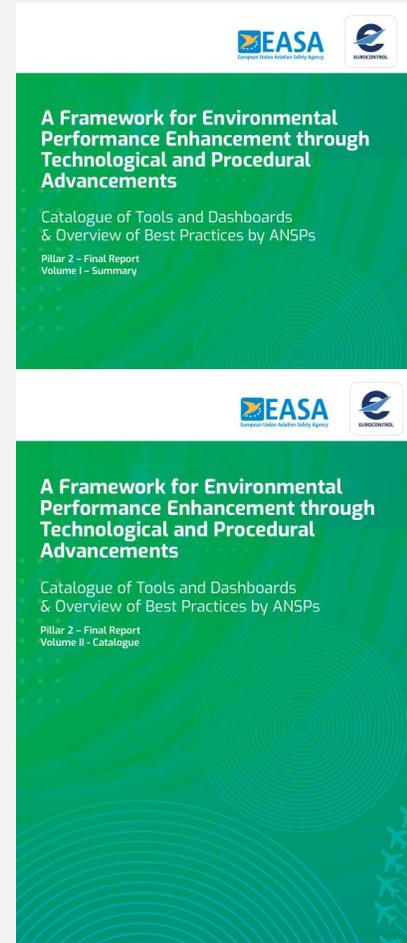
- Mapping of tools, dashboards & use cases across **criteria, flight phases, and indicators**.
- Endorsed by ANSPs as a first step towards **greater transparency & knowledge sharing**.

Recommendations

- Maintain the Catalogue as a **living repository** (annual updates).
- Foster **knowledge-sharing** & ANSP–developer feedback loops.
- Ensure dashboards systematically support **environmental transparency** with clear KPIs.
- Develop **guidance on interdependencies** (noise vs emissions trade-offs).
- Embrace **AI/ML and new data sources** to improve accuracy (fuel burn estimation, non-CO₂ impacts).

Bottom line

 AVENIR Pillar 2 provides ANSPs with a **practical toolkit** to monitor, benchmark, and improve environmental performance, reinforcing transparency and collaboration across ATM.



<https://www.eurocontrol.int/sites/default/files/2025-09/avenir-wg-pillar-2-final-report-volume-2-catalogue.pdf>

AVENIR WG – Pillar 3: ANSPs & Non-CO₂ Impacts

Purpose

- Assess ANSP role in mitigating **aviation's non-CO₂ climate effects**, focusing on **contrails**.

Key Insights

- **Contrails** (esp. persistent/night-time) = major short-term climate impact, potentially > CO₂.
- Mitigation feasible via **flight level/route adjustments**, but risks trade-offs in CO₂, safety & capacity.
- **Prediction & verification** of ISSRs remains uncertain (MET, AI, satellite, cameras).
- Trials (MUAC COAV, BeCoM, D-KULT, 100 Flights, SESAR projects) show promise but highlight workload & capacity impacts.

Challenges for ANSPs

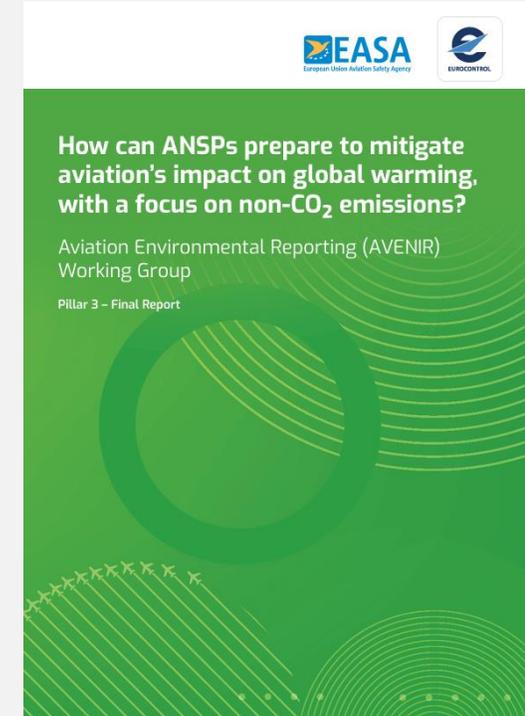
- **Capacity & workload** constraints if flight levels blocked in busy airspace.
- Need new **tools, training & cross-border coordination**.
- **Economic/operational trade-offs** (fuel burn vs. contrail reduction) still unresolved.

Recommendations

- ANSPs should **monitor research & join trials** (SESAR, BeCoM, ContrailNet, etc.).
- Develop **decision-support tools** for ISSR prediction & capacity planning.
- Prepare for **future obligations** (CO₂ + non-CO₂ climate performance in CSRD/EU Taxonomy).
- Strengthen **collaboration with airlines, scientists, and regulators**.

Bottom line

🌍 Contrail mitigation is an **emerging but essential role** for ANSPs. Early engagement, tools, and cross-stakeholder cooperation are key to integrating **non-CO₂ climate impacts** into ATM.



<https://www.eurocontrol.int/sites/default/files/2025-09/avenir-wg-pillar-3-final-report.pdf>

AVENIR 2 – Extending the Scope (2025–2028)



Pillar 1 – Indicators

Develop & update CO₂ indicators.
Operationalise reference trajectories.



Pillar 2 – Tools & Procedures

Maintain & update catalogue
Support deployment
Promote best practice exchange.



Pillar 3 – Non-CO₂ Impacts

Link with ANCEN.
Consolidate research.
Consolidate contrail & other non-CO₂ mitigation strategies.



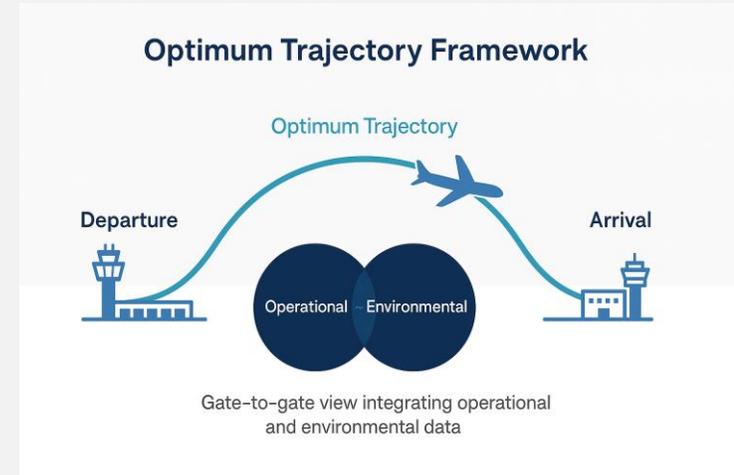
Pillar 4 – Climate Impact Indicator (new)

Explore options for a single indicator combining CO₂ & non-CO₂ effects to measure overall climate impact.

