International Aviation: Bringing CORSIA to the Next Level while shaping the global carbon markets and fostering international cooperation

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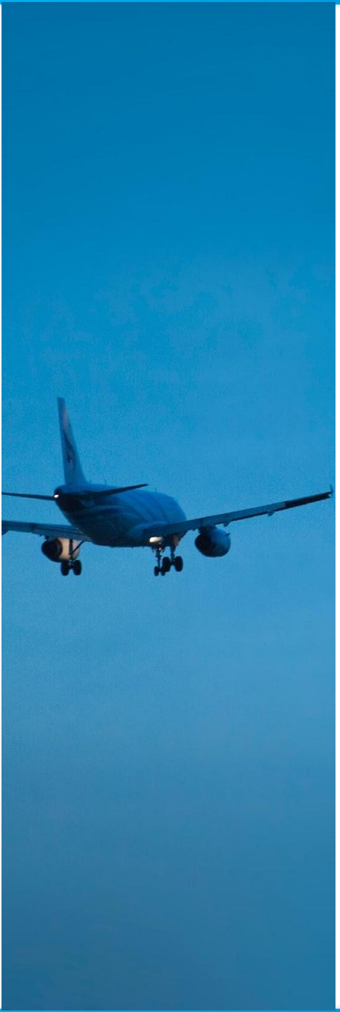
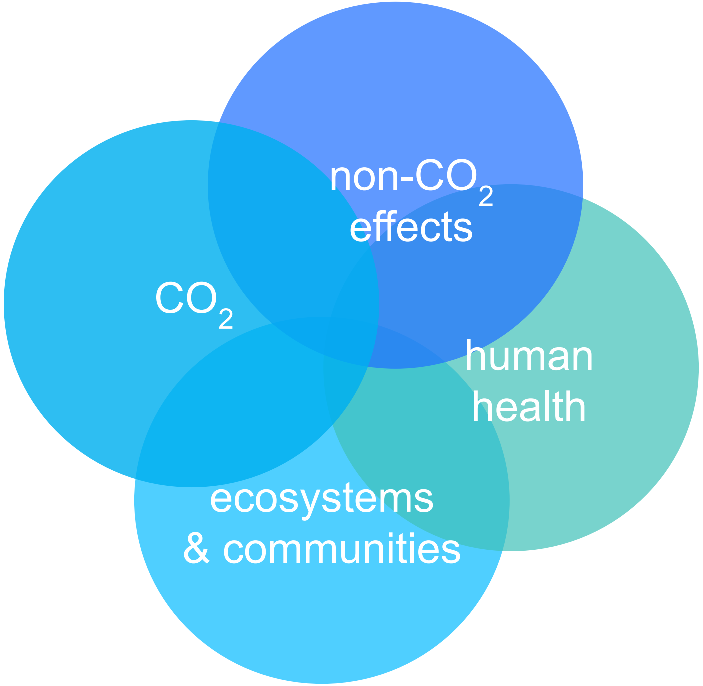
Cleaner skies at a crossroads



- If it were a country, aviation would be a **top 10 CO_2 emitter** whose emissions are slated to grow absent intervention.
- Decarbonizing aviation requires improvements in (1) **flight operations**, (2) **aircraft technology**, (3) **alternative fuels** and (4) **market-based measures.**
- **Non-CO_2 effects** amplify aviation's role in driving climate change.
- **Non-CO_2 toxic pollutants** also endanger the health of communities and airport workers.
- **Alternative fuels** can pose environmental and social risks.



CARBON OFFSETTING AND REDUCTION SCHEME FOR INTERNATIONAL AVIATION (CORSIA)

- **Market-based measure** for **2021-2035** capping emissions at “2020 level”.
- Adopted by the International Civil Aviation Organization (**ICAO**) in 2016.
- First effective voluntary phase: 2024-2026/ Mandatory phase begins in 2027.
- Potential to mitigate **1.5 billion tons of CO_2** emissions through **2035**.
- Compliance tools_**Offsets** & **alternative fuels**, but also **in-sector abatement** to some degree.

✔ Global Monitoring, Verification and Reporting (MRV) system.

✔ Integrates all elements of the basket of measures.

✔ CORSIA is poised to shape **carbon markets** and **international cooperation**.

