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AI: The Green Catalyst for Aviation

IAGA Case Competition 2024
'Ze Pioneers' competing team

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IAGA International Association for Green Aviation

Steering the short-term progress of green aviation with sustainable artificial intelligence innovation

Aviation's Dilemma:
Rapid post-COVID recovery vs. urgent need for net zero carbon emissions.

Obstacles:
Limited progress with sustainable alternative fuels (SAFs) and hydrogen power, short-term action plan shortage.

AI as a Game-Changer:
Innovation driving sustainable solutions while addressing budget constraints.

Our Mission:
Reverse the trend of greenhouse gas emissions through AI-powered, practical, and cost-effective solutions.

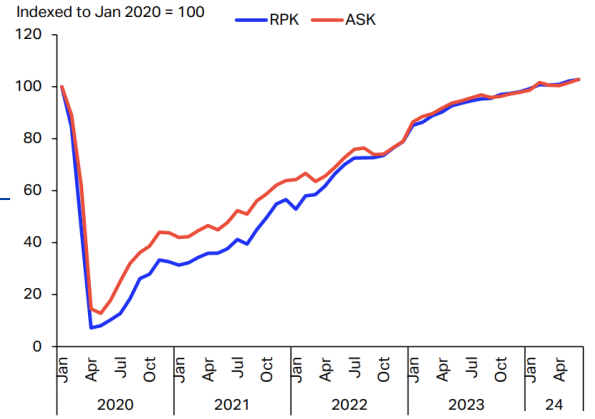
The recovery of the aviation market and the return of its climate impact

Current situation of the aviation industry

1 Post-pandemic air traffic growth rececovery

- The air traffic market is recovering post-pandemic, with passenger traffic measured in RPK (Revenue Passenger Kilometers) showing an 8% YoY growth.

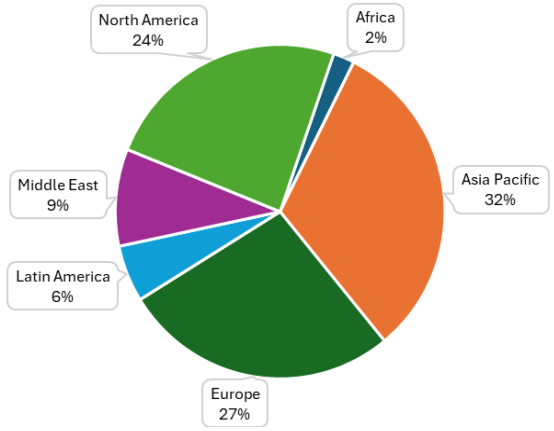
Chart 1 – Global RPK and ASK, Seasonally Adjusted, Indexed to Jan 2020 = 100



2 Market trends and shares are led by Asia-Pacific Airlines

- APAC Region based airlines carry over 31% of global air traffic by volume, as well as being the main driver of the recent growth

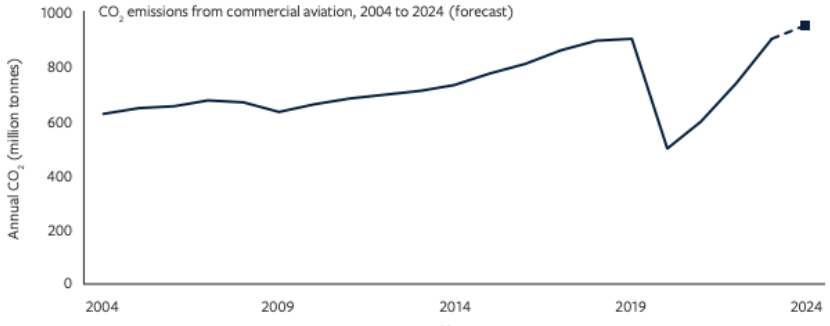
Market share of air traffic volume by region



3 Greenhouse gases upward trend as a result of post-pandemic air traffic growth

- Despite improvements in aircraft efficiency, **overall emissions continue to rise** due to increasing air traffic.
- Forecasts show that the demand for aviation fuel will conservatively increase by 2% annually resulting in up to **seven times more global carbon emissions by 2050** (as compared to 2019 levels).