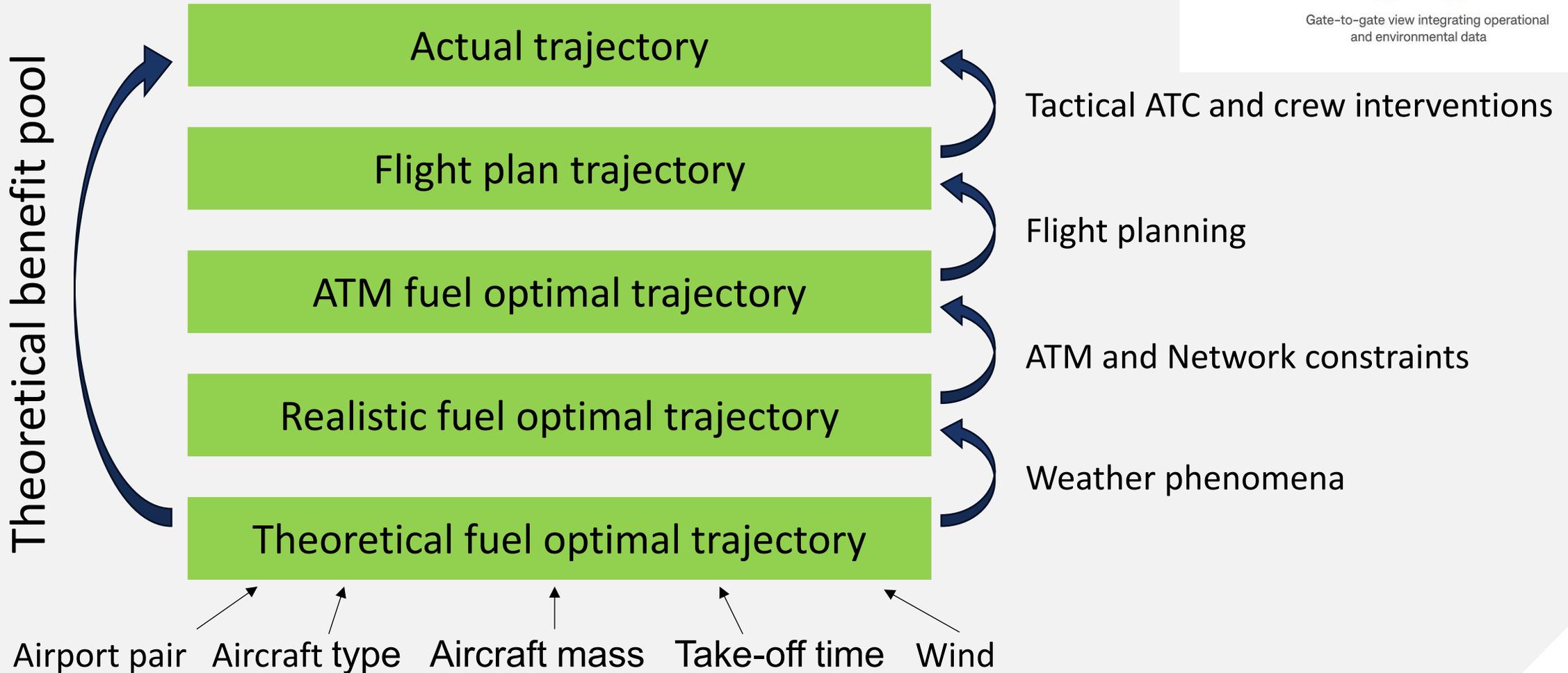


→ AVENIR 2 will deliver a harmonised set of indicators, tools, and methodologies to support ANSPs in transparent reporting and climate-optimised operations.

Gate-to-Gate (G2G) – Optimal Trajectories



Optimum Reference trajectories



Gate-to-Gate (G2G) fuel burn & emissions metric



Optimal Trajectory Task Force

- AVENIR Working Group
- Airlines and CFSPs
- Supported by A4E
- Data sharing and validation



FINNAIR

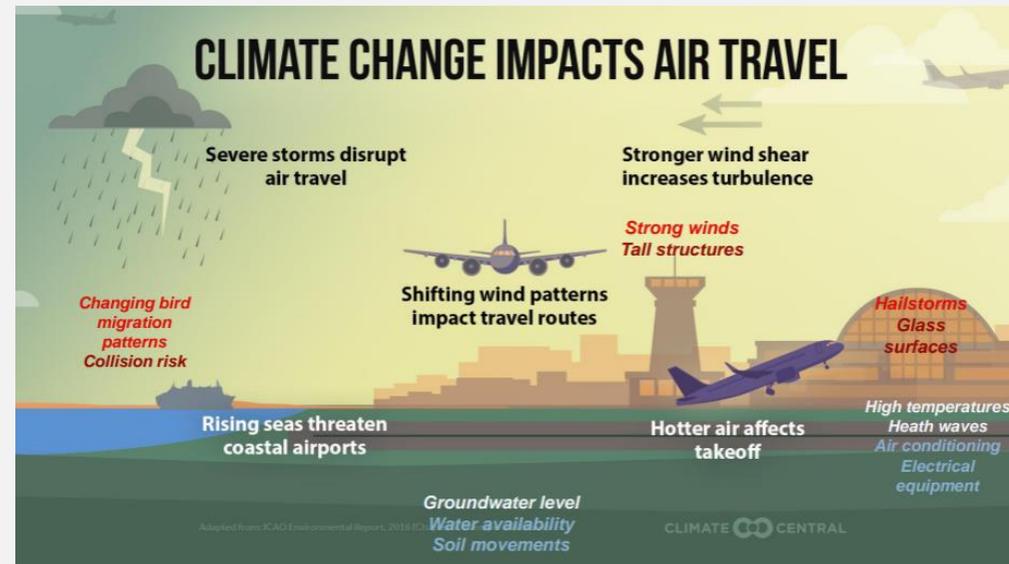
AIRFRANCE

vueling

Building aviation resilience to climate change

CLIMATE CHANGE ADAPTATION

Climate Change Adaptation and Resilience



Impacts of:

- changes in storm patterns & intensity on flight operations
- sea level rise on European airport capacity
- climate change on tourism demand
- changes in wind patterns on flight operation

