European Journal of Sustainable Development Research
2026, 10(1), em0360
e-ISSN: 2542-4742
https://www.ejosdr.com/

MODESTUM

Research Article

OPEN ACCESS

Sustainability transitions in European aviation: A private-sector case study of Hi Fly and the Mirpuri foundation

Yazan Khalayleh [1]*, João Carlos de Oliveira Matias [1], Carina Maria Oliveira Pimentel [2]

[1] Department of Economics, Management, Industrial Engineering and Tourism (DEGEIT), University of Aveiro, Campus Universitário de Santiago, 3810-193 Aveiro, PORTUGAL
[2] Production and Systems Department, School of Engineering, University of Minho, Campus Azurém, 4800-058 Guimarães, PORTUGAL
***Corresponding Author:** khalayleh@ua.pt

Citation: Khalayleh, Y., Matias, J. C. de O., & Pimentel, C. M. O. (2026). Sustainability transitions in European aviation: A private-sector case study of Hi Fly and the Mirpuri foundation. *European Journal of Sustainable Development Research, 10*(1), em0360. https://doi.org/10.29333/ejosdr/17554

ARTICLE INFO

Received: 12 Jul 2025
Accepted: 05 Nov 2025

ABSTRACT

This paper investigates how the Mirpuri Foundation and its affiliated airline, Hi Fly, have led a private-sector sustainability transition in European aviation between 2015 and 2025. Using a longitudinal single-case study grounded in the multi-level perspective (MLP) and reflexive governance theory, the study analyses Hi Fly's evolution across three phases: early experimentation, crisis-induced strategic reflection and regime-aligned institutionalization. Based on 25 stakeholder interviews, document analysis and survey data, the research traces how Hi Fly, and other similar European airlines in general, have advanced operational sustainability, influenced policy discourse and embedded environmental governance across their organization. The study identifies five interrelated measures that supported this transition: (1) operational innovations, (2) strategic governance reform, (3) value chain alignment, (4) policy engagement and (5) resilience-based sustainability framing. These findings illustrate how a mid-sized carrier, such as Hi Fly, can act as a transition intermediary, aligning with EU climate policy, Sustainable Development Goals (SDGs) and emerging Environmental, Social and Governance (ESG) disclosure frameworks. Although this case is situated within the Portuguese aviation context, its insights may be relevant to other mid-sized airlines in similar regulatory environments. The study suggests that the most resilient actors in 2025-2030 may be those who treat sustainability not merely as compliance, but as a strategic capability and long-term organizational value.

Keywords: sustainable aviation, sustainability transitions, reflexive governance, resilience framing, multi-level perspective, future sustainability

INTRODUCTION

Aviation Background and Information

Aviation is both a catalyst for global economic integration and a significant contributor to climate change. Although it accounts for approximately 2.5% of global carbon dioxide (CO_2) emissions, its total climate impact, when accounting for contrails and high-altitude nitrogen oxides, exceeds 3.5% (Lee et al., 2021). Without major intervention, aviation emissions are projected to double or even triple by 2050 (IEA, 2023). The urgency to decarbonize aviation has intensified since the adoption of the Paris Agreement in 2015 and the United Nations 2030 Agenda for Sustainable Development, which collectively redefined environmental responsibility across economic sectors.

Within this global context, the European Union has emerged as a frontrunner in climate governance, introducing regulatory frameworks such as the European Commission "European Green Deal" in 2019, "Fit for 55" legislative package in 2021 and "ReFuelEU Aviation Regulation" in 2023. These initiatives include binding emission reduction targets, sustainable aviation fuel (SAF) blending mandates and reforms to the EU Emissions Trading System (ETS), all of which aim to transition the aviation sector toward net-zero emissions by mid-century.

As these EU climate regulations become binding, questions emerge around how smaller or non-flag carriers "particularly those in peripheral markets" can comply with, contribute to and shape the sustainability agenda. Despite the growing prominence of Fit for 55 and ReFuelEU mandates, the capacity of mid-sized private actors to implement meaningful transitions remains underexplored. This study directly addresses this gap by examining how Hi Fly, through the Mirpuri Foundation, translated high-level EU policy into practical sustainability governance at the organizational level.

Case Study: Hi Fly and the Mirpuri Foundation

Case selection and context

Hi Fly, a mid-sized charter airline based in Portugal and its affiliated nonprofit, the Mirpuri Foundation, were chosen for their mission-driven approach to advancing environmental sustainability in aviation and for operating in a peripheral EU market where private initiative is pivotal.

Uniqueness

Under foundation guidance, Hi Fly implemented several first of kind or early mover measures; most visibly operating "Single Use Plastic Free Flights", complemented by early SAF flights analysis and SDG-aligned reporting that integrated sustainability into corporate strategy (Hi Fly, 2024). These initiatives elevated Hi Fly's profile and created channels to share practical insights in European policy and industry forums, illustrating how a mid-sized carrier can influence norms without being a flag carrier.

Significance

The Portuguese context "smaller market, comparatively limited state support" required leveraging reputation, partnerships and clear sustainability framing rather than relying primarily on public funding. This case shows how a private actor can translate EU climate policy into organizational practice by acting as a facilitator, broker, and advocate (i.e., transition intermediaries) bridging high-level objectives with operational experimentation.

Additionally, the foundation's efforts intensified during the COVID-19 crisis, which despite devastating air traffic losses, became a turning point for reimagining aviation's sustainability trajectory. Between 2015 and 2025, Hi Fly and the Mirpuri Foundation not only advanced internal sustainability practices but also shaped broader national and regional discourses on aviation decarbonization. Their approach emphasized proactive leadership, functioning as governance intermediaries and cross-sector catalysts, rather than merely responding to top-down compliance mandates.

This paper presents an in-depth case study of the Mirpuri Foundation and Hi Fly, analysing their role in driving sustainable aviation in Portugal from 2015 to 2025. Drawing on document analysis, semi-structured interviews and survey data, the study applies sustainability transitions theory, particularly the multi-level perspective (MLP), to trace how these actors engaged with niche innovations, influenced regime practices and responded to external shocks such as the COVID-19 pandemic and shifting EU regulatory landscapes. The main research question guiding this study is: Which supporting measures should mid-sized European airlines prioritize in 2025-2030 to advance sustainability transitions?

By examining the evolution of sustainability measures initiated by Hi Fly and the Mirpuri Foundation, this study offers evidence-based insights and strategic recommendations applicable to policymakers, industry stakeholders and sustainability scholars. While rooted in the Portuguese context, the findings may offer insights for other small and medium-sized aviation markets pursuing decarbonization under similar governance regimes.

LITERATURE REVIEW

Decarbonization Pathways in Aviation

Aviation decarbonization remains one of the most technically and economically challenging aspects of the global energy transition. Unlike other transport modes, aviation is constrained by long fleet lifecycles, high energy density requirements and limited short-term alternatives to fossil-based jet fuel (IEA, 2023). Scholars widely recognize that no single solution exists and that a portfolio of interventions, including sustainable aviation fuels (SAF), electric and hydrogen-powered aircraft and operational efficiencies, is required (Schäfer et al., 2016).

Among these, SAF is considered the most viable near-term lever. Derived from waste oils, biomass or captured CO_2, SAF can reduce lifecycle emissions by up to 80% (Airbus, 2023). However, adoption remains below 1% of global jet fuel use due to high costs and limited supply infrastructure (IEA, 2023). In response, the European Union's ReFuelEU Aviation Regulation mandates progressive SAF blending targets, 2% by 2025 and 70% by 2050, to stimulate production and market demand (European Commission, 2023).

Meanwhile, electric and hydrogen aircraft offer medium to long-term potential, particularly for regional and short-haul routes. Yet these technologies remain in early development stages, with significant barriers in energy density, certification and infrastructure readiness (Aviation International News, 2024). Moreover, operational improvements, such as weight reduction, continuous descent approaches and electrification of airport ground operations, offer modest but immediate gains (EASA, 2022). While most policy frameworks prioritize supply-side interventions (e.g., SAF, fleet renewal), several entities suggest that demand-side strategies, including modal shifts, pricing reforms and behavioural change, must also be integrated to meet the targets (Gössling et al., 2020). However, these approaches remain politically sensitive and less developed in both academic modelling and policy implementation.

Despite promising demonstrations, recent case evidence shows that SAF's climate benefit and scalability depend on cost, supply and certification details (EASA, 2022; European Commission, 2023; IEA, 2023). Demonstrator flights (such as 100%-SAF transatlantic trials and high-profile zero-waste operations) illustrate technical feasibility and operational learning, but they also reveal persistent constraints in price premiums, logistics and standardization that slow routine adoption (Etihad Airways, 2019; IATA, 2025; Qantas Airways, 2019). These examples therefore function as niche experiments in an MLP sense, valuable for learning yet insufficient without policy support.

The Role of Policy and Governance

Public policy and governance frameworks are emerging as primary drivers of sustainability transitions in aviation. In Europe, climate legislation has rapidly expanded to cover aviation through instruments like the EU Emissions Trading System and proposed kerosene taxes, as part of the European Green Deal and "Fit for 55" package. These top-down regulations, alongside global schemes such as ICAO's CORSIA

offset program, show that regulatory pressure is mounting at all levels, although some mechanisms (like CORSIA) have been critiqued for weak enforcement and limited impact (Kharina et al., 2016).

Scholars emphasize that effective transition governance must be coordinated across scales: International agreements (Paris Agreement, CORSIA, and the UN Sustainable Development Goals), regional mandates (e.g. the new ReFuelEU Aviation SAF blend requirements) and national policy strategies all need alignment (Rogge & Reichardt, 2016). Within this multi-level governance mix, non-state and private-sector actors increasingly serve as transition intermediaries linking policy, technology and social change. Mid-sized airlines, industry alliances and civil society organizations can facilitate the implementation of policy goals by piloting innovations and sharing knowledge across networks. This literature highlights that governance for sustainability is not a one-way, top-down process: It involves feedback loops where industry initiatives inform policy and vice versa.