Figure 1 Global carbon emissions from aviation



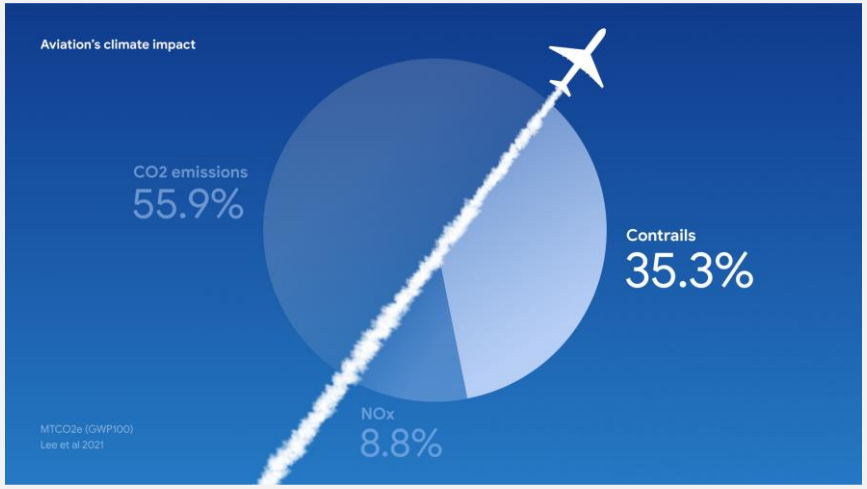
Sources :

A deeper look into aviation pollution drivers - the staggering scale of aviation emissions necessitates urgent action

Aviation polluting factors contributing to climate change

- The aviation industry accounts for over 5% of the total greenhouse gas emissions.
- While CO_2 counts for about half of the industry's GHG emission by mass, **non-CO_2 air pollutants count for 2/3 of the warming. NO_x gases and Contrails** — water vapor from aircraft exhausts — account for the largest share of these non-CO2 forcings.
- When a plane flies through **humid areas**, the soot from the exhaust can creates **contrails & Ice crystal clouds (cirrus)**, **trapping heat** into the Earth's atmosphere.
- Aviation's impact on climate change goes beyond the **quantity of GHG** as the **greater warming effect** renders mass as an incomplete unit of measurement

Breakdown of CO2 and non-CO2 forcings in terms of aviation pollution



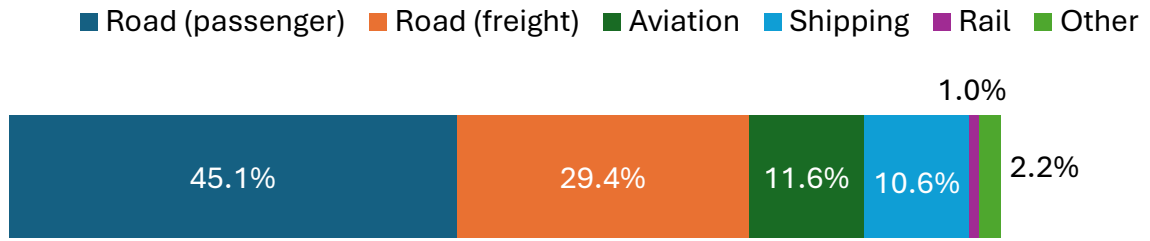
Greenhouse gas emissions are following an upward trend that is not expected to slow down

Since the global financial crisis in 2009, aggregate CO2 and non-CO2 emissions from all aircraft types have grown steadily, **increasing by almost 22% between 2009 and 2019**. This increase makes aircraft one of the **fastest growing sources of GHG** in the US transportation sector (and possibly globally) over the past decade. Emissions are expected to surpass pre pandemic levels around 2025.

If carbon emission related to aviation is so small, why should we care?

Aviation's emissions occur in the atmosphere and not at ground level, making them unique in terms of the significance of climate impact. They stem predominantly from the **combustion of aviation fuel** in aircraft engines which contributes to global warming by closely **affecting the ozone layer formation and contributing radiative forcing.**

Global CO2 emissions by transport



Sources :

The 3 pillars: a framework to analyze our green aviation solutions

Pillars of Green Aviation

Community Impact
noise, visual, and air pollution

- Analyzing and understanding the direct impact aviation, its infrastructure, and its activity can have is key to building an industry that enhances the quality of life of the people impacted by it.