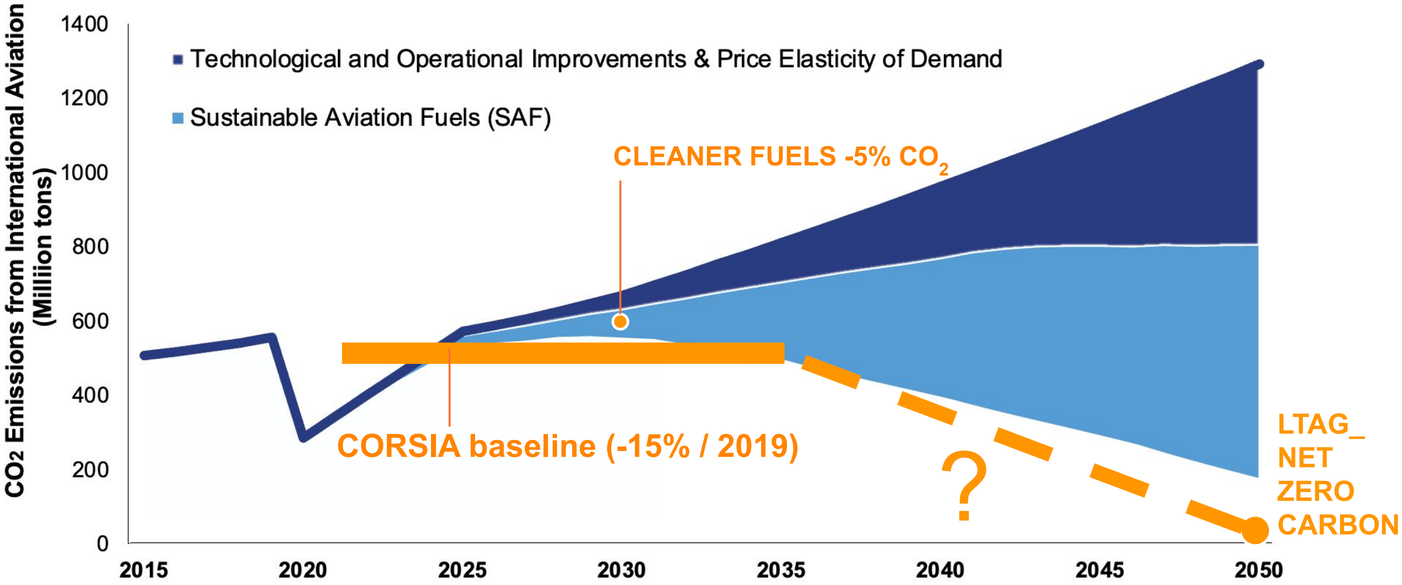
But CORSIA integrity also hinges on **alternative fuel claims**, which are prone to **double counting**.

Avoiding double counting of alternative fuels is easy with already existing infrastructure

- Involves reconciling the **producer** and **consumer accounting principles.**

UNFCCC - PARIS AGREEMENT		ICAO	
Biennial Transparency Report			Transparency Report
National Inventory Report (NIR)	**Structured Summary** "Information necessary to track progress made in implementing and achieving the NDC"	…Underlying ICAO Inventory Report	**CORSIA Central Registry** (consistent with Structured Summary)
IPCC Guidelines for bioenergy **International Bunkers**	**Selected indicators** **Emissions Balances (ITMOs)**	…IPCC Guidelines for bioenergy …International Bunkers	**Selected indicators for CORSIA Eligible Fuels (LCA)** **Emissions Balance**