Alignment with the Sustainable Development Goals (SDGs)

The United Nations Sustainable Development Goals (SDGs) provide a broad, holistic framework for sustainability that extends well beyond carbon emissions alone. While SDG 13 (Climate Action) is most directly pertinent to decarbonizing aviation, the sector also intersects with SDG 7 (Affordable and Clean Energy), SDG 9 (Industry, Innovation and Infrastructure), SDG 12 (Responsible Consumption and Production) and SDG 17 (Partnerships for the Goals). By aligning initiatives with relevant SDGs, aviation stakeholders can ensure that environmental efforts co-benefit social and economic objectives, reinforcing the industry's contribution to sustainable development. Recent studies indicate that airlines and organizations integrating the SDGs into their sustainability strategies tend to exhibit stronger governance, transparency and long-range planning (Gössling et al., 2020).

In practice, the SDGs have begun to serve as operational tools for decision-making, guiding companies in setting targets, measuring progress and communicating impact in terms that resonate with global goals. The International Civil Aviation Organization has explicitly mapped aviation activities to the SDGs, underlining that the sector's climate actions (e.g. emissions reduction, introduction of SAF) and ancillary initiatives (technology innovation, waste reduction, partnerships) collectively support multiple UN goals (ICAO, 2022).

This literature perspective on SDG alignment is significant for the study's aims because it situates Hi Fly's efforts in a wider context of global sustainability commitments. It suggests that evaluating the impact and credibility of the airline's transition requires looking at not only carbon metrics or compliance, but also how well the initiative supports overarching development goals and engages stakeholders through a shared language of the SDGs.

Sustainability Transitions and the Multi-Level Perspective (MLP)

This study is anchored in the multi-level perspective (MLP) on socio-technical transitions, which views change as the interaction between:

- Niches (sites of radical innovation, e.g., SAF trials),
- The regime (dominant systems, e.g., commercial aviation norms and incumbents),
- The landscape (external pressures, e.g., pandemics, climate policy).

According to Geels (2002), transitions occur as innovations at the niche level mature and align with destabilizing pressures at the landscape level to transform or infiltrate the existing regime. Geels' seminal work on MLP emphasizes that major "landscape" events (for example, a pandemic) can weaken the incumbent regime's stability, creating windows of opportunity for niche solutions to scale up. The MLP framework also reminds us that transitions need to be steered carefully: They should be just and inclusive, avoiding simply shifting problems or creating new inequalities (Hess, 2014).

Empirically, the application of MLP to aviation is still emerging. Many transition case studies to date have centred on ground transport or energy, with relatively fewer focusing on private-sector pioneers in aviation, especially in smaller markets. Some recent research has started examining low-cost carriers and Nordic aviation initiatives through a transitions lens, but there remains a gap regarding how mid-sized airlines in peripheral regions enact governance-driven innovation. This study helps fill that gap by examining Hi Fly's evolution as an MLP case: By analyzing how the Mirpuri Foundation and Hi Fly acted at the niche level (championing new practices), influenced regime expectations (industry norms and policies), and responded to landscape pressures (EU regulatory shifts and global crises) over the 2015-2025 period. Using the MLP as a guiding theory thus directly supports the paper's aim to trace multi-level dynamics in Hi Fly's sustainability transition.

Conceptual Framework: Textual Synthesis

Aviation's transition emerges at the intersection of four literature streams. Decarbonization pathways define the technical menu, near-term SAF scale-up alongside incremental operational efficiencies, with electric/hydrogen options developing for short-haul horizons (Airbus, 2023; EASA, 2022; IEA, 2023). Policy and governance supply the binding incentives and constraints (EU ETS reform, ReFuelEU blend mandates) and organize a multi level policy mix within which firms act (European Commission, 2023; Rogge & Reichardt, 2016). SDG alignment provides a normative and managerial compass that links project-level actions to broader social value (SDG13, and co-benefits for SDG7/9/12/17), strengthening legitimacy and strategic coherence (Gössling et al., 2020; ICAO, 2022). The MLP integrates these strands by explaining how landscape signals (e.g., Paris Agreement, COVID-19) open windows for niche innovations to influence the regime when intermediaries translate policies into organizational practice (Geels, 2002, 2020; Hess, 2014; Kivimaa et al., 2019; Loorbach et al., 2017). From this synthesis, four analytical expectations guiding the case were derived:

1. Under strong EU signals (e.g., ReFuelEU), mid-sized airlines will prioritize SAF readiness and targeted efficiency measures as immediately deployable pathways (EASA, 2022; European Commission, 2023; IEA, 2023).
2. Transition intermediaries (airlines, foundations, alliances) will broker, facilitate and advocate between policy arenas and operations, accelerating implementation and learning (Kivimaa et al., 2019; Rogge & Reichardt, 2016).
3. Embedding SDGs will enhance internal alignment, reporting discipline and stakeholder legitimacy, helping sustain efforts beyond compliance cycles (Gössling et al., 2020; ICAO, 2022).
4. Landscape shocks (e.g., COVID-19) will increase reflexivity and resilience framing, fostering the institutionalization of sustainability in governance structures (Geels, 2020; Hess, 2014; Loorbach et al., 2017).

These expectations tie directly to the paper's research aim, which supporting measures mid-sized European airlines should prioritize in 2025-2030 and motivate the evaluation of operational innovations, governance reforms, value-chain alignment, policy co-design and resilience framing in the Hi Fly case.

Taken together, these expectations inform the research design and data collection choices in the next section, where we test how a mid-sized European airline operationalizes pathways under evolving EU policy and SDG-aligned governance.

MATERIALS AND METHODS

Research Design

A single-case, longitudinal case study of Hi Fly and the Mirpuri Foundation (2015-2025) to generate analytical generalization on how a mid-sized private actor advances a sustainability transition (Yin, 2018). A mixed-methods design combined semi-structured interviews, document analysis and an online survey to enable triangulation and strengthen credibility (Creswell & Plano Clark, 2018; Denzin, 1978).

Participants and Sampling

25 semi-structured interviews were conducted using purposive, maximum-variation sampling to capture diverse roles (operations, management, regulators, experts, suppliers) and viewpoints (Palinkas et al., 2015). All interviews were in English (≈45–90 minutes).

Table 1 presents an anonymized demographic summary of the interview participants, indicating their gender, age ranges and educational backgrounds.

Data Collection

General approach

Several documents (internal plans/reports, public sustainability reports, EU policy Texts etc.) were reviewed to establish timelines and inform the interview guide. After that, interviews were prioritized as the primary qualitative source. Finally, a survey (52 complete responses from 70 invitees) captured prevalence of perceptions (Likert items + open questions) and corroborated qualitative themes. This sequence

Table 1. Demographic characteristics of interview participants (N = 25)

Gender	Age Range	Academic Degree:	Experience:	Ethnicity / Origin:
Male	25–29	Master's degree	3 - 5 Years	European
Male	25–29	Master's degree	3 - 5 Years	European
Female	35–39	Master's degree	More than 10 Years	European
Female	25–29	Master's degree	5 - 10 Years	European
Male	35–39	Bachelor's degree	More than 10 Years	South American
Male	40–44	Bachelor's degree	More than 10 Years	European
Male	25–29	Master's degree	1 - 3 Years	European
Female	45–49	Master's degree	More than 10 Years	European
Male	25–29	Bachelor's degree	1 - 3 Years	European
Male	30–34	Master's degree	5 - 10 Years	European
Female	25–29	Bachelor's degree	5 - 10 Years	African
Male	25–29	Bachelor's degree	1 - 3 Years	South American
Female	40–44	Bachelor's degree	More than 10 Years	European
Male	45–49	Master's degree	More than 10 Years	Asian
Male	30–34	Master's degree	5 - 10 Years	African
Male	30–34	Master's degree	5 - 10 Years	Asian
Male	25–29	Master's degree	1 - 3 Years	European
Female	25–29	Master's degree	1 - 3 Years	European
Female	45–49	Master's degree	More than 10 Years	European
Male	40–44	Master's degree	More than 10 Years	European
Male	30–34	Master's degree	5 - 10 Years	European
Female	40–44	Bachelor's degree	More than 10 Years	European
Male	35–39	Master's degree	More than 10 Years	European
Male	30–34	Bachelor's degree	5 - 10 Years	European
Female	35–39	Master's degree	More than 10 Years	European

Rationale for selection: Inclusion criteria targeted information-rich respondents with direct experience or oversight of sustainability initiatives, policy engagement or operational implementation; we also included critical/sceptical voices to reduce positivity bias (Patton, 2015)

supported progressive instrument refinement and methodological triangulation (Patton, 2015; Yin, 2018).

Interview protocol

A semi-structured guide covered:

(1) Drivers/barriers,

(2) Experiences with specific measures (e.g., SAF, plastic-free operations, electrification),

(3) Organizational learning during COVID-19,

(4) Engagement with EU climate policy and SDGs, and

(5) Enablers/resistances.

Sample prompts included: "What enabled or constrained implementation of SAF?" and "How did COVID-19 reshape priorities?" The format balanced comparability with flexibility for probing (Kvale & Brinkmann, 2009).