Sustainable resources and energy
non-renewable resources & energy, operational efficiency

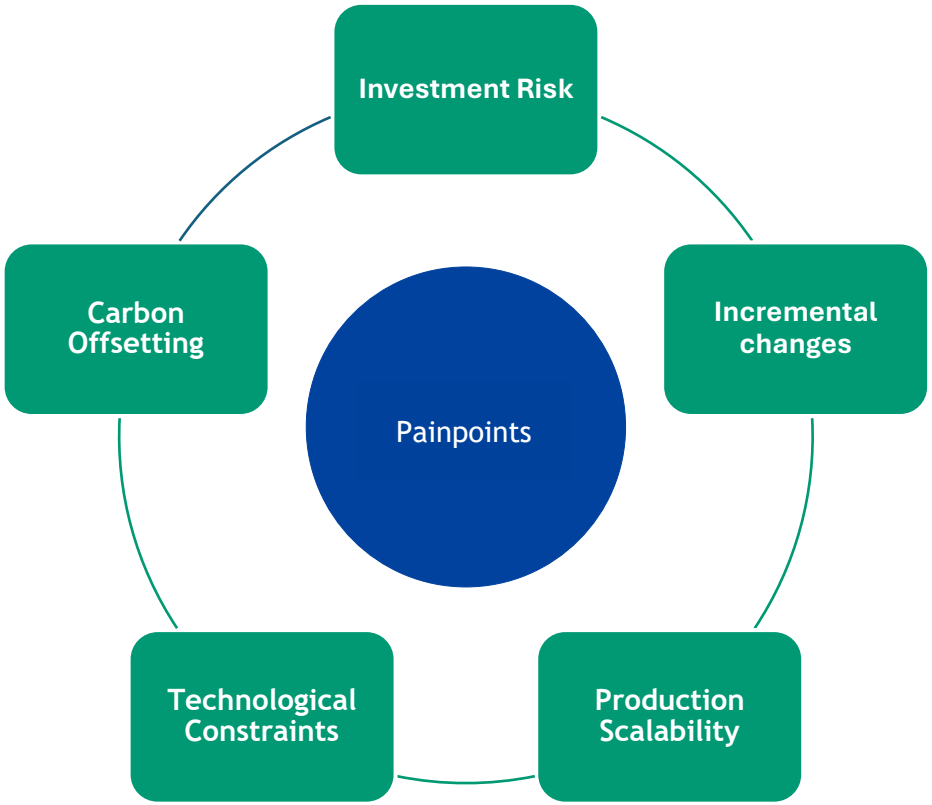
- A harmonious relation with the environment requires a careful consideration of the sourcing, transportation, transformation and exploitation of energy and other resources

Climate disruption and GHG emissions
biofuel, battery power propulsion

- Due to the context of high altitude and the diverse air pollutants that are released by aircraft flight, the climate disruption caused by the emissions is amplified Initiatives to mitigate these emissions will be key in reducing the detrimental impact of the industry on the environment.

Sources :

Painpoints of green aviation innovation and transformation



1 Investment Risk Chain | Direct Impact, GHG, Energy & Resources

- Especially with propulsion technologies, it is currently unviable for individual stakeholders to invest in the implementation of transformative solutions. **Additional operational** expenses and the **rarity of related infrastructure** yield an outlook of **unprofitable capital investments.**

2 Incremental changes | GHG

- Certain types of improvements relating to **optimization** do improve the rates at which aviation operations generate GHG, but their effects are **outpaced by the market** growth, resulting in **ultimately increasing global emissions** nonetheless.

3 Production Scalability | GHG, Energy & Resource

- The current production of **Sustainable aviation fuels (SAF)** that are aiming to replace traditional fossil fuels is currently **unable to significantly support the aviation industry**. SAFs would **require a much tighter and immediate market integration** in the aviation industry to undergoes the necessary scale ups.

4 Technological Constraints | Energy & Resource

- Given that international flights compose a majority of air traffic volume, it is difficult to this activity sectors with propulsion alternatives like battery-power flights as the technology has yet to scale to the **long-haul sector**.

5 Carbon Offsetting | GHG

- The aviation industry is also subject to **greenwashing**, where **net-zero commitments** are heavily reliant on carbon capture or carbon offsetting practices. **Carbon removal does not replace decarbonatization** and the mitigation of all other GHG emissions.