CORSIA and the other ICAO goals



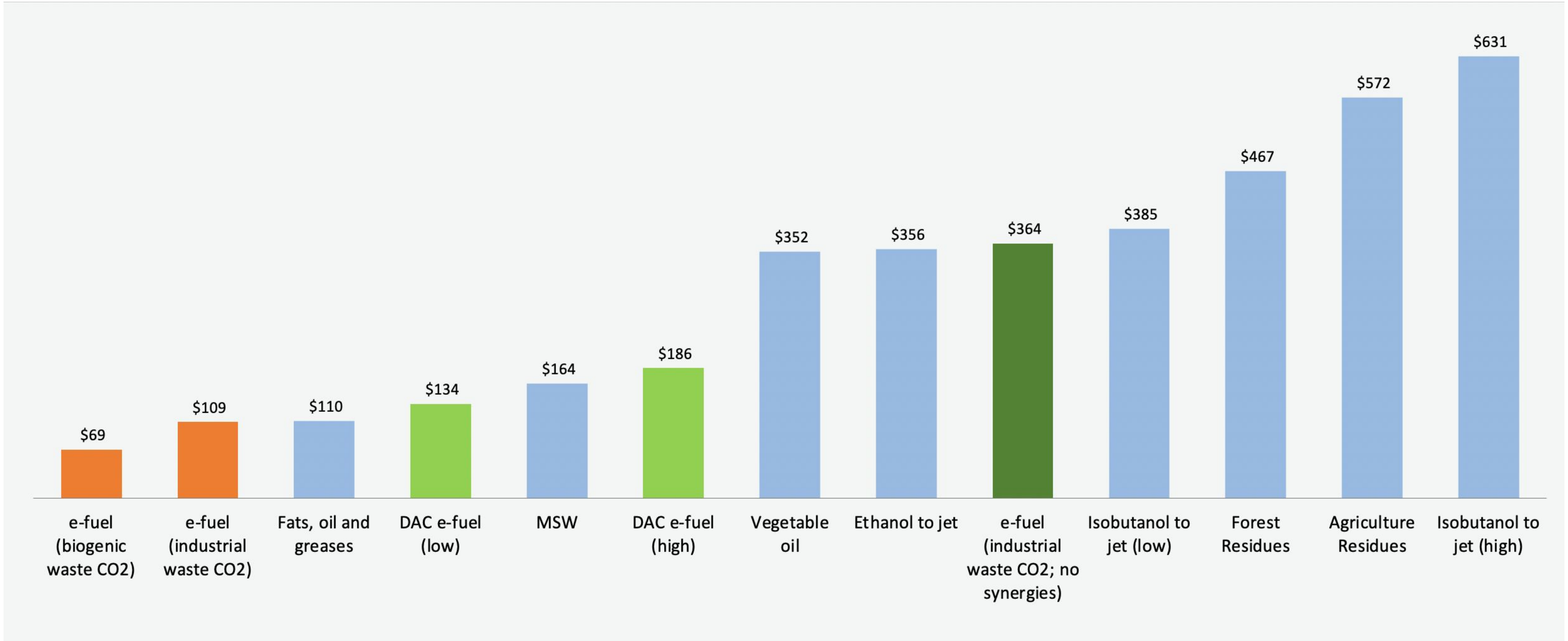
- Need for greater **ambition** (bilateral agreements / mature route groups?)
- **Non-CO_2 climate impacts** still missing (first step: EU ETS MRV?)

✔ **Offsets** will play a significant role for decades to address residual:

- Lifecycle emissions from eligible fuels.
- Non-CO_2 climate impacts.

✔ **Sustainable aviation fuels** (SAF) have the potential to unlock the greatest emission reductions.

SAF merit order in the mid 2030s
Abatement costs ($/$tCO_2$e)



Data source: EDF's "The High-Integrity Sustainable Aviation Fuels Handbook", Pedro Piris-Cabezas (2022)

Electrofuels (e-fuels) link the energy ecosystem

- E-fuels can soon be the most competitive SAF in terms of abatement cost.
- When situated wisely, e-fuels foster mutual benefits between power grid and aviation sector decarbonization.
- Critical demand-side management role:
    - reliance on **surplus renewable electricity** cuts costs and avoids indirect emissions.
    - **flexible demand & grid balancing** enable renewable power system expansion.
- Broad range of e-fuel co-products serves **other transport modes** as well.

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Intermittent production of electricity-based synthetic jet fuel as a demand-side management strategy for grid decarbonization

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Highlights

- E-fuel pathways can unlock significant cost savings in the near- to mid-term and become cost competitive with other alternative fuels if they are designed to provide grid balancing services.
- There will be sufficient high-quality surplus renewable electricity to meet most or all of U.S. jet fuel demand in 2050, and potentially a significant fraction of demand in 2030.
- By drawing upon abundant wind power and industrial fermentation waste CO_2, e-SAF synthesized in the Midwest alone could inexpensively deliver a bulk of the 3-billion-gallon target for 2030 under the national SAF Grand Challenge.
- The grid receives substantial benefits in terms of expediting the power sector's energy transition.
- The adoption of e-fuel technology serves not only aviation, but also other hard-to-decarbonize sectors with vested interests in the co-produced long-chain synthetic hydrocarbons.
- Fully capitalizing on synergies across sectors and within the e-fuel production pathway itself is of paramount importance.