Data analysis

All qualitative data (including interview transcripts, open-ended survey responses and collected documents) were analyzed using qualitative content analysis procedures supported by NVivo 12 software. Qualitative content analysis is a systematic technique for interpreting textual data by coding it and identifying recurring themes or patterns (Hsieh & Shannon, 2005). A hybrid coding strategy was used, that combined deductive and inductive approaches, in order to capture both expected and emerging aspects of the sustainability transition. In the first phase, a preliminary codebook was constructed deductively based on the conceptual framework and interview protocol. For example, guided by the multi-level perspective theory and our research questions, we started with categories corresponding to known themes such as "niche innovation initiatives," "regime-level barriers," "COVID-19 disruptions," and "policy responses." Many of these initial codes were aligned with the interview topics (e.g., we had codes for "SAF experimentation," "plastic-free initiative," "SDG alignment," and "organizational learning"). In the second phase, codes were allowed to emerge inductively from the data itself. As transcripts and documents were examined line-by line, new themes that were not fully anticipated by the initial framework were identified and added to the codebook. Examples of emergent codes included notions like "resilience framing" (participants frequently mentioned framing sustainability as a long-term resilience strategy), "partnership leverage" (the role of partnerships in enabling projects), and "transition fatigue" (signs of stakeholder fatigue or scepticism after initial enthusiasm). This blend of "conventional" content analysis (deriving codes from the data) with a "directed" approach (using theory-driven codes) follows best practices suggested by Hsieh and Shannon (2005), allowing for a comprehensive analysis that is both structured and open to novel insights. Using NVivo, researchers collaboratively coded the interview transcripts and other qualitative materials. We first coded a subset of transcripts together to ensure a mutual understanding of the code definitions and to refine the codebook. Once a high level of consistency was achieved, the approach was to divide the remaining transcripts and documents for individual coding. The coding process was iterative: The team held periodic meetings to discuss any ambiguous text segments and to reconcile differences in code application, thereby improving inter-coder reliability. Through this process, all textual data were categorized under thematic codes, which were then examined for patterns and relationships.

The coded data were used to identify higher-level themes and to chronologically map the case's evolution. Notably, the analysis revealed three broad phases of the transition (which are discussed in the Results): An early experimentation phase (2015-2019), a crisis-driven reflection phase (2020-2021) and a policy-aligned acceleration phase (2022-2025). To arrive at these phases, we clustered codes by time period and by conceptual similarity, observing how certain initiatives and attitudes clustered in distinct time windows. For instance, codes related to experimentation and niche projects peaked in the early period, whereas strategic realignment and institutionalization codes became more prominent post-2020. This coding-driven mapping provided a coherent structure for reporting the findings.

The survey data (quantitative part) were analyzed using basic descriptive statistics. Likert scale responses were summarized in terms of frequencies and percentages, and mean scores were calculated for key questions. These summary statistics helped highlight general levels of agreement or variance on issues such as "perceived readiness for SAF adoption" or "approval of management's sustainability strategy." Due to the modest sample size (n = 52) and the primarily descriptive intent, no complex statistical tests were performed. Instead, the quantitative results were integrated with the qualitative findings in a comparative manner. For example, if many interviewees asserted that internal communication was a barrier, we checked the survey results for how employees rated the clarity of sustainability communication. In this way, analysis of quantitative and qualitative data proceeded in tandem, each informing the interpretation of the other (Creswell & Plano Clark, 2018).

The triangulation of coded themes with survey metrics enabled a more nuanced understanding, reinforcing points of convergence and noting any divergences. All analyses were conducted with an eye toward answering the central research question: Which measures most effectively advanced Hi Fly's sustainability transition and why. By using a content analysis with a robust coding scheme, we ensured that evidence supporting each conclusion was traceable back to multiple data excerpts, enhancing the transparency and trustworthiness of the analysis.

Validity and ethics

Multiple strategies were employed to ensure methodological rigor:

1) Triangulation of data sources (interviews, documents and surveys) was used to verify findings and reduce bias.

2) Member validation was conducted by sharing preliminary findings with selected participants, whose feedback was incorporated into the analysis.

3) The sample was intentionally diverse, including both proponents and sceptics of sustainability transitions, as well as external experts with no direct affiliation to Hi Fly or the Mirpuri Foundation.

Given the close relationship between the Mirpuri Foundation and Hi Fly, steps were taken to mitigate potential confirmation bias and ensure analytical distance. This included sampling interviewees beyond the core organization, such as external partners, consultants and policy observers and anonymizing all contributions. The research design prioritized triangulation across interviews, internal documents and public reports to validate claims. Additionally, participant responses were not universally positive; some stakeholders expressed scepticism about the scalability of SAF, the resource intensiveness of SDG integration or the operational costs of supply chain reforms. These tensions were included in the coding framework and are reflected in the analysis. The study thus aims to offer a balanced portrayal, capturing both ambition and constraint in the organization's sustainability journey. All procedures adhered to General Data Protection Regulation (GDPR) regulations. Data were securely stored, anonymized in all outputs and used with participants' explicit consent.

RESULTS

Phase 1 (2015-2019): Early Initiatives and Partnerships

Between 2015 and 2019, the Mirpuri Foundation and Hi Fly emerged as first movers in sustainable aviation within Portugal and among European charter airlines. In the absence of binding national sustainability mandates, this period was characterized by voluntary innovation, driven by an organizational commitment to environmental responsibility and reputational leadership. The Foundation, guided by its climate and ocean protection mission, catalysed several pilot projects and awareness campaigns that positioned Hi Fly as a sustainability pioneer.

Plastic-free flights and operational waste reduction

In 2018, Hi Fly became the first airline in the world to operate a "Single Use Plastic Free Flight", replacing items such as plastic cutlery, cups and packaging with compostable materials and paper-based alternatives. Interview participants from within Hi Fly noted that the initiative was partly symbolic but helped galvanize internal cultural shifts and demonstrate feasibility for broader airline adoption.

Concurrently, Hi Fly implemented waste-reduction initiatives across its flight operations and catering supply chains. These included the introduction of weight optimization protocols and cabin crew sustainability training. While emissions reductions from these actions were modest, they were viewed as essential first steps in building credibility and embedding sustainability into daily practice.

SAF awareness and early engagement

Although Hi Fly did not begin full-scale sustainable aviation fuel (SAF) operations during this phase, the Mirpuri Foundation collaborated with European SAF researchers and industry groups to explore feasibility scenarios for Portugal. Internal Foundation documents and public conference materials show that early awareness-raising efforts were aimed at aligning Hi Fly's strategic vision with the future SAF trajectory outlined by the European Commission and ICAO. Interviewees noted that Hi Fly's SAF readiness was limited by Portugal's lack of local production capacity and the absence of blending mandates at the time. However, participation in international forums on SAF innovation (e.g., Clean Skies for Tomorrow) positioned the airline to move quickly once regulatory incentives and infrastructure matured.

Cross-sector collaboration and SDG framing

During this period, the Mirpuri Foundation leveraged its partnerships in ocean conservation, academic research and international development to reframe aviation sustainability within the context of the UN Sustainable Development Goals (SDGs). By 2019, all of Hi Fly's flagship initiatives were being publicly aligned with specific SDGs, most notably:

- SDG 13 (Climate Action): Through emissions reduction commitments and awareness campaigns.
- SDG 12 (Responsible Consumption and Production): Via plastic-free flights and sustainable procurement.
- SDG 14 (Life Below Water): Through marine plastic campaigns that connected air travel with ocean health.
- SDG 17 (Partnerships for the Goals): Via joint initiatives with NGOs, academic institutions and intergovernmental bodies.

This framing served two purposes: it attracted external legitimacy and funding opportunities, and it helped internal stakeholders understand sustainability as a systemic, mission-aligned goal, not just an operational challenge.

Stakeholder mobilization and early cultural shift

Annual sustainability summits hosted by the Mirpuri Foundation, often co-branded with Hi Fly's public commitments, helped mobilize a network of stakeholders, including suppliers, regulators and environmental experts. Interviewees described this phase as one of "vision-building and narrative testing", where the Foundation's public advocacy began to influence internal airline strategy.

Survey data from later phases confirm that many Hi Fly staff members recall 2017-2019 as a formative period for building sustainability awareness, with 76% of 2024 survey respondents citing the plastic-free flight initiative as the moment they first viewed environmental action as "core to the organization's identity".

Phase 2 (2020-2021): Disruption and Strategic Reflection

For Hi Fly and the Mirpuri Foundation, the crisis triggered both operational suspension and a period of intensive strategic reflection. Flight activity across the aviation network dropped by more than 80% during 2020, while revenue losses and travel restrictions forced the temporary scaling back of many ongoing sustainability initiatives.

Yet rather than derailing the transition agenda, the pandemic served as a catalyst for deeper institutional commitment. This period marked a pivotal shift in organizational discourse, from voluntary green practices to the integration of resilience, long-term planning and systemic decarbonization into core strategy.

Crisis-induced suspension and organizational pivot

In line with global aviation trends, Hi Fly was forced to suspend several high-profile environmental initiatives during the peak of the pandemic. For instance, the single-use plastic-free program was partially paused due to public health regulations that reintroduced disposable materials into catering protocols. Likewise, early planning for SAF integration was placed on hold as supply chain disruptions and cost sensitivities made implementation unfeasible. However, internal interviews revealed that this period was not one of sustainability abandonment but strategic recalibration. A senior sustainability advisor noted:

> We didn't step away from our vision. We used the downtime to think more seriously about how we scale and institutionalize sustainability, not just showcase it.

Roadmap development and strategic realignment

The Foundation and other European carriers responded by launching a participatory process to develop a Sustainability Roadmap for Aviation Recovery, initiated in mid-2020 and finalized in early 2021. The roadmap outlined specific targets and timelines for:

- SAF adoption readiness and sourcing strategies.
- Electrification of ground support equipment and operations.
- Aircraft modernization and weight-efficiency measures.
- SDG-integrated reporting and governance models.
- Stakeholder engagement platforms for post-pandemic alignment.

This roadmap process brought together internal teams, academic collaborators and public policy advisors in structured workshops and digital forums. Document analysis shows the roadmap explicitly framed recovery as an opportunity to "build back greener", with a focus on embedding climate risk resilience and energy diversification into the organization's long-term aviation strategy.

Framing sustainability as resilience

COVID-19 also catalysed a discursive shift inside Hi Fly. Interviews and internal memos show that sustainability was increasingly framed not just as environmental ethics, but as core to risk management, operational continuity and strategic differentiation.

For example, fuel diversification (via SAF and electrification pilots) was discussed as a hedge against global volatility. Environmental reporting was reframed as a mechanism for investor and customer trust during turbulent periods. Also, investment in sustainable infrastructure was positioned as futureproofing, not just CSR.

This reframing is visible in internal communications, where "sustainability" and "resilience" were used interchangeably in executive briefings. One pilot summarized the new view by saying: "We realized green aviation wasn't just a goal anymore, it was insurance."