Climate Change Risks for European Aviation Summary of the key findings		EUROCONTROL
Short-term weather outlook	There are clear links between high impact weather events and disruption to the European aviation network.	While weather events will continue to cause ATM delays across the European aviation network, climate change is not expected to drive significant changes in the occurrence of weather patterns associated with high impact weather events in the next five years.
	Weather significant days impacting en-route traffic occur mainly during summer.	Weather significant days impacting arrival traffic occur mainly during winter.
Storms & flight operations	On average, storms are responsible for up to 7.5% of total en-route ATM delays at network level, and the trend is increasing.	Extreme rainfall days and associated convective activity (i.e. storms) are projected to increase across northern Europe and to decrease across southern Europe by 2050.
	In 2019, over 1 million km were flown as a result of avoiding a major storm. This corresponds to over 6,000 of extra fuel consumed, or over 19,000t of CO ₂ produced.	The impact of storms on Vertical Flight Efficiency varies geographically. Generally, the impact is greater during climb than descent.
	A small number of localised storms cause substantial increases in Horizontal Flight Inefficiency. Historical performance on days where storms accounted for at least 50% of en-route ATM delays was 3.5%, but in general it rarely exceeds to more than 4%.	The total storm-induced costs in the ECAC area, calculated on days of major storms (across the countries that incurred weather-related en-route ATM delays) was 22 billion EUR in 2019.
	Horizontal Flight Inefficiency could potentially rise from 3.5% today on days when major storms occur, to 4.0%-4.2% in 2050. An increase of 0.5% corresponds to the emission of an additional 5,700t of CO ₂ per year.	The average en-route ATM delay for a flight delayed by a major storm is currently around 17-18 minutes. This is forecast to increase to 21-22 minutes per flight by 2050. The additional distance flown per flight would also increase, from 8.6km to 10.0-10.6km.
Sea level rise & airport operations	Storm surges will still represent the main driver of marine inundation along most European coasts in the 21st century.	Two thirds of coastal and low-lying airports are forecast to be at risk of some level of runway flooding by 2050 under both lower intermediate and worst case emissions scenarios. Countries around the North Sea are forecast to be particularly affected.
	The number of airports at risk from severe/full flooding will increase by 15% by 2050, under the lower intermediate emissions scenario and by 21% by 2050 under the worst case scenario.	A one-day closure of an airport due to full or partial severe flooding could potentially impact 1% (medium airports) and 2-3% (large airports) of all air traffic movements per day in the ECAC area.
	A total of 91% of the airports identified to be at risk of flooding in the future are small airports. These airports play a key role in transportation for local communities or have an important role for the military, tourism or the General Aviation community.	Unplanned loss of airport capacity due to sea level rise can pose a significant threat to the efficiency and delay performance of the entire European Air Traffic Management system.
Tourism	The increase in Tourism Climatic Index in the summer months in the North-West ECAC area suggests this destination will become increasingly attractive for general tourism by 2050.	The decrease in Tourism Climatic Index in the summer months in the South-East and South-West ECAC areas by 2050 is not significant enough to imply a decrease in the attractiveness of these destinations for general tourism.
	The proportion of summer tourists that are flexible to travel in the months shouldering the summer season ('shoulder months') is set to increase by 2050 – there could be 50% more passengers, aged 65 and older.	Longer periods of optimal index values in the 'shoulder months', coupled with the rising level of tourist flexibility regarding travel dates, indicate potential for a widening summer traffic peak by 2050.
Upper winds & flight operations	Flight durations are likely to decrease in both directions during summer and winter on transatlantic flights, as well as between Europe and Asia, except in winter from Asia to Europe where there is unlikely to be any change.	The overall impact of changing wind patterns on flight duration is expected to be small when considering the impact on a single flight.
	Flight durations are likely to decrease in both directions during summer and winter between North Europe and the Caucasus, except in winter when flight durations from North Europe to the Caucasus could increase.	The reduction in flight times as a result of projected changes in high-altitude winds is likely to bring annual savings of more than 32,000t of aviation fuel and almost 175,000t of CO ₂ on the traffic flows analysed.

<https://www.eurocontrol.int/publication/eurocontrol-study-climate-change-risks-european-aviation>



EUROCONTROL & ACI EUROPE Initiatives

- **2014** – EUROCONTROL and ACI EUROPE publish **first factsheet** to help air transport adapt to a changing climate
- **2021** – EUROCONTROL and ACI EUROPE launch the **European Aviation Climate Change Adaptation Working Group** composed of a team of experts from Airport Operators, Air Navigation Service Providers, Aircraft Operators, European aviation industry associations, aircraft manufacturers
- **2023** – Publication of Summer and Winter weather guidance for adverse weather



Climate Effects in Europe

CHANGES IN
AVERAGE AND
EXTREME
TEMPERATURES



CHANGES IN
FREQUENCY AND
INTENSITY
OF STORMS



CHANGES IN
PRECIPITATION



CHANGES IN
WIND



CHANGES IN
ICING



SEA LEVEL RISE



DESERTIFICATION



CHANGES IN
BIODIVERSITY



Key Impacts on Airport Operations

- **Increased cooling demand** in terminals and aircraft
- **Damage to infrastructure**
- Increased **flooding risk**
- Increased **traffic disruption**
- Temporary or permanent **loss of airport capacity**
- **Heat stress** for passenger and personnel

**Any disruption in one location can have an impact
across the whole network**

EACCA-WG Briefing on Adapting Aviation to a Changing Climate

1

Compliance check: identify any relevant national legislation and reporting requirements (e.g national reporting requirements, TCFD, CSRD).

3

Select a risk assessment methodology: choose between the organisation's existing risk assessment framework or an external climate risk assessment methodology.

5

Assess risks and vulnerabilities : apply the selected risk assessment methodology to identify potential impacts, thier likelihood and consequences. Focus on critical safety and operational risks.

7

Review and update the assessment and plan: periodically assess, allowing for flexibility as the extent and timing of impacts evolves.

2

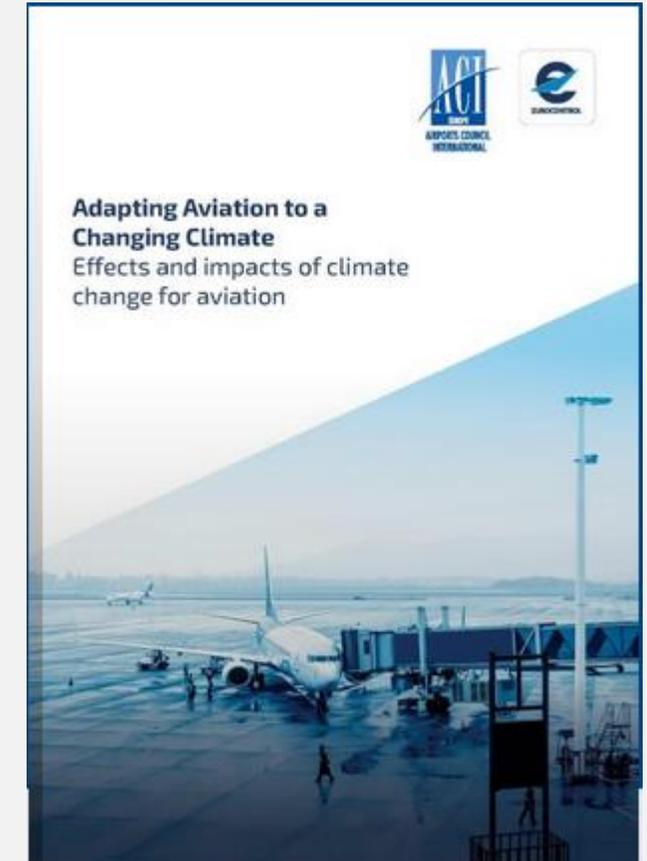
Assemble the team: designate responsible individuals and departments, including operations, safety, business managers and key stakeholders.

4

Understand local climate change projections: work with local meteorological organisations to identify climate scenarios and understand projected climate changes.

6

Develop and prioritize adaptation actions: develop a Climate Adaptation Plan, prioritizing actions based on criticality and available resources.