Source: external interviews

AI has particularly become even more promising with regards to development of image recognition technology (The effect of image recognition in AI)

AI advancements in green aviation

- **AI is revolutionizing the aviation industry by optimizing operations, enhancing safety, and improving sustainability**
- **Process streamlining, fuel consumption reduction, decision-making improvements, leading to a more efficient, reliable, and sustainable aviation industry**
- **Image recognition technology, have the potential to address key green aviation challenges and contribute to a more sustainable future**

Solutions	Feasibility	Immediate impact	How it works	Benefits
Mitigating Contrails (addressing GHG reduction)			AI Image recognition to detect contrail clusters and flight planning to avoid these clusters	Ease of implementation and training for a very high impact on reducing non-CO2 forcings related to fuel exhaustion in high-altitude
Enhancing ATC decision making			AI-driven air traffic flow optimization, congestion reduction, and holding patterns minimization	Reduces fuel consumption, emissions, and noise pollution, while also improving safety.
Implementing AI-driven fuel consumption optimization			Analysis of aircraft performance data by AI along with fuel prices, and sustainability metrics to determine the optimal blend of sustainable aviation fuels	Reduces carbon emissions, supports the development of sustainable fuel markets, and helps airlines meet their sustainability goals.

Sources :

Using AI to mitigate contrails and their global warming effect by redirecting airplane traffic.

SOLUTION

Google's response to contrails:

- Google AI developed a system to predict and avoid contrail formation
- Tests demonstrated significant effectiveness in reducing contrails

54%
Reduction in contrails with AI solution

0.2%
Increase in fuel cost for a fleet

How do we know it works?

- American Airlines and Google AI partnership
- Conclusions led to think that this could be a highly cost-effective solution for green aviation

70+
Test flights over 6 months

$5-$25
Per ton of CO2 equivalent in cost savings

What do 'Ze Pioneers' bring to the table?

Going the extra-mile by implementing:

- Pre-Flight Planning: implemented solution in dispatcher control room to optimize contrail avoidance in pre-flight planning
- In-Flight Adjustments: integrated AI solution in pilots' cockpits to mitigate contrail spread-out in real time

Airlines get the opportunity to profit from data collection, while notably reducing the impact of their operations on the climate

Sources :

Implementation Plan + a timeline to take action (KPIs)

Implementation timeline

Short-term impact

Long-term impact

Key Performance Indicators (KPIs)

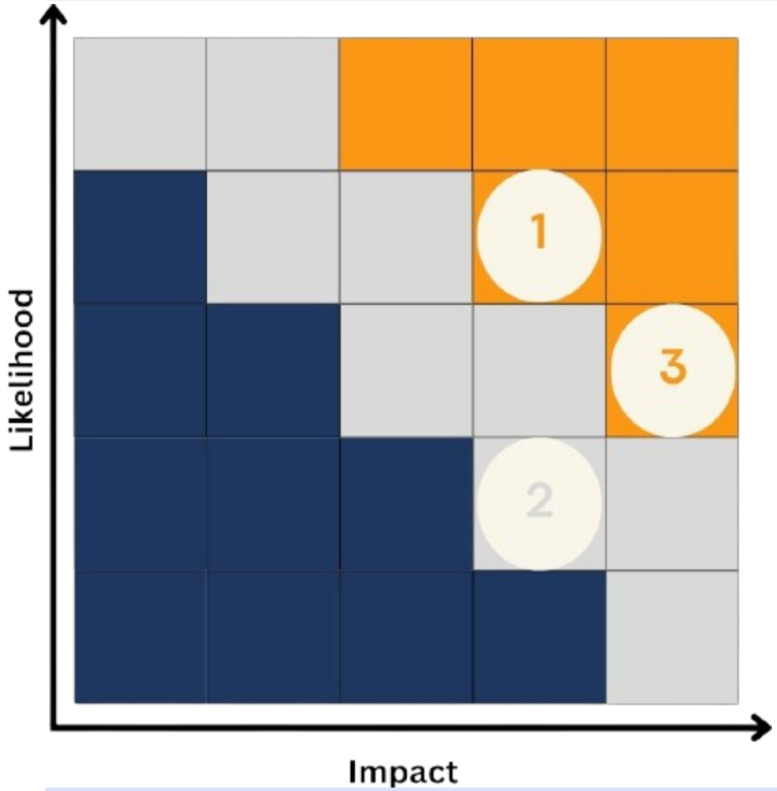
$\$ \ amount \ of \ cost \ reduction \ per \ ton \ of \ CO2$