Alignment with recovery funding and EU strategy

Capitalizing on its repositioning efforts, the foundations engaged with Portuguese public agencies to advocate for green aviation funding within the national Recovery and Resilience Plan (RRP). Moreover, aviation decarbonization was included in Portugal's RRP portfolio, with eligibility for targeted investments in SAF readiness, airport electrification and training programs.

Although Hi Fly did not directly receive RRP funding in this phase, its roadmap and policy advocacy played a critical role in shaping eligibility criteria and raising the profile of aviation decarbonization within broader national recovery planning. Survey collected data confirmed strong internal awareness of this strategic influence, with 83% of respondents agreeing that "the pandemic strengthened the case for embedding sustainability in core strategy."

Phase 3 (2022-2025): Policy-Driven Acceleration and Institutionalization

Following the strategic recalibration of the COVID-19 period, the years 2022-2025 marked a phase of policy-driven acceleration and organizational deepening of the sustainability agenda at Hi Fly and the Mirpuri Foundation.

European carriers transitioned from an innovator at the margins to a recognized actor within the regime-level transition process, aligning operational strategies with Fit for 55 targets, SAF blending mandates under the ReFuelEU Aviation Regulation and updated emissions trading obligations under the revised EU ETS. These developments catalysed new investments, reporting structures and cross-sector collaborations, consolidating sustainability as a core organizational function.

SAF strategy maturation and blending readiness

Building on feasibility studies and roadmap planning from the previous phase, several airlines initiated their partial SAF-powered flights in collaboration with European SAF suppliers. While full-scale adoption was still constrained by cost and supply limitations, these test flights served as operational pilots for route-based SAF integration on select transatlantic and intra-European flights.

Additionally, several European airlines integrated SAF procurement scenarios into their fuel contracting process and signed letters of intent for future purchase agreements, particularly in anticipation of the 2% SAF blending mandate effective from 2025 under ReFuelEU. Some internal strategic reports reviewed during this study show a marked shift from SAF as a public-facing aspiration to a logistically embedded fuel diversification plan, framed around risk management and regulatory foresight. This positioning allowed airlines to become an early alignment case under the European Commission's policy monitoring program for SAF preparedness, with one interviewee noting:

> We stopped treating SAF as a pilot experiment and started treating it as the future baseline.

Progress, however, was partially constrained by Southern Europe's relatively slower SAF infrastructure development

compared to Northern EU markets, posing logistical and cost challenges for medium-sized carriers like Hi Fly.

Internal governance reform and reporting integration

To support the scaling of sustainability commitments, it was initiated internal governance reforms. These included:

- Creating a dedicated Sustainability and ESG Office, reporting directly to the CEO
- Launching a biannual internal SDG alignment audit, linking operational metrics to UN targets
- Publishing sustainability performance dashboards across all operational departments

This institutionalization marked a decisive move away from fragmented project-based approaches. Sustainability was now monitored through Key Performance Indicators (KPIs) embedded in staff evaluations, budget planning and external reporting. Interviews with operations personnel confirmed a "culture shift" where climate considerations became "non-negotiable components of planning and procurement."

Supplier engagement and sustainable value chain expansion

European airlines also extended their sustainability ambitions to the supplier ecosystem, launching a Supplier Sustainability Charter that established minimum environmental, labour and circular economy standards. Selected vendors, especially those in catering, maintenance and ground services, were required to complete annual compliance self-assessments aligned with ISO 14001 principles and EU taxonomy-aligned disclosures.

Survey responses from supply chain staff indicated that 68% of vendors viewed the Charter as "challenging but necessary" while 81% reported increased dialogue with procurement teams about sustainability strategy.

These efforts align with sustainability transitions literature emphasizing the importance of value chain coordination and intermediary leverage in regime-level shifts (Kivimaa et al., 2019; Rogge & Reichardt, 2016).

Institutional partnerships and policy co-design

During this period, European airlines strengthened their presence in multi-stakeholder climate policy platforms, including the Clean Skies for Tomorrow Coalition and the European Climate Pact. Airlines representatives participated in policy consultation rounds on Fit for 55 aviation targets and offered operational case inputs on SAF scaling challenges, especially for smaller EU carriers.

One interviewee described this role as "bridging between Brussels and the runway", highlighting Hi Fly's emerging identity as a policy-practice intermediary that contributed grounded technical insights into decarbonization planning at both EU and national levels.

At the Portuguese level, the Foundation supported co-design processes for decarbonization pilots under the country's Green Airports initiative, offering operational data and organizational models for smaller carriers aiming to meet EU sustainability obligations.

This pattern of institutional engagement and internal integration parallels trends observed among regional carriers and low-cost operators, where regulatory alignment and governance innovation have similarly accelerated sustainability transitions.

Strategic impacts and cultural consolidation

By the end of 2024, sustainability was no longer a peripheral or promotional domain within Hi Fly, it had become a core organizing logic. Survey collected data showed:

- 91% of internal respondents agreed that "sustainability goals influence the team operational decisions"
- 87% felt "clear accountability mechanisms are in place for environmental performance"
- 79% viewed the organization as "ahead of regulatory timelines".

This internal consolidation, coupled with external recognition, confirmed Hi Fly and the Mirpuri Foundation's evolution from early sustainability pioneers to institutionalized change agents embedded in the multi-scalar regime transformation.

This phase demonstrates the final transition from niche experimentation and crisis adaptation to policy-aligned acceleration and deep organizational integration, offering a replicable model for how private aviation actors can internalize sustainability transitions in both structure and culture. **Figure 1** summarizes the three transition phases identified in the analysis, outlining the key sustainability initiatives that characterized each period.

Additional Quantitative Impacts of Key Aviation Sustainability Initiatives

Sustainable Aviation Fuel can dramatically cut aviation's carbon emissions. Industry analyses show that using 100% SAF can reduce life-cycle CO_2 emissions by up to 80% compared to standard jet fuel (IATA, 2025). In practice, the CO_2 savings scale with blend ratio (e.g. a 50% SAF blend yields roughly a 40% net CO_2 reduction). For example, a recent transatlantic flight using 100% SAF avoided about 95 tons of CO_2, approximately 64% emissions reduction on the London-New York route (Duncan, 2024). Such results highlight the per-flight carbon avoided through SAF, underscoring its value as a mid-term decarbonization tool.

On the other hand, eliminating single-use plastics on board can significantly shrink cabin waste. Audits find that disposable plastics make up roughly 17-20% of airline cabin waste by weight (Pyzyk, 2024). Replacing plastic items with compostable or reusable alternatives therefore removes a substantial portion of inflight waste. For instance, Qantas's "zero-waste" flight substituted ≈ 1,000 plastic items and resulted in zero landfill waste; about 34 kg less trash than a typical flight of that length (Qantas Airways, 2019). This one-off demonstration kicked off a broader Qantas initiative to cut total waste by 75% by 2021 (Qantas Airways, 2019). Similarly, Etihad's ultra-long-haul Earth Day flight in 2019 flew with no single-use plastics, preventing over 50 kg of plastic from ending up as waste (Etihad Airways, 2019). These case studies show on the order of tens of kilograms (or ≈ 20-30% less cabin waste) saved per flight by going plastic-free, alongside improved recycling and composting of service items.

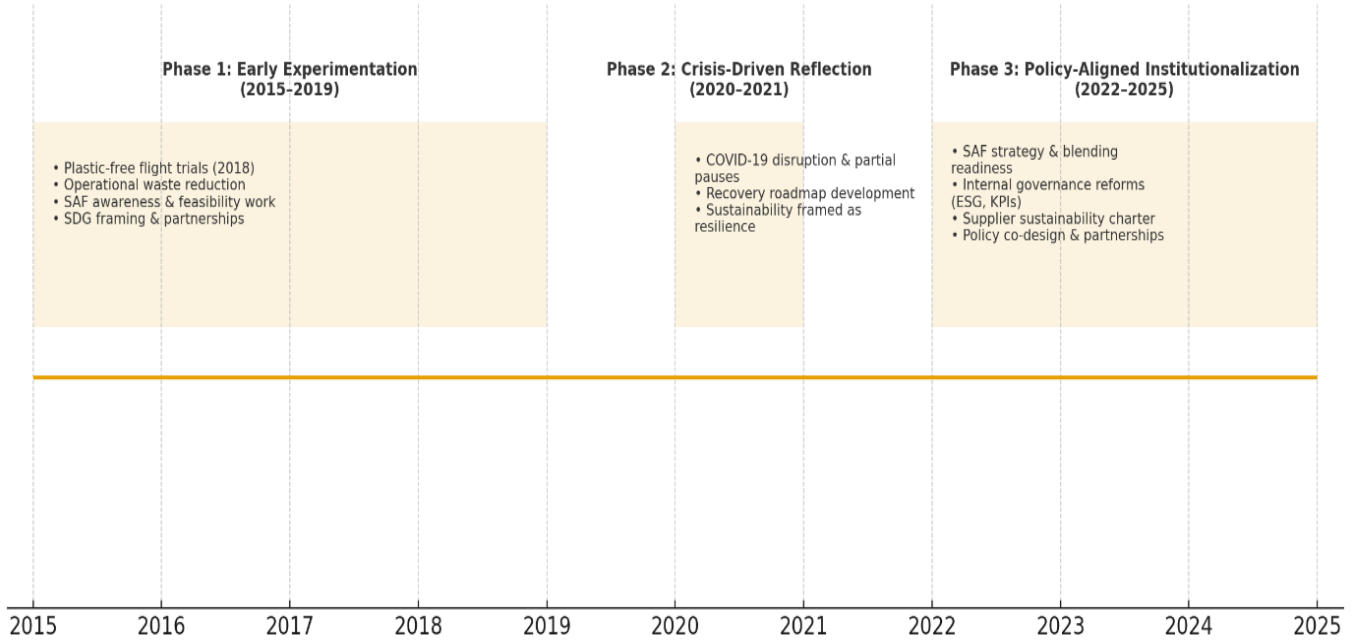

Figure 1. Summary of the transition phases & supporting sustainability measures observed (Source: Authors' own elaboration)

Finally, airlines have achieved notable efficiency gains through fleet modernization and operational measures. Each new aircraft generation is about 15-20% more fuel-efficient per seat than the previous (today's fleet is around 80% more efficient in fuel burn per passenger than 50 years ago) (IATA, 2025). For example, the latest Airbus A330NEO offers roughly a 25% lower fuel burn per seat compared to older A330 models (Hi Fly, 2020). Weight optimization also yields measurable savings: analyses show a 1% reduction in aircraft weight produces about a 0.75% decrease in fuel consumption (Almussa & Almaktoom, 2021). Airlines have pursued this via lighter seats and service equipment, digitized manuals and optimized catering loads. Even procedural changes can help; single-engine taxiing during ground operations cuts fuel burn for taxi by ≈ 20-40% (Hi Fly, 2020) (reducing both cost and emissions). Furthermore, shifting airport operations to cleaner power curbs fuel use: Electrifying ground support equipment (e.g. baggage tugs, gate power units) at Seattle-Tacoma airport now saves on the order of 10,000 tons of CO_2 emissions annually for airlines (Port of Seattle, 2014) and providing pre-conditioned electric air to aircraft at gates (allowing auxiliary engines to stay off) avoids another ≈ 40,000 tons of CO_2 per year at that hub (Port of Seattle, 2014). Together, such measures translate into several percentage points improvement in fleet-wide fuel efficiency, helping carriers meet fuel savings and emissions targets (IATA, 2025).