Key climate change impacts for airports, ANSPs and airlines

 Airports
  ANSPs
  Airlines
  People (passengers and personnel)

CLIMATE EFFECT ³	IMPACTS	IMPACTED ACTORS			
					
CHANGES IN AVERAGE AND EXTREME TEMPERATURES 	<ul style="list-style-type: none"> Changes in aircraft performance <ul style="list-style-type: none"> Decreased aircraft performance e.g. climb Increased take off distance or less weight Reduction in MTOM Changes in noise impact Heat damage to airports (runway, taxiway) Heat stress for personnel and passengers <ul style="list-style-type: none"> Increased cooling requirements Lack of capacity in HVAC systems / potential failure of cooling systems Disruption to ground transport access Increased probability of wildfires Increase in disease vectors from climate change providing a newly hospitable environment for imported species. 	•	•	•	
CHANGES IN FREQUENCY AND INTENSITY OF STORMS 	<ul style="list-style-type: none"> Disruption to operations: delays, cancellations, route extensions, diversions, reduction in en-route capacity and airport throughput Disruption to ground transport access (passengers and staff) Injuries to passengers and staff, including those caused by turbulence Disruption to supply of utilities e.g. power outages Increased risk of lightning strikes (personnel, aircraft airport infrastructure) 	•	•	•	•
CHANGES IN PRECIPITATION 	<ul style="list-style-type: none"> Inadequate drainage system capacity: <ul style="list-style-type: none"> flooding of airfield and/or infrastructure Inundation of surface and underground infrastructure (e.g. electrical) Disruption to operations: delays, cancellations, reduction in airport throughput, diversions Inundation of ground transport access (passengers and staff) Reduced water availability due to drought Pollution due to too much or too little precipitation Damage to underground infrastructure due to drying 	•	•	•	•

CLIMATE EFFECT ³	IMPACTS	IMPACTED ACTORS			
					
CHANGES IN WIND 	<ul style="list-style-type: none"> Disruption to operations: delays, cancellations, route extensions; diversions; temporary loss of capacity Injuries to passengers and staff (including those caused by turbulence) Damage to infrastructure and equipment Disruption to ground transport access Disruption to supply of utilities e.g. power outages Increase in en-route turbulence Changes to optimal flight routes: impacts for ATC workload and staffing 	•	•	•	•
SEA LEVEL RISE 	<ul style="list-style-type: none"> Inundation of airfield and/or airport infrastructure <ul style="list-style-type: none"> Loss of capacity (temporary or permanent) Disruption to operations: delays, cancellations, diversions Temporary/permanent inundation of ground transport access 	•	•	•	•
CHANGES IN BIODIVERSITY 	<ul style="list-style-type: none"> Increased risk of birdstrikes Infectious diseases from new vectors (e.g. dengue) 	•	•	•	•
CHANGES IN ICING 	<ul style="list-style-type: none"> Decrease in de-icing requirements in regions experiencing warmer winters Increase in unexpected extreme icing events 	•	•	•	•
DESERTIFICATION 	<ul style="list-style-type: none"> Increased dust storms or sand storms 	•	•	•	•

Climate-related hazards consist of “acute” climate-related (extreme) events and “chronic” climate trends that change over time (e.g. slow-onset events). For example, acute temperature events include heatwaves, wildfires and cold waves. For precipitation this includes drought, heavy precipitation and floods.

Chronic climate hazards for temperature include average and extreme temperature increase, heat stress and permafrost thawing. For wind this includes changing wind patterns and for water increases or decreases in mean precipitation and sea level rise.

³ Based on the 2018 ICAO Climate Adaptation Synthesis

2024 ICAO Climate Adaptation Synthesis Report

Purpose

- Update the 2018 ICAO report on **climate impacts on aviation**.
- Provide a global synthesis of **risks, vulnerabilities, and adaptation needs** for States, ANSPs, airports, airlines.

Survey (2022, 259 responses, all ICAO regions)

- **73% already experiencing climate impacts.**
- **95%** expect to be affected by **higher temperatures**.
- **92%** expect to be affected by **changing precipitation**.
- **81%** expect to be affected by **increased storm intensity**.
- Other risks: sea level rise, biodiversity loss, wind shifts, icing, desertification, business/economic disruption.

Key Impacts on Aviation

- Infrastructure damage (heat, floods, sea level rise, permafrost thaw).
- Operational challenges (runway performance, delays, cancellations).
- Safety risks (storms, turbulence, icing).
- Economic disruption, esp. for **Small Island Developing States (SIDS)**.

Adaptation & Resilience

- 74% of respondents have or plan a **risk assessment**.
- Only **12% already implementing measures**; 87% say more work needed.

Bottom line

 Climate change is already affecting aviation. **Global, regional, and local adaptation strategies** must be accelerated to safeguard **safety, capacity, and resilience**.



Climate Adaptation – Implications for ATM Layers

Tower (Airport/TMA)

- Rising **temperatures & precipitation extremes** → more **runway performance issues**, surface flooding, permafrost damage.
- Need for **low-visibility / GBAS procedures**, snow & ice contingency, and **resilient ground infrastructure**.
- Staff access issues during extreme events.

Approach

- **Storms & icing changes** → higher need for **dynamic capacity balancing** and flexible arrival sequencing.
- **MET forecasting improvements** critical for safer, predictable approaches.
- A-CDM procedures support resilience during disruption.

En-route

- **Jet stream shifts, wind pattern changes** → altered flows, risk to RVSM capacity, and increased **Clear Air Turbulence (CAT)** .
- Requires **probabilistic forecasting**, turbulence awareness tools, pilot feedback loops.
- Potential **fuel-critical challenges** on long-haul routes.

Network

- Climate events at hubs create **knock-on effects** across the system .
- SESAR studies recommend **flexible use of airspace (AFUA)** to cope with convective weather .
- Strengthen **network-level coordination & contingency planning** to manage cascading impacts.

Bottom line

 **Adaptation must be integrated at every ATM layer:** tower resilience, approach flexibility, en-route turbulence management, and network-wide coordination.



<https://www.icao.int/sites/default/files/environmental-protection/Documents/T2024-ICAO-Climate-AdaptationSynthesis-Report-1.pdf>

Sustainability reporting & regulatory compliance

ANSP CARBON FOOTPRINT, CSRD, EU TAXONOMY

Measuring & Reducing ANSPs' Carbon Footprint

Why it matters

- Supports EU Green Deal & ICAO NetZero 2050 goals.
- Demonstrates leadership & compliance (CSRD, EU Taxonomy, ESG).

Step-by-Step Approach

1. **Calculate** → Scope 1, 2, 3 emissions using GHG Protocol.
2. **Reduce** → Practical measures:
 1. ⚡ Renewable energy contracts & onsite generation (solar, wind, hydrogen).
 2. 🚗 Green mobility & low-carbon travel policies.
 3. 🗑️ Waste, food & biodiversity actions.
 4. 🖨️ Decommission/modernise CNS & optimise IT infrastructure.
3. **Report** → Aligned with CSRD, GRI, TCFD, SBTi.
4. **Communicate** → Transparent, multi-channel to staff, public, policymakers.