Abstract

Variable renewable energy (VRE) is poised to become a cornerstone in the effort to meet economy-wide climate change mitigation targets. However, while transport electrification is advancing for road vehicles, it remains challenging for long-haul aviation. In this hard-to-abate sector, policy and research focus on producing drop-in fuels compatible with existing aircraft technology. Although the alternative jet fuel market is currently dominated by biofuels, diversifying fuel production pathways is crucial for a resilient future. Emerging electricity-based synthetic jet fuels offer promising new routes nearing commercialization. Despite adoption barriers posed by the cost ratio between electrolytic sustainable aviation fuel (e-SAF) and conventional fossil jet fuels, techno-economic assessments involving an integrated power systems perspective suggest potential synergies to both bring down e-SAF production costs and facilitate the energy transition of the power sector towards renewables-based power generation systems. Large VRE capacity necessitates flexible demand management, with interruptible technologies like e-fuel electrolyzers potentially playing a critical role in grid balancing and cost

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Particulate matter (PM) pollution from aviation

- Jet fuel regulation can address aviation's **environmental injustices** in and around airports, while simultaneously contributing to mitigate aviation's **non-CO_2 climate impacts**.
- Setting jet fuel's **aromatic content** to as close as possible to **8%** can slash PM pollution in the near term by as much as 50 to 70% in some instances.
  - 8% ensures adherence to existing flight safety certifications and fuel quality specifications.
- The **cost** would amount to an increase in jet fuel cost for air carriers well below 2%, or less than 0.4% of their total operating expenses.
- Delivering lower aromatic content jet fuel implies the **optimization of existing refinery operations**.

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Particulate matter pollution from aviation: Effective measures for changing the course of longstanding environmental injustices

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Highlights

- Adopting federal jet fuel regulations to set the aromatic content to as close as possible to 8% can slash particulate matter (PM) pollution in the near term –by as much as 50 to 70% in some instances–, while ensuring adherence to existing flight safety certifications and fuel quality specifications.
- While alternative fuels hold potential for reducing PM emissions, only cleaner conventional jet fuel has the potential to deliver short-term benefits.
- Delivering lower aromatic content jet fuel implies the optimization of existing refinery operations for available jet fuel blend stocks to meet lower aromatic content specifications in the aggregate.
- The cost of setting aromatics to just above 8% in jet fuel would amount to an increase in jet fuel cost for air carriers well below 2%, or less than 0.4% of their total operating expenses, but any potential cost increases should be significantly tempered with fuel efficiency gains.
- Absent swift federal action in the United States, state-level regulatory authorities could implement jet fuel regulations that avoid running afoul of any of the relevant federal statutes or doctrines.
- Jet fuel regulation can address aviation's environmental injustices in and around airports, while simultaneously contributing to improve regional and global air quality, and to mitigate aviation's non-CO_2 climate impacts.
- Geospatial proximity mapping suggests a nationwide pattern of socioeconomic and racial/ethnic disparities in exposure to aircraft pollution in airport-adjacent residential communities across the United States.
- Census estimates from a sample of 64 large- and medium-hub U.S. airports give nationwide totals of 5.8 million and 16 million residents for 10km x 5km and 20km x 5km exposure zones oriented along airport runways to reflect flightpaths.

Abstract

Aircraft gas turbine engines emit substantial quantities of fine particulate matter ($PM_{2.5}$) pollution, notably at sizes in the ultrafine particle (UFP) range smaller than 100 nanometers. In addition to the contributions of $PM_{2.5}$ emissions to degrading regional air quality, impacts of direct exposure in and around airports are an important public health concern. Regulatory controls on $PM_{2.5}$ pollution are crucial to achieving a meaningful and equitable improvement in public health outcomes. Aircraft $PM_{2.5}$ emissions are largely influenced by the aromatic content in jet fuel and engine design. To achieve near-term reductions while maintaining compliance with existing airworthiness certifications, the U.S. government should prioritize the adoption of regulations limiting the aromatic content in jet fuel to 8%, or as close as practicable. This

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We can bring CORSIA to the next level by…

- Increasing **ambition** and **aligning with 2050 goals**.
- Fostering **international cooperation.**
- Covering **non-CO_2 climate impacts**.
- Maximizing public health **co-benefits**.
- Incentivizing the deployment of **e-fuels**.
- Ensuring the **integrity** of alternative fuels.
- Avoiding **double counting** of alternative fuels.

Thanks

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