DISCUSSION

Overview of the Transition Trajectory

The case of Hi Fly and the Mirpuri Foundation illustrates a rare and analytically rich example of a private-sector-led sustainability transition in aviation. Spanning nearly a decade, their trajectory moved from niche-level experimentation (2015-2019) to crisis-induced strategic reflection (2020-2021) and finally to regime-aligned institutionalization (2022-2025). This progression aligns well with the multi-level perspective (MLP), demonstrating how actors can evolve in response to external shocks and policy changes, leveraging innovation, narrative and governance restructuring to shift their position within the aviation system.

Answering the Research Question

RQ1 What are the types of sustainable development supporting measures to consider in the aviation industry in the upcoming period to achieve sustainability (2025-2030)?

Based on the findings, five key types of supporting measures emerge, each illustrated by the case and scalable across the aviation sector:

Operational sustainability innovations

These include early interventions such as plastic-free flights, waste reduction programs and electric ground operations. In the case of Hi Fly, they laid the groundwork for more substantial investment in SAF and organizational reform.

Beyond their symbolic role, comparable industry evidence suggests that such initiatives can reduce inflight waste by up to 30% and deliver several percentage points of fleet-wide fuel efficiency improvements, underscoring their contribution to near-term decarbonization alongside their reputational and cultural value.

Strategic integration and governance reform

Sustainability becomes durable when embedded into formal structures: ESG offices, SDG audits, emissions dashboards, KPIs and board-level reporting. Such governance mechanisms enable continuity across leadership cycles and allow alignment with evolving regulatory frameworks. Hi Fly's

internal reform between 2022-2025 exemplifies how governance redesign enables systemic accountability.

Supply chain and partner alignment

Decarbonization is not limited to direct operations; it requires engaging the aviation value chain, including catering, maintenance, airport logistics and procurement. The introduction of Supplier Sustainability Charter demonstrates how carriers can shape upstream and downstream behaviour to align with SDG and EU Taxonomy criteria, acting as leverage points within the larger regime.

Policy engagement and co-design

Aviation actors must move from passive compliance to proactive participation in policy shaping. European airlines exemplified this by contributing case-based evidence to Fit for 55 consultations and SAF implementation roadmaps, helping close the feedback loop between innovation and regulation.

Resilience-based framing and long-term positioning

Perhaps most importantly, sustainability was reframed as a core resilience strategy, not merely an environmental or reputational issue. This framing (especially during COVID-19) enabled Hi Fly to protect its sustainability agenda, maintain organizational focus and use crisis conditions as an opportunity for long-term value creation. It demonstrates that disruption-resilient strategies are crucial to keeping sustainability on the agenda during volatility. The case underscores the value of strategically sequencing innovations, governance reform and policy engagement as mutually reinforcing pathways.

For mid-sized carriers like Hi Fly, these economics are particularly salient given thinner margins and limited hedging capacity relative to large flag carriers. A key uncertainty in the SAF transition is its cost-benefit profile, as current SAF options remain significantly more expensive than fossil jet fuel. SAF prices are reported at several times the price of conventional kerosene (European Commission, 2023), with some 2023 market quotes reaching around $3,400 per tonne (Van Dyk & Saddler, 2024). This steep price differential has so far kept SAF uptake very low (European Commission, 2023), underscoring that airlines have little economic incentive to adopt SAF at scale without external support. Accordingly, SAF uptake is heavily dependent on policy interventions, such as government subsidies, tax credits and blending mandates, designed to narrow the cost gap (Klimczyk et al., 2025). For example, the EU's new ReFuelEU Aviation regulation mandates a minimum 2% SAF blend by 2025, rising to 70% by 2050, to stimulate demand despite the higher fuel costs (European Commission, 2023). In the United States, recent legislation under the SAF Grand Challenge provides federal production credits (up to $1.75/gal, depending on lifecycle carbon intensity) to improve price-competitiveness and attract investment (Morciani, 2024). However, an overreliance on such policy support raises concerns about transition fragility and market distortion. The nascent SAF market is highly sensitive to policy and subsidy signals (Morciani, 2024), so if incentives are reduced or not globally synchronized, there is a risk airline could revert to cheaper fossil fuels or reroute operations to avoid unequal cost burdens. Studies warn, for instance, that unilateral SAF mandates can lead to "leakage" effects (shifting traffic to jurisdictions with less stringent requirements) if cost disparities become large (Surgenor, 2025). In the long run, therefore, a sustainable SAF transition hinges on reducing production costs and improving fuel economics, so that decarbonization can continue without perpetual subsidies or protectionist measures (Morciani, 2024). While scale-up and technology learning could reduce unit costs over time, the speed and extent of these cost declines remain uncertain.

Cross-case comparison: Hi Fly, Widerøe and Transavia

Company profile

In Europe's mid-sized aviation sector, Hi Fly (a Portuguese wet-lease specialist), Widerøe (a Norwegian regional carrier) and Transavia (a Dutch low-cost airline under Air France-KLM) have each adopted distinct sustainability strategies. Hi Fly frames itself as an innovation leader, investing in new technologies and industry dialogues. It has convened forums on "net-zero emissions travel" and pioneered zero-waste flights (Hi Fly, 2025). Its corporate foundation underwrites carbon-offset research (e.g. seaweed CO_2 capture) and Hi Fly explicitly "takes the view that carbon reduction rests upon the company" not passengers (Hi Fly, 2020).

By contrast, Widerøe emphasizes resilience and social responsibility: It calls itself "more than just an airline" essential for rural connectivity and is "committed to a fossil-free technological transition" (Widerøe, 2025). This mission-driven framing underpins Widerøe's pledge to introduce fossil-free short-haul routes by 2030 and adopt new aircraft concepts (via Widerøe Zero) (European Regions Airline Association, 2025).

Transavia's framing is more compliance and efficiency driven: It acknowledges that "flying is currently unsustainable" and focuses on reducing CO_2 through innovation and fleet renewal (Transavia, 2025). Transavia supports its parent KLM's stance on the EU's Fit-for-55 climate goals (KLM, 2025) and pursues incremental improvements (lighter planes, recycling, etc.) within existing market frameworks (KLM, 2025).

Technological adoption

Hi Fly has modernized its fleet (e.g. taking delivery of an Airbus A330neo with roughly 25% better fuel burn per seat) and uses operational efficiencies (FANS navigation, single-engine taxiing) to cut emissions (Hi Fly, 2020). It is researching bio-based fuels and offsets, though it has not committed to electric or hydrogen aircraft (its widebody wet-lease model precludes short-haul tech).

Widerøe, by contrast, is aggressively pursuing new propulsion: It has upgraded to more efficient turboprops and Embraer E2 jets (17% more efficient than their predecessors) and will consolidate to Dash 8 Q400 aircraft (78 seats) by 2023 for lower per-seat emissions (Widerøe, 2025). Crucially, Widerøe is collaborating on next-generation technologies: its Widerøe Zero incubator plans to put a zero-emission regional plane into service by 2026 and to replace its entire Dash 8 fleet by 2030 (European Regions Airline Association, 2025). In the near term, Widerøe is increasing use of Sustainable Aviation Fuel (SAF) and even allows passengers to buy SAF for their

ticket (Widerøe, 2025). Transavia is also renewing its fleet (phasing out Boeing 737s in favour of Airbus A321neos to reduce fuel consumption) and it complies with EU SAF mandates (≈ 2% SAF blend as of 2025) (Transavia, 2025). It invests in marginal innovations and funds start-ups through Transavia Ventures, but electric/hydrogen aviation is not yet in its operational plans (Transavia, 2025).

Governance models

Hi Fly's approach is company-driven with NGO partnerships. It established a sustainability-focused foundation and collaborates with groups like the Mirpuri Foundation on conservation initiatives (Hi Fly, 2025). The airline's governance relies on internal ESG commitments rather than government mandates.

Widerøe, however, operates within a semi-public model: it is state-partnered and has launched the independent Widerøe Zero incubator as a separate unit to navigate regulatory, financial and technical challenges (European Regions Airline Association, 2025; Rolls Royce, 2022). This blends government support (e.g. incentives and subsidies) with industry R&D alliances (e.g. partnerships with Embraer, Rolls-Royce).

Transavia's governance is embedded in the Air France-KLM corporate structure: Its climate actions are driven by group targets and EU policy compliance (KLM, 2025). It has internal teams for sustainability and leverages market-driven solutions rather than NGO programs.