Good practices

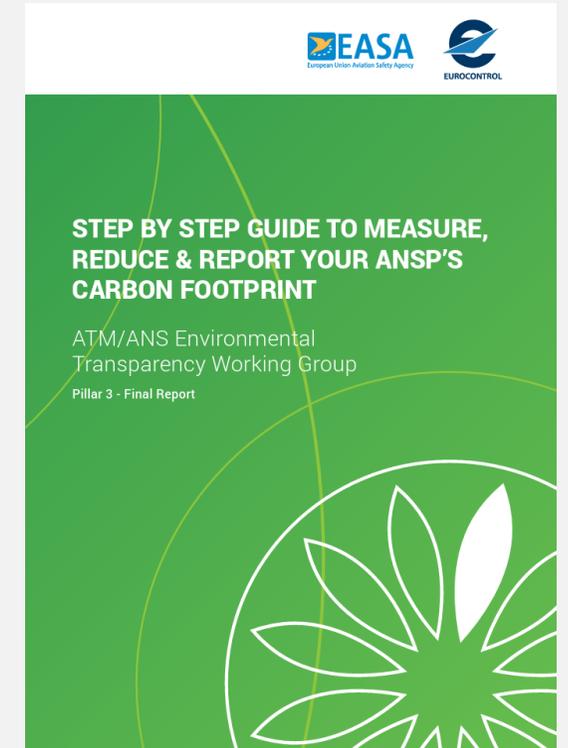
- ENAIRE: 100% renewable electricity + hydrogen backup.
- Austrocontrol: reduced IT & radar energy use.
- DSNA: solar + hydrogen powering remote CNS sites.

Frameworks & Tools

- ISO 14001 / EMAS for environmental management.
- CANSO **GreenATM** accreditation.
- EUROCONTROL CBA tool for CNS optimisation.

Bottom line

🌍 **ANSPs can significantly cut Scope 1 & 2 emissions now** through renewable energy, CNS optimisation & IT efficiency, while preparing for robust reporting and ESG alignment.



<https://www.eurocontrol.int/sites/default/files/2023-01/eurocontrol-step-by-step-guide-measure-ansps-carbon-footprint.pdf>

Supporting ATM for taking informed decisions

FLYINGGREEN PLATFORM

FlyingGreen

<https://flying-green.eurocontrol.int/>



SUPPORTING
EUROPEAN
AVIATION

NetZero

FuellingDecarb ▾

ClimAdapt ▾

DecarbFin

 User Manual



Login

FLYINGGREEN

Supporting a sustainable future for aviation

FlyingGreen was built with you, for you



More than a tool

a collaborative platform,
co-developed with ANSPs, airports, CAAs, OEMs...



Brings together data, models, and user-driven scenarios



Dashboards, modelling tools, and sustainable intelligence access



Helps to plan, assess, justify, and act on sustainability

FlyingGreen

- [FlyingGreen](#): public, web-based platform
- Objective: provide **States, ANSPs, airports and other aviation stakeholders** with the **tools and resources** needed to **adopt green practices** and **strive towards a more sustainable future**
- Launched July 2024 – 3 releases in 2025
- In collaboration with 100+ aviation stakeholders
- 4 pillars - Demonstration [NetZero](#)
- G2G indicator: increasingly being used as reference for emission calculations
- [Recording of FlyingGreen onboarding event \(3 JUL 2025\)](#)





Stakeholder engagement – real use cases



CO₂ & OPERATIONS

States: National CO₂ forecasts & validation (e.g. Finland, NL)

ANSPs: Prioritise operational improvements by emissions impact (e.g. MUAC, NATS, LVNL, DSNA, Skeyes, Borealis)

Airports: More detailed LTO emissions for the purpose of airport environmental permits (e.g. Charleroi, Amsterdam, Paris, Copenhagen, Zurich, Ljubljana, Paris AdP, and ACI-E.)

Programmes: Using NetZero to determine environmental performance. (e.g. AZEA, SDM, SESAR projects.)



SAF, H₂, ELECTRIC

Industry/Commission: SAF demand & supply forecasts (used in EU Renewables & LCF Alliance)

Airlines/OEMs: Business case & infrastructure planning (e.g. AF-KLM, Airbus)



CLIMATE RESILIENCE

ANSPs/Airports: Assess climate risks & adaptation costs (e.g. MUAC, Skyguide, ANA Portugal)

Regulators: Inform risk discussions & climate resilience and preparedness (e.g. IAA)



FINANCE & FUNDING

ANSPs: Access EU funds & green finance (Bluebook, Fund Pathfinder) (e.g. Austrocontrol and MUAC)

Airlines/OEMs: Support ESG, CSRD & double materiality analysis (e.g. Airbus, AirNostrum)

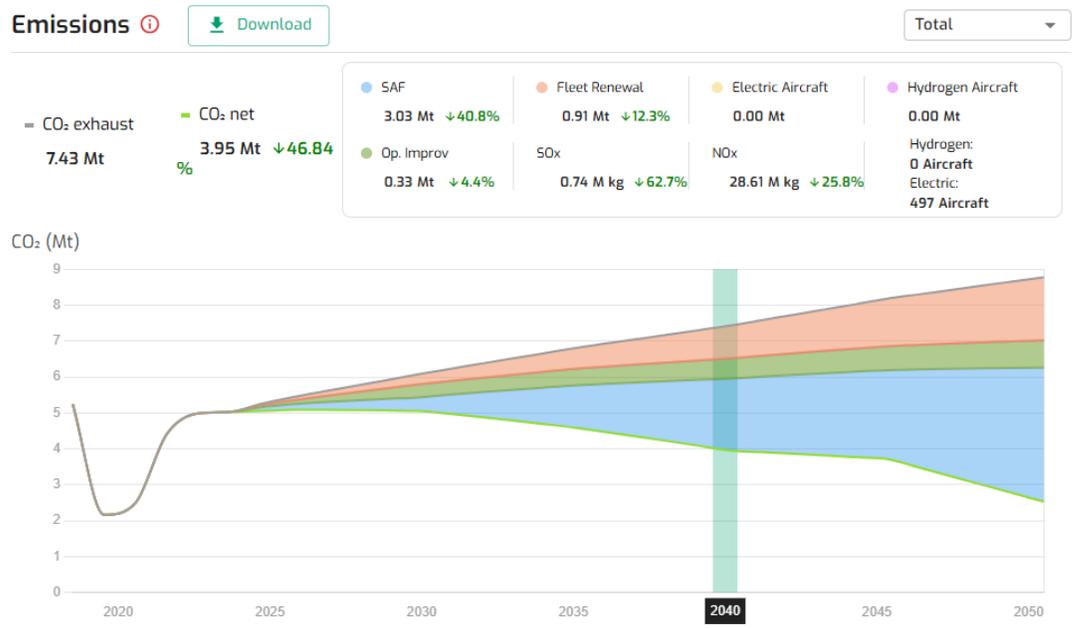
links with ACI ACA program and CANSO GreenATM, ongoing discussions with ICAO (LMR), ECAC.