$\% \ reduction \ in \ contrails$

$$\frac{\% fuel \ burned \ with \ contrail \ mitigation}{kilometre}$$

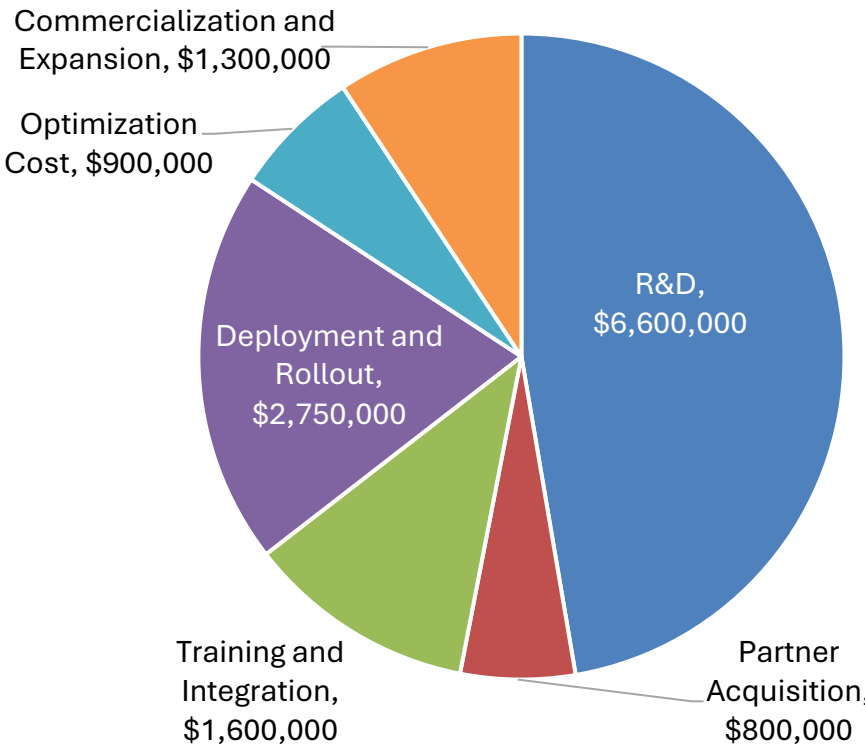
Feasibility and Potential Cost of this idea, include a budget

Risk and Mitigation Plan

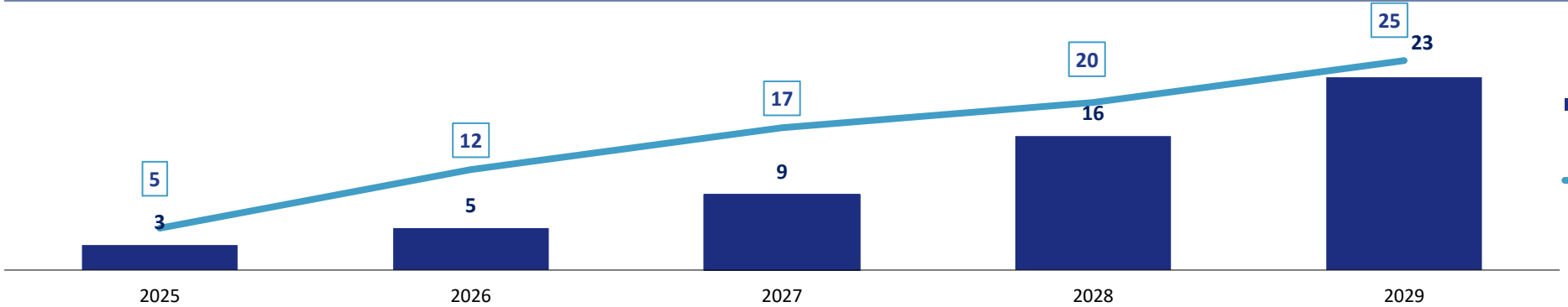


1	Investment pushbacks	1	Outsourcing business model with local data providers
2	Data collection discrepancies	2	R&D focus on detecting contrails at night + using data reinforcement
3	Non-compliance with cockpit regulations	3	Separate from critical flight systems, manufacturer partnerships

Project Cost Breakdown ($13,950,000 Y1)



Revenue and Sustainability Impact Projections



CAGR 2025-2029

Projected Revenue (in $M)	+50,3%
Projected CO2 Savings (in M$/ton/km)	+38.0%

In Brief, leveraging environmental data with AI to cut the impact of contrails in the environment

SUMMARY

A recoverying market

The increasing carbon emission due to the high demand of air transportation in a post-pandemic context requires direct action.

The gap for short-term impact:

With many solutions relying on an ultimate decrease in cost and an optimistic improvements in technological capability in decades, we are looking to change the scene of today.

Contrails - the ignored contributor:

We are tackling an often forget aspect of global warming contributors. Mitigating contrails evidently leads to reduced climate disruption

AI assisted flight operations:

Leveraging artificial intelligence will allow for global innovation as it relates to data collection and improving transportation. Contrail mitigation is just a first step into complete total quality management.