Policy alignment and engagement

All three carriers align with European decarbonization policies but with different emphases. In the EU, Fit-for-55 and ReFuelEU Aviation set binding SAF blending quotas (2% by 2025, rising toward 6% by 2030) and tighten Emissions Trading Scheme (ETS) charges. Transavia explicitly commits to these EU goals through its parent company (KLM, 2025). It reports meeting the 2% SAF requirement on flights from Europe (Transavia, 2025). Hi Fly, as an EU operator, similarly must blend SAF and is exploring future SAF supply (e.g. potential conversion of seaweed to jet fuel). Widerøe works under Norway's equivalent regulations: Its government mandates 20% SAF by 2035 (70% by 2050) and Widerøe aims to exceed these if possible (Widerøe, 2025). In summary, while all three engage with EU climate policy (SAF mandates, ETS), Hi Fly leans on voluntary innovation and offsetting, Widerøe leverages state partnership and R&D programs, and Transavia operates through corporate compliance and industry coalitions.

Each airline thus illustrates a pathway in the broader European mid-size segment: Hi Fly as a market-driven pioneer, Widerøe as a public-interest innovator and Transavia as a cost-focused carrier adapting to regulation. These cross-case contrasts underscore how fleet strategy, ownership structure, and regulatory context shape sustainability transitions in regional aviation.

Hi Fly as a Transition Intermediary: Roles and Functions

Kivimaa et al. (2019) describe transition intermediaries as actors that connect diverse stakeholders and levels of a system, thereby facilitating sustainability transitions. Their typology highlights several intermediary roles "notably facilitators, brokers and advocates" which differ in function and orientation. Facilitators are often "neutral" coordinators who convene networks and enable innovation without pushing a specific agenda. Brokers serve as go-betweens, mediating between groups (e.g. translating between policymakers and practitioners or linking niche innovators with regime actors). In contrast, advocates (or "champions") adopt a more normative stance, actively promoting particular sustainability solutions or agendas. Importantly, these roles can overlap; the same intermediary may simultaneously facilitate collaboration, broker knowledge and advocate for change. Hi Fly's case exemplifies this multi-faceted intermediary capacity, acting at different times as facilitator, broker and advocate in Europe's aviation transition.

As a facilitator, Hi Fly (through the Mirpuri Foundation) played a coordinating role by engaging a wide range of stakeholders and building coalitions around green innovation. The case study showed that Hi Fly fostered stakeholder engagement and internal buy-in for sustainability initiatives. For instance, the airline introduced supplier sustainability charters and staff training programs, aligning its value chain and employees with environmental goals. These efforts created shared sustainability commitments across the organization and its partners, essentially facilitating collaboration for niche experiments (like single-use plastic-free flights and operational waste reduction).

As a broker, Hi Fly acted to bridge the gap between high-level policy ambitions and on-the-ground practice. The company effectively connected EU policy frameworks with practical implementation, serving as a two-way conduit between regulators and industry. Notably, Hi Fly translated high-level EU climate directives into organizational governance measures, aligning its operations with emerging regulations like ReFuelEU Aviation and Fit for 55. This brokering role is evident in how Hi Fly shaped broader discourses on decarbonization: the airline brought insights from its niche experiments into national and regional forums, while simultaneously preparing internally for future policy mandates. For example, during "2020-2021" Hi Fly participated in developing a Sustainability Roadmap for Aviation Recovery, linking policy advisors, academics and internal teams to co-create transition strategies. Such initiatives positioned Hi Fly in between policy and practice, interpreting regulatory goals into actionable plans and feeding practical lessons back into policy discussions.

As an advocate, Hi Fly took on a proactive agenda-setting role in the sustainability transition of aviation. Rather than remaining a neutral player, the company (via the Foundation) became an outspoken champion for decarbonization, leveraging its experience to influence broader change. Hi Fly's sustainability leadership gained it access to European climate policy networks, including Clean Skies initiatives and EU consultation platforms. In these arenas, Hi Fly acted as a transition advocate by sharing empirical evidence and pushing for supportive policies. For instance, the case notes that Hi Fly's early green initiatives placed it in key EU sustainability forums where it contributed practical insights on implementing green aviation practices. The airline's input in such forums, ranging from technical feasibility of biofuels to the business case for single-use plastic, exemplifies advocacy: Hi Fly was not just complying with policy but actively shaping

the policy narrative. Moreover, the Mirpuri Foundation's leadership played an agenda-setting role domestically, signalling to regulators and competitors that ambitious climate action in aviation is attainable even for smaller carriers. In sum, Hi Fly functioned as an advocate by lobbying for transition-supportive measures and by publicly championing a vision of sustainable aviation grounded in its case experience.

In linking these roles to the case findings, Hi Fly emerges as a nuanced transition intermediary in European aviation. It facilitated change by orchestrating stakeholder alliances and internal reforms, brokered knowledge and goals between EU policy and industry practice and advocated for transformative change in policy circles. This alignment of Hi Fly's actions with the facilitator-broker-advocate typology underscores the firm's intermediary character. Rather than a passive recipient of top-down mandates, Hi Fly became a change agent "in-between" multiple arenas, convening partners, translating policies and campaigning for systemic shifts. This multi-role engagement strengthens the interpretation of Hi Fly as a transition intermediary in the aviation sector, concretely illustrating how a mission-driven private actor can fulfil the various functions identified in transition intermediary theory (facilitation, brokerage and advocacy) to drive sustainability transitions.

MLP Analysis: Niches, Regime, and Landscape

Hi Fly's case can be read through this lens: it acted as an intermediary linking niche experiments to regime actors. Importantly, Geels (2002) emphasizes that major landscape events can weaken incumbent stability and open windows for niche solutions.

Niches

Hi Fly's pioneering initiatives functioned as classic niche experiments. Under the Mirpuri Foundation's guidance, the airline launched world First "Single Use Plastic Free Flights".

As the interviews and documents show, some pilots (even if partly symbolic) yielded important lessons (testing new procedures and passenger-facing practices) and helped to galvanize internal support for sustainability. In MLP terms, they generated "learning" about feasibility and cost and built momentum for change. However, the case also underlines the limitations of niche experiments. Industry literature notes that high-profile green flights often expose persistent barriers (high SAF prices, supply bottlenecks, certification hurdles) that slow mainstream adoption. In our case, Hi Fly found that scaling SAF beyond trials remained difficult without external support. In summary, Hi Fly's zero waste flights and SAF flights analysis exemplified protected niche innovations: They enabled hands-on learning and signalled possibilities, but their broader scaling was constrained by the incumbent system's structural and economic limits.

Regime

At the regime level, Europe's commercial aviation system still centers on legacy fleets, cost driven operations and slow-moving institutions. Hi Fly's green experiments were atypical within these norms; for example, flying with zero-waste catering goes against the prevailing logic of minimizing service costs. To navigate this regime, Hi Fly embedded its niche lessons into the organization and market relations.

Internally, it codified new practices (e.g. staff training) so that sustainability became part of standard procedures. Externally, it aligned its strategy with emerging regulations: for instance, once EU climate targets became clear, Hi Fly reformed its governance to anticipate the ReFuelEU mandates and Fit-for-55 requirements. In doing so, it effectively acted as a translator between the regime and innovative niches. The interviewees noted that early SAF pilots' analysis, while niche, "demonstrated feasibility to industry peers" and helped shift perceptions about what a mid-sized carrier could do. Hi Fly also moved to challenge the status quo by sharing its experience in policy forums.

Between 2020-2021 it actively contributed to EU consultations and recovery roadmaps, bringing niche lessons to bear on policy design. These brokering and advocacy efforts (lobbying for SAF incentives, stricter waste rules, etc.) show Hi Fly pushing back on regime inertia. In sum, the airline both adapted to the regime (by complying with new rules and aligning its operations) and nudged it (by exemplifying alternative practices). As Hess (2014) suggests, altering the regime ultimately involves new coalitions; Hi Fly's role in EU forums and sustainability networks indicates that it began to build such alliances, even if incumbents still dominate.

Landscape

Broad external forces "the landscape" had a decisive impact on Hi Fly's trajectory. Two in particular stand out. First, the COVID-19 pandemic was a massive landscape shock for aviation. Paradoxically, it became a window of opportunity for Hi Fly.

The analysis shows that the foundation "doubled down on its green commitments" during the crisis, using the downtime to intensify sustainability pilots and reframe strategy around resilience. The pandemic disrupted demand, but it also weakened normal pressures and opened space for reflection, fitting Geels's idea that a major event can destabilize the regime.

Second, evolving EU climate policy constituted another landscape pressure. The European Commission "European Green Deal" in 2019, "Fit for 55" legislative package in 2021 and "ReFuelEU Aviation Regulation" in 2023 introduced binding targets and SAF blending mandates. These policies sent clear signals: By 2025-2030, airlines must deploy SAF at scale. Hi Fly took these cues seriously, proactively integrating SAF planning into its fleet and operations. In effect, these landscape pressures "Created windows of opportunity": Because the incumbent regime was being reshaped top down, Hi Fly's niche innovations suddenly gained greater relevance. It could position itself as ahead of the regulatory curve, framing its small-scale trials as pilot projects for the forthcoming era. At the same time, the case underscores the fragility of this alignment: as literature warns, without ongoing policy support (subsidies, mandates) niche gains can evaporate.

In sum, the Hi Fly/Mirpuri case illustrates classic MLP dynamics. Its early SAF analysis and zero-waste flights were niche experiments, yielding learning but limited by the regime's inertia. The regime (commercial aviation) displayed

rigidity, but Hi Fly worked within it (modifying internal rules and engaging incumbents) while also pushing its boundaries by demonstrating new norms and feeding insights into policy discussions.

Crucially, landscape forces like COVID-19 and EU climate mandates reshuffled the context. COVID weakened aviation's status quo and spurred Hi Fly's reflexivity and Fit-for 55/ReFuelEU created external expectations that made Hi Fly's niche activities strategically valuable. These layered dynamics confirm that sustainable aviation transitions depend on multi-level alignment: radical niche projects must be nurtured and linked to changing regime structures under favourable landscape signals.