NetZero – NavAir traffic and forecasts



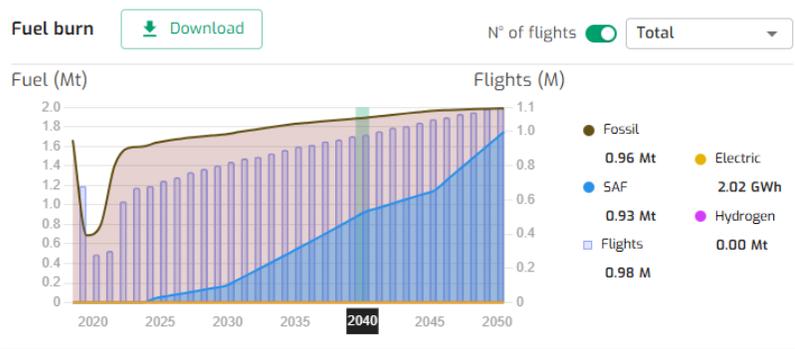
- 2024 actual traffic as baseline
- EUROCONTROL Long Term Forecast applied
- NetZero used to explore Emission reduction scenarios
- Options to select and filter, e.g.:
 - Cork Tower emissions
 - Dublin ACC emissions
 - 4 Irish airports and several airspace areas included
- Enter different scenarios such as:
 - Aircraft Renewal and Revolution (zero emission aircraft potential)
 - Ops improvements
 - Economic scenarios



KPIs

2040

OPS improvement Taxi-Out	OPS improvement Climb	OPS improvement Cruise
5962.26t ↓-0.63%	10601.21t ↓-2.03%	2470.46t ↓-76.06%
OPS improvement Descent	OPS improvement Taxi-In	Total mileage
39013.15t ↓-1.20%	15817.42t ↓-0.21%	190 142 413Nm



Airport & ANSP Environmental Management System information

AirNav

Top Airports in ANSP

Airport	Level
Dublin	Level 3+
Cork	Level 3+
Shannon	Level 2
Ireland West	Level 3

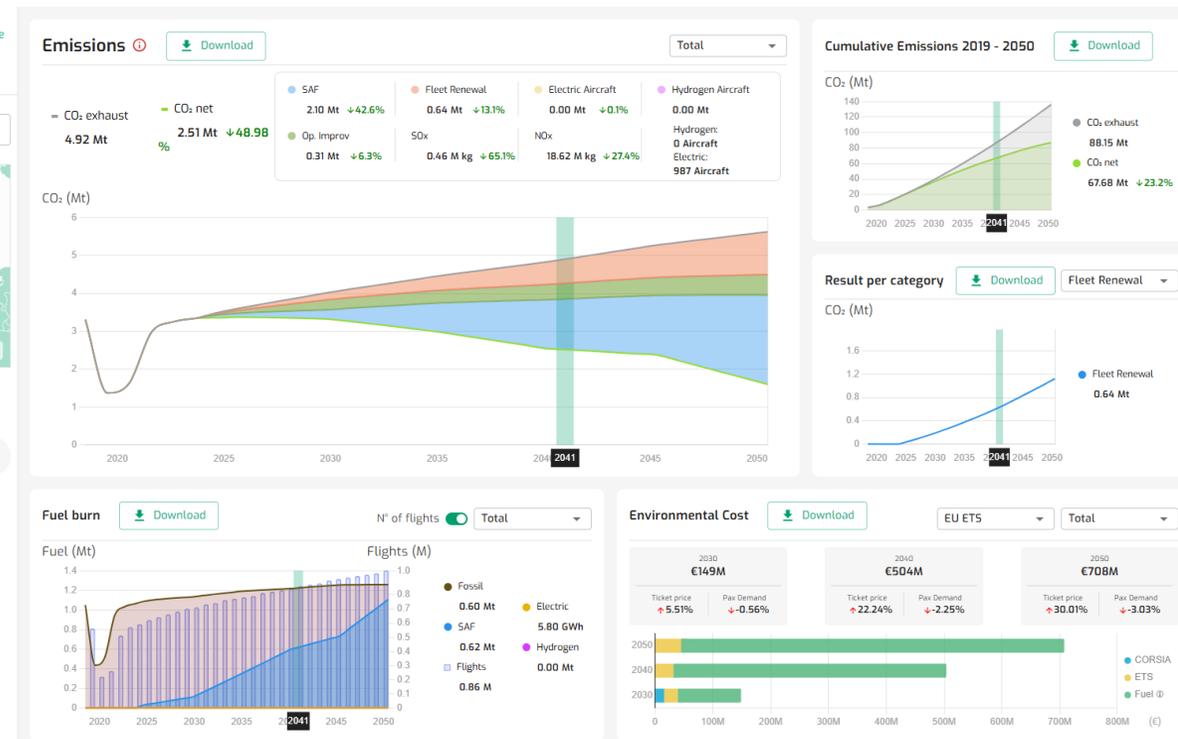


A centralised source of information for emissions and decarbonisation strategies

Comprehensive Fuel Burn and Emissions overview 2019-2050

Based on EUROCONTROL operational data & latest forecasts

- Explore:
 - SAF pathways potential
 - Fleet renewal impact
 - Zero emissions aircraft projections
 - ATM Operational efficiency scenarios analysis
- Provide evidence-based inputs to:
 - Achieve in-sector CO₂ reductions through efficiency gains
 - Scale up SAF deployment and alternative fuels
 - Support technology transition to cleaner fleets
 - Assess residual emissions for market-based measures
- Aviation's Economics & Cost Implications assessment
 - Additional Environmental Cost: CORSIA, ETS, and SAF costs
 - Total costs or average cost per flight
 - Links to Environmental Management Systems





NetZero - a comprehensive toolkit for decarbonisation efforts



Granularity of Analysis

- Network-wide, State level, FABs, ANSPs and AUA/sectors, Airports (TMA/LTO)

Scenario Horizon

- Historic & forecast emissions and fuel burn to 2050
- Aligned with ICAO LTAG milestones

Filters & Dimensions

- Flight type (DAIO)
- Flight phases: climb, cruise, descent, taxi-in, taxi-out, full flight
- Market segments: Regional, Low-cost, Long-haul, Business aviation

The screenshot displays the NetZero toolkit interface with several panels:

- Zone Panel:** Includes 'Level' (Network selected), 'Area' (ECAC), and a map of Europe. A dropdown menu shows options: Network, State, FAB, ANSP & AUA, and Airport.
- Economic Panel:** Contains sliders for 'ETS CO₂ Allowance Price', 'CORSA CO₂ Allowance Price', 'Jet Fuel Price', and 'SAF Price', each with 'Low', 'Moderate', and 'High' options.
- Operational Improvements Panel:** Features a slider for 'Renewal' (Moderate to Accelerate) and a 'Hydrogen Aircraft' section with a 'Start year' slider (2030 to 777).
- Fleet Panel:** Includes an 'Electric Aircraft' section with a 'Start year' slider (2030 to 194).
- Filters Panel:** Shows 'Flight type' (Departures, Arrivals, Internal, Overflight), 'Flight phases' (Taxi-out, Climb, Cruise, Descent, Taxi-in), and 'Market segment' (Mainline, Low-Cost, Regional, Business Aviation, All-Cargo, Other).
- Scenario Panel:** Includes 'Scenario' (Low, Base, High) and 'SAF' (SAF mandate) with a table:

By 2030	By 2040	By 2050
6 %	34 %	70 %



FuellingDecarb - a comprehensive toolkit for energy needs and production

FuellingDecarb provides you with the elements to answer the following questions:

- How to **assess SAF availability**, production or gaps in my country or region?
- How to **assess availability/gaps in renewable energy or low-carbon (nuclear) electricity needs** ?
- How to assess the **cost of deploying renewable or low-carbon (nuclear) electricity infrastructure**? How to assess required number of SAF plants?
- How to assess the **SAF costs**?

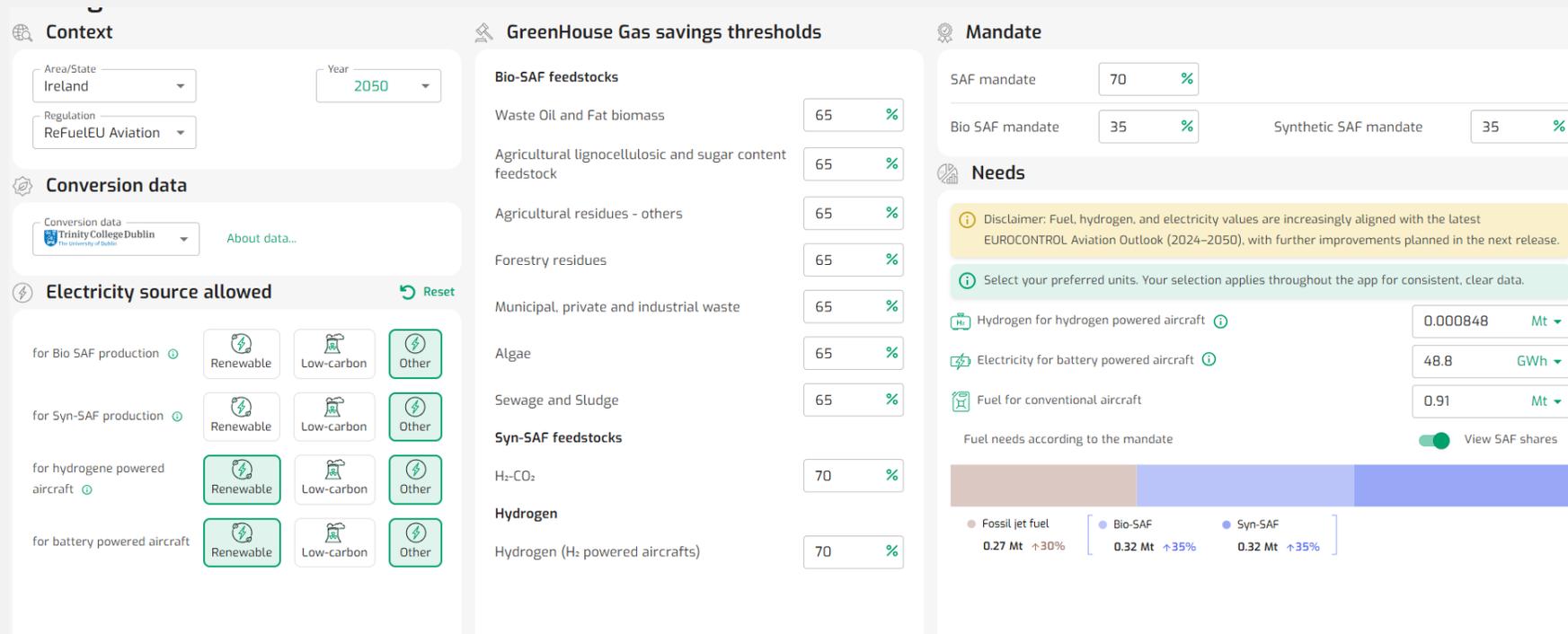




FuellingDecarb - a comprehensive toolkit for energy needs and production

A **centralised source** of information to support the **transition** from a fossil fuel to sustainable aviation

- **Fuelling Estimation Tool:** Provides **estimates** on **energy** requirements and **techno-economic aspects** of SAF, H₂ and electricity production in your country, group of countries such as EU27 or ECAC to support **decision-making**.
- It helps **identify gaps** between **SAF production** and **demand**



A **centralised source** of information for Climate Change impacts and adaptation measures

- **High level Screening Tool**

- Is your operation climate-proof?

- **High-level ECON assessment Tool**

- Run a financial assessment and evaluate the potential costs of climate impacts

- **Repository of potential impacts and adaptation measures**

- Explore key climate impacts and adaptation measures (by stakeholder, climate effect, or risk category)

- **Checklist for adaptation planning and implementation**

- Use the checklist to plan a climate change risk assessment and adaptation strategy.

Do you know by how much mean temperatures are projected to increase in your subregion?

Do you know how much extra cooling capacity will be required to prevent sensitive equipment from overheating?



Do you know to what extent storms are projected to increase in frequency and/or intensity in your subregion?



Geographical subdivision

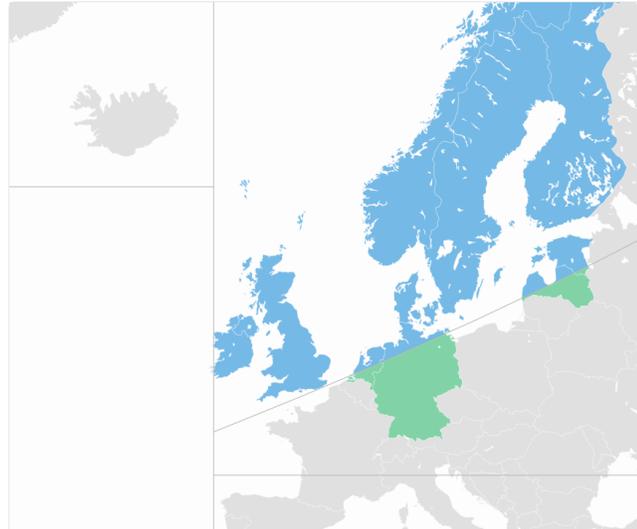
NEU WCE WCA MED GIC

Northern Europe - This region encompasses countries in Northern Europe as well as the western part of Russia. It is characterised by a temperate to subarctic climate.

Climate change effects

- Increase in mean air temperature
Increase in extreme heat
Temperatures are projected to increase by more than the global mean temperature, and heatwaves are likely to become more frequent and intense.
- Increase in severe wind storms
Storminess is projected to increase in the North Atlantic, with an increase in the number of winter storms in northern Europe.
- Relative sea level rise
Relative sea level is projected to rise, increasing the risk of coastal flooding and erosion (except in the Baltic Sea).
- Increase in mean precipitation
Increase in heavy precipitation
Precipitation is expected to increase in winter. There is high confidence that heavy precipitation events will increase.

Key climate change effects in Europe





DecarbFin - Toolkit for access to sustainable finance



EU Green Deal

- To support for at least 55% reduction in greenhouse gas emissions by 2030 (vs. 1990)
- To mobilise > **EUR 1 trillion investments** between 2020 – 2030
- ✦ More than **EUR 4 trillion** needed to decarbonise global aviation



Financing the EU Green Deal – EU sustainable finance framework

Financial institutions

EU funding

Which of the investments could be considered sustainable and under which conditions?

EU standards

What type of sustainability data should we report to improve compliance with regulations and enhance company image?