Contributions to Theory and Practice

From a theoretical standpoint, this case expands MLP applications by showing how mid-sized private actors can act as both niche innovators and policy-aligned regime shapers. It also reinforces the importance of reflexive governance; the ability to adapt sustainability strategy under uncertainty, not just during stable growth periods.

Practically, the study offers a replicable transition model for airlines that are not flag carriers or industry giants. Through organizational reform, supplier leverage, policy advocacy and SDG alignment, smaller airlines can move ahead of regulatory curves while building reputational and operational resilience.

A persistent tension, however, lies in balancing the pace of policy ambition with the operational and financial capacity of smaller carriers, especially around SAF scaling and emissions reporting. The case illustrates that while innovation leadership is possible, asymmetries in infrastructure and funding access may widen unless policy mechanisms are tailored to support diverse actor types within the regime. This case contributes to sustainability-transitions theory in four ways.

1) Re-positioning mid-sized private actors as multi-role transition intermediaries

   While MLP studies frequently emphasize incumbents and state-led trajectories, the study findings show a mid-sized, mission-driven firm can combine facilitation, brokerage, and advocacy to connect niche experiments to regime agendas (Kivimaa et al., 2019). In the Hi Fly-Mirpuri configuration, intermediary work was not "neutral" coordination; it also involved normative agenda-setting and direct operational implementation. This extends intermediary typologies by theorizing blended roles within a single organization that operates across levels (niche, regime, landscape) (Geels, 2002; Kivimaa et al., 2019). Empirically, the case evidences this blended intermediation in both internal change and external coalitioning.

2) Resilience-based sustainability framing as a landscape-agency coupling mechanism

   MLP highlights how landscape shocks open windows for realignment (Geels, 2002). The study theorizes resilience-based framing as a mechanism that links those shocks to intra organizational institutionalization: Sustainability is recast as core risk management and continuity, accelerating the entrenchment of green practices during disruption rather than merely pausing them. This complements reflexive-governance ideas by showing how crises trigger strategic learning loops that stabilize sustainability routines (Loorbach et al., 2017). Evidence from the pandemic period supports this mechanism.

3) Internal governance instrumentation as micro-foundations of regime alignment

   Beyond policies "from above", the study conceptualizes internal instruments (ESG offices, supplier charters, SDG-linked KPIs) as organizational micro-foundations that translate policy signals into operational change and, over time, prefigure regime shifts (Markard et al., 2011; Rogge & Reichardt, 2016). These instruments act as institutional design choices that stabilize new norms, reducing dependence on exogenous alignment alone.

4) Boundary conditions and periphery pathways

   Finally, the study qualifies transferability. The trajectory observed here (private governance in a relatively underfunded context) suggests a periphery pathway where non-state actors may punch above their weight, but outcomes remain sensitive to infrastructure, finance and policy capacity (Hess, 2014). This refines expectations about generalization and clarifies when mid-sized private leadership is most plausible.

However, the transferability of these findings is subject to important limitations imposed by context. The outcomes observed were shaped by specific features of Portugal's regulatory environment. In addition, the Mirpuri Foundation's uniquely mission-driven leadership model provided a driving force that is not easily replicated in other organizations. As such, generalizing beyond similar organizational and national contexts should be approached with caution. Indeed, sustainability transition outcomes are often highly context-dependent, meaning that efforts to replicate this model in a large national flag carrier or under different political conditions could yield markedly different results (Gerlitz et al., 2024).

Key Enablers and Barriers

The case analysis highlights that Hi Fly's sustainability transition was driven by several enabling conditions, even as systemic barriers persist. Crucially, the Mirpuri Foundation's mission-driven leadership provided a clear, agenda-setting vision, signalling that ambitious climate action is attainable even for smaller carriers. This leadership opened doors to European sustainability networks: Hi Fly's early green innovations earned it a seat in EU policy forums (e.g. public consultations), where it shared practical insights and advocated for decarbonization measures. Internally, active stakeholder engagement (for example, pioneering pilot initiatives) generated strong staff buy-in. The survey found that many employees later viewed these initiatives as making environmental action "core to the organization's identity". Importantly, the COVID-19 downturn was used as strategic "downtime": Hi Fly leveraged the pause in operations to refine

its sustainability roadmap and integrate climate resilience into its core strategy.

Nonetheless, several persistent barriers remain. Chief among these is sustainable aviation fuel (SAF) supply: Hi Fly's experience shows that Southern European carriers suffer from scarce local SAF production and blending mandates, which constrain SAF availability and keep costs high. This mirrors broader evidence that SAF uptake is hampered by high prices and limited infrastructure. More generally, as a mid-sized airline in a peripheral market, Hi Fly operates with comparatively little state support, infrastructure or funding compared to larger flag carriers. Finally, the rapidly evolving regulatory environment (e.g. EU ETS reforms, kerosene taxes and ReFuelEU SAF mandates under "Fit-for-55") imposes complex compliance burdens on smaller operators. Together, these enabling conditions and obstacles underscore the need for coordinated public-private efforts and tailored support mechanisms for smaller, sustainability-committed airlines.

CONCLUSIONS

This study examined the role of the Mirpuri Foundation and Hi Fly in driving sustainability transitions in aviation between 2015 and 2025. Drawing on document analysis, stakeholder interviews and survey data, it traced the organization's evolution across three distinct phases: early experimentation, crisis-induced strategic reflection and regime-aligned institutionalization. Anchored in the multi-level perspective (MLP) and concepts of reflexive governance, the study highlights how a private-sector actor "such as Hi Fly" can act as a transition intermediary, helping to reshape aspects of the aviation system from within.

The central research question asked: What are the types of sustainable development supporting measures to consider in the aviation industry in the upcoming period to achieve sustainability (2025-2030)?

In response, the case identified five interrelated categories of action (which may be transferable under similar conditions):

1. Operational innovations that build internal momentum and stakeholder trust,
2. Governance reform and strategic integration that institutionalize sustainability across planning and reporting systems,
3. Value chain alignment through supplier charters and ESG criteria,
4. Policy engagement and co-design, where carriers become active participants in shaping the rules that govern them, and
5. Resilience framing, in which sustainability is understood not only as an environmental imperative but as a strategic asset.

These findings offer both theoretical and practical contributions. Theoretically, the findings suggest that MLP-aligned transitions might also be initiated by mission-driven mid-sized firms with the agility to experiment, the credibility to influence and the governance capacity to embed change. Practically, the study proposes a potential roadmap (based on this case) for aviation actors seeking to align with EU policy targets, SDG frameworks and emerging sustainability standards. While based on a single case, the findings offer analytical insights that may inform sustainability transition strategies in other mid-sized aviation markets.

Looking forward, the aviation industry faces a defining decade. Achieving sustainability by 2030 will require not only technological breakthroughs and regulatory reforms, but also organizational transformation, value chain collaboration and multi-level governance coordination. As this case suggests, progress may be possible "even under conditions of disruption" when sustainability is treated not merely as a compliance burden but as a source of strategic direction and adaptive capacity. Hi Fly and the Mirpuri Foundation's experience points to a key lesson for the sector: Actors who do not wait for mandates, but lead through purpose, partnership and preparation, may achieve greater resilience.

While the case is grounded in Portugal, the findings contribute to broader debates about how sustainability transitions unfold in aviation systems with varying governance capacities. Unlike Northern European markets, where strong public policy, state ownership and infrastructure investment guide transitions, this study illustrates how private actors in peripheral contexts may rely more heavily on reputational leverage, partnership networks and discursive framing to drive change. This distinction highlights the existence of multiple viable transition pathways, each shaped by regulatory maturity, market size and institutional culture. The Hi Fly-Mirpuri case does not serve as a universal blueprint; instead, it offers a grounded framework for understanding how mid-sized carriers can lead sustainability transformations within constrained or evolving policy environments. These findings are particularly applicable to aviation actors in peripheral EU markets or other regions with limited state support, where reputational leverage, stakeholder collaboration and reflexive governance can act as powerful tools for transition.

LIMITATIONS AND FUTURE RESEARCH

While this study provides rich qualitative insights into organizational transitions, governance reform and stakeholder engagement in sustainable aviation, it does not include direct measurement of emissions reductions or lifecycle environmental impacts associated with the initiatives described. This is due in part to data availability limitations and the strategic rather than technical scope of the case study. Future research could complement these findings through quantitative assessments of carbon savings from sustainable aviation fuel (SAF) usage, electrified operations and waste reduction measures. Combining transition analysis with environmental performance metrics would strengthen causal attribution and further inform cost-benefit evaluations. Additionally, comparative studies across multiple carriers or regional contexts should test the transferability of the mechanisms identified here under varying institutional conditions.

This case contributes to a broader understanding of how aviation sustainability transitions can take shape across diverse institutional and geographic contexts. Compared to

Northern European pathways, often driven by state ownership, public funding and regulatory certainty, the Hi Fly-Mirpuri trajectory highlights the potential of private-led, reputationally driven and partnership-based models in more peripheral or under-resourced settings. This suggests that aviation transitions are not monolithic but may emerge through plural pathways shaped by actor type, governance context and external shocks. The findings encourage future research to build typologies of aviation transition models, distinguishing between state-centric, hybrid and market-driven approaches across different regional and institutional environments.

The quantitative data cited in the Results (e.g., estimated CO_2 reduced from SAF, plastic-free cabin waste reductions and efficiency gains from operational measures) are drawn from comparable industry case studies and airport programs; they serve as context-setting benchmarks rather than direct measurements of Hi Fly's operations. Future work should collect Hi Fly specific operational data (fuel uplift, SAF blend shares, waste audits, taxi/turnaround logs) to validate and refine these benchmarked figures and enable causal attribution.

Author contributions: YK: conceptualization, methodology, data curation, formal analysis, investigation, writing – original draft, visualization, project administration; **JM:** conceptualization, methodology, supervision, validation, writing – review & editing, project administration; **CP:** conceptualization, methodology, supervision, validation, writing – review & editing, project administration. All authors agreed with the results and conclusions.

Authors' notes: This work was derived from a PhD thesis (Major: Industrial Engineering and Management) being currently carried out at the University of Aveiro.