Disclosures

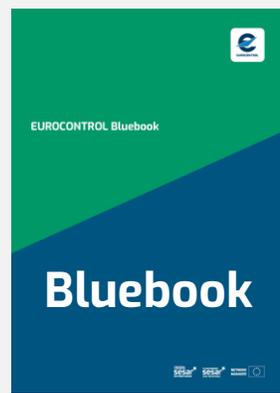
Sustainable finance instruments (loans, bonds..)

What type of opportunities are there in EU funding programmes and financial institutions and how we can prepare to access them?

CEF, Horizon Europe, Invest EU, EIB...

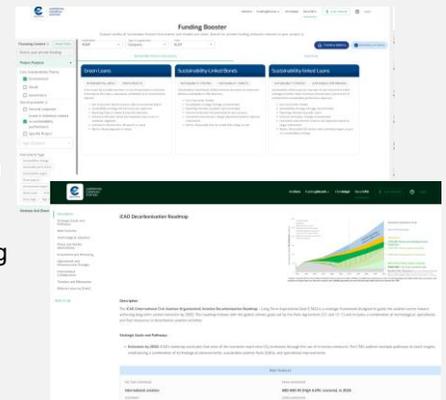
Guidance to enhance understanding and compliance with mandatory regulations

- Bluebook:**
- ✓ CSRD & EU Taxonomy introduction
 - ✓ Access to regulations & EC tools
 - ✓ Aviation-specific
 - ✓ Infographics & visuals to simplify decision-making
 - ✓ Examples & industry's practices

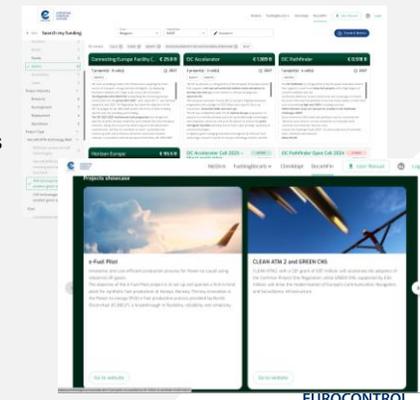


Tailor-made search of funding opportunities for decarbonisation and climate adaptation

- Funding Booster:**
- ✓ Search tool for ESG financing instruments
 - ✓ Latest decarbonisation roadmaps & ESG reporting
 - ✓ Real cases of financing sustainable aviation
 - ✓ Aviation market's trends & metrics



- Fund Pathfinder:**
- ✓ Search tool for EU Funds & Calls
 - ✓ Repository of EU Funding with key standardised info
 - ✓ Aviation-relevant funded projects



European Aviation Climate Change Adaptation Working Group



- Co-chaired by EUROCONTROL and ACI-EUROPE
- The creation of the EACCA Working Group responds to requests from stakeholders to take a coordinated approach towards the adaptation of European aviation to the impacts of climate change
- More than 35 organisations ...



ICAO Environmental Report 2025: Overview

Purpose

- Showcase ICAO's latest work on **aviation & the environment**, linked to the **LTAG (NetZero 2050)**.
- Provide States, ANSPs, airports & airlines with **guidance, tools, and monitoring frameworks**.

Key Themes

- **NetZero Pathways:** LTAG implementation, SAF, new fuels, technology, operations.
- **Monitoring & Reporting:** New ICAO MRV framework for CO₂ & non-CO₂.
- **Climate Adaptation:** Updates to 2018 study – stronger focus on resilience of aviation infrastructure & services.
- **ATM Role:** Operational improvements (PBN, CDO/CCO, free route, AFUA, VFE) & non-CO₂ contrail management.
- **Noise & Local Air Quality:** Updated guidance, community engagement, and ICAO Balanced Approach.

Highlights

- **Global uptake of SAF still <1%**, but ICAO drives new standards & policies.
- **Indicators evolving:** CO₂ + non-CO₂, network dashboards, airport/local metrics.
- **States surveyed:** strong need for adaptation & risk assessments.



<https://www.icao.int/sites/default/files/environmental-protection/Documents/EnvironmentalReports/2025/ICAO-EnvReport-2025.pdf>

ICAO Environmental Report 2025: Key Recommendations

Tower / Airport Ops

- Adopt **eco-airport toolkits**, resilient infrastructure, digital/remote towers.
- Expand **noise & LAQ engagement** with communities.

Approach / TMA

- Scale up **CCO/CDO** and **PBN STARs/SIDs** for efficiency & noise.
- Improve **MET integration** for storm/icing risk.

En-route

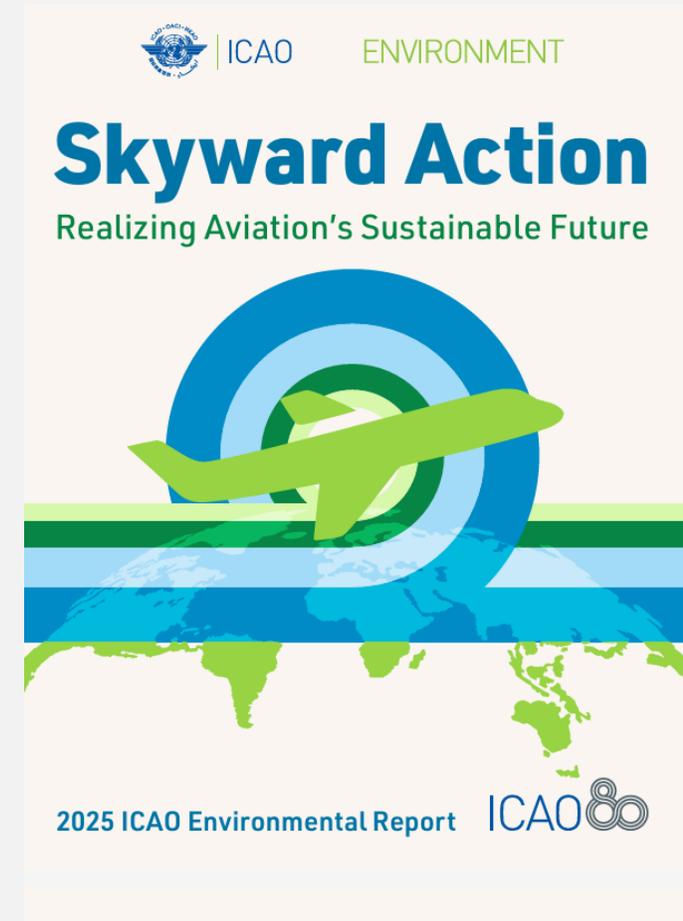
- Deploy **VFE-ER metrics**, free route, flexible airspace.
- Invest in **space-based ADS-B & datalink**.
- Prepare for **contrail mitigation tools**.

Network

- Strengthen **ATFM & cross-border contingency planning**.
- Link GANP to **LTAG monitoring**.
- Develop **network dashboards** for CO₂, non-CO₂, noise, LAQ.

Bottom Line

🌍 ICAO's 2025 report calls for **integrated action across all ATM layers**: operational measures, data-driven monitoring, non-CO₂ management, and climate resilience — essential to achieve **NetZero 2050**.



<https://www.icao.int/sites/default/files/environmental-protection/Documents/EnvironmentalReports/2025/ICAO-EnvReport-2025.pdf>