Acknowledgments: The authors wish to express sincere gratitude to the Mirpuri Foundation and its partners for their invaluable support and contributions to this research. Their commitment to advancing sustainable aviation provided critical insights and access to resources that greatly enriched this study

Funding: This research received no specific grant from any funding agency in the public, private or non-profit sectors.

Ethical statement: The authors stated that the study involved voluntary interviewing and surveying aviation professionals about organizational sustainability practices. Interviews and surveys were fully anonymous, and no personal identifiers, sensitive information or confidential data were collected. Additionally, all General Data Protection Regulation (GDPR) requirements were taken into consideration throughout the study. Studies that do not involve personal data, vulnerable populations or identifiable information are typically exempt from formal ethics committee review under the institutional and national policies. Prior to each interview/survey, participants were informed about the purpose of the study, the voluntary nature of participation and their right to withdraw at any time. Verbal informed consent was obtained from all participants and all data was stored, managed and analyzed securely.

AI statement: The authors stated that AI tools were not used to produce or revise the scientific content of this manuscript. AI was used only for minor editing assistance, such as grammar checking and language improvement.

Declaration of interest: The authors declare no conflict of interest.

Data sharing statement: Data supporting the findings and conclusions are available upon request from corresponding author.

REFERENCES

Airbus. (2023). *Sustainable aviation fuel (SAF): A key lever for decarbonisation*. https://www.airbus.com/en/innovation/energy-transition/our-commitment-to-saf

Almussa, N., & Almaktoom, A. (2021). The effects of reducing aircraft weight on profitability and fuel consumption. *Palarch's Journal of Archaeology of Egypt/Egyptology, 18*(15), 206-214.

Aviation International News. (2024). *Electric and hydrogen aircraft: Innovation outlook and infrastructure challenges*. https://www.ainonline.com/

Creswell, J. W., & Plano Clark, V. L. (2018). *Designing and conducting mixed methods research* (3rd ed.). SAGE.

Denzin, N. K. (1978). *The research act: A theoretical introduction to sociological methods* (2nd ed.). McGraw-Hill.

Duncan, C., (2024). *First transatlantic sustainable aviation fuel flight 'saved 95 tonnes of CO2'*. IMPERIAL. https://www.imperial.ac.uk/news/253193/first-transatlantic-sustainable-aviation-fuel-flight/

EASA. (2022). *European aviation environmental report 2022*. European Union Aviation Safety Agency Official Website. https://www.easa.europa.eu/sites/default/files/eaer-downloads//230217_EASA%20EAER%202022.pdf

Etihad Airways. (2019). *Etihad airways to operate single-use plastic free flight on earth day as part of its commitment to sustainability*. Etihad Official Website. https://www.etihad.com/en-us/news/etihad-airways-to-operate-single-use-plastic-free-flight-on-earth-day-as-part-of-its-commitment-to-sustainability

European Commission. (2019). *The European Green Deal: Communication from the Commission to the European Parliament, the European Council, the European Economic and Social Committee and the Committee of the Regions (COM (2019) 640 final)*. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52019DC0640

European Commission. (2021). *'Fit for 55': delivering the EU's 2030 climate target on the way to climate neutrality (COM (2021) 550 final)*. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A52021DC0550

European Commission. (2023). *ReFuelEU aviation: Sustainable fuel for a greener future*. Directorate-General for Mobility and Transport. https://transport.ec.europa.eu/transport-modes/air/environment/refueleu-aviation_en

European Regions Airline Association. (2025). *Norwegian regional airline Widerøe launches Widerøe Zero*. https://www.eraa.org/member_initiatives/norwegian-regional-airline-wideroe-launches-wideroe-zero/

Geels, F. W. (2002). Technological transitions as evolutionary reconfiguration processes: A multi-level perspective and a case-study. *Research Policy, 31*(8-9), 1257-1274. https://doi.org/10.1016/S0048-7333(02)00062-8

Geels, F. W. (2020). Micro-foundations of the multi-level perspective on socio-technical transitions: Developing a multi-dimensional model of agency through cross-case analysis. *Technological Forecasting and Social Change, 152*, Article 119894. https://doi.org/10.1016/j.techfore.2019.119894

Gerlitz, L., Meyer, C., & Henesey, L. (2024). Sourcing sustainability transition in small and medium-sized ports of the Baltic Sea Region: A case of sustainable futuring with living labs. *Sustainability*, *16*(11), Article 4667. https://doi.org/10.3390/su16114667

Gössling, S., Scott, D., & Hall, C. M. (2020). Pandemics, tourism and global change: A rapid assessment of COVID-19. *Journal of Sustainable Tourism, 29*(1), 1-20. https://doi.org/10.1080/09669582.2020.1758708

Hess, D. J. (2014). Sustainability transitions: A political coalition perspective. *Research Policy, 43*(2), 278-283. https://doi.org/10.1016/j.respol.2013.10.008

Hi Fly (2025). *Hi Fly reinforces commitment to sustainable aviation at the 2025 Mirpuri foundation conservation forum*. https://hifly.aero/media-center/hi-fly-reinforces-commitment-to-sustainable-aviation-at-the-2025-mirpuri-foundation-conservation-forum/

Hi Fly. (2020). *Hi Fly Sustainability*. https://www.hifly.aero/public/uploads/2020/01/HiFly_Sustainability_site.pdf

Hi Fly. (2024). *Five years since the first single-use plastic free flight in the world*. https://hifly.aero/media-center/five-years-since-the-first-single-use-plastic-free-flight-in-the-world/

Hsieh, H.-F., & Shannon, S. E. (2005). Three approaches to qualitative content analysis. *Qualitative Health Research, 15*(9), 1277-1288. https://doi.org/10.1177/1049732305276687

IATA. (2025). *Developing sustainable aviation fuel (SAF)*. The International Air Transport Association. https://www.iata.org/en/programs/sustainability/sustainable-aviation-fuels/

ICAO. (2022). *Aviation and the UN sustainable development goals (SDGs)*. International Civil Aviation Organization. https://www.icao.int/about-icao/aviation-development/pages/sdg.aspx

IEA. (2023). *Global aviation sector: Tracking progress 2023*. International Energy Agency. https://www.iea.org/reports/aviation

Kharina, A., Rutherford, D., & Zeinali, M. (2016). *Cost assessment of near- and mid-term sustainable aviation fuel pathways*. International Council on Clean Transportation. https://theicct.org/sites/default/files/publications/ICCT%20aircraft%20fuel%20efficiency%20cost%20assessment_final_09272016.pdf

Kivimaa, P., Boon, W., Hyysalo, S., & Klerkx, L. (2019). Towards a typology of intermediaries in sustainability transitions: A systematic review and a research agenda. *Research Policy, 48*(4), 1062-1075. https://doi.org/10.1016/j.respol.2018.10.006

Klimczyk, W., Jasiński, R., Niklas, J., Siedlecki, M., & Ziółkowski, A. (2025). Sustainable aviation fuels: A comprehensive review of production pathways, environmental impacts, lifecycle assessment, and certification frameworks. *Energies*, *18*(14), Article 3705. https://doi.org/10.3390/en18143705

KLM. (2025). *Climate action plan*. https://img.static-kl.com/m/7b0b0f3946d5bb53/original/KLM-Climate-Action-Plan.pdf

Kvale, S., & Brinkmann, S. (2009). *Interviews: Learning the craft of qualitative research interviewing* (2nd ed.). SAGE.

Lee, D. S., Fahey, D. W., Skowron, A., Allen, M. R., Burkhardt, U., Chen, Q., Doherty, S. J., Freeman, S., Forster, P. M., Fuglestvedt, J., Gettelman, A., De León, R. R., Lim, L. L., Lund, M. T., Millar, R. J., Owen, B., Penner, J. E., Pitari, G., Prather, M. J., … Wilcox, L. J. (2021). The contribution of global aviation to climate change for 2000 to 2018. *Atmospheric Environment, 244*, Article 117834. https://doi.org/10.1016/j.atmosenv.2020.117834

Loorbach, D., Frantzeskaki, N., & Avelino, F. (2017). Sustainability transitions research: Transforming science and practice for societal change. *Annual Review of Environment and Resources, 42*, 599-626. https://doi.org/10.1146/annurev-environ-102014-021340

Markard, J. (2011). Transformation of infrastructures: Sector characteristics and implications for fundamental change. *Technological Forecasting and Social Change, 78*(8), 1224-1235. https://doi.org/10.1061/(ASCE)IS.1943-555X.0000056

Morciani, J. (2024). *Propelling forward: SAF and the path to a greener aviation industry*. Fastmarkets. https://www.fastmarkets.com/insights/saf-aviation-industry-market-trends/

Palinkas, L. A., Horwitz, S. M., Green, C. A., Wisdom, J. P., Duan, N., & Hoagwood, K. (2015). Purposeful sampling for qualitative data collection and analysis in mixed method implementation research. *Administration and Policy in Mental Health and Mental Health Services Research, 42*(5), 533-544. https://doi.org/10.1007/s10488-013-0528-y

Patton, M. Q. (2015). *Qualitative research & evaluation methods* (4th ed.). SAGE.

Port of Seattle. (2014). *Sea-tac airport unveils electrification project to save airlines millions in fuel and dramatically reduce greenhouse gas emissions*. https://www.portseattle.org/news/sea-tac-airport-unveils-electrification-project-save-airlines-millions-fuel-and-dramatically

Pyzyk, K. (2024). *Aviation industry group recommends how plastic reduction can take off*. Packaging Dive. https://www.packagingdive.com/news/airlines-single-use-plastics-sustainable-aviation-air-transport/712707/

Qantas Airways. (2019). *QANTAS operates world's first zero waste flight*. https://www.qantasnewsroom.com.au/media-releases/qantas-operates-worlds-first-zero-waste-flight/

Rogge, K. S., & Reichardt, K. (2016). Policy mixes for sustainability transitions: An extended concept and framework for analysis. *Research Policy, 45*(8), 1620-1635. https://doi.org/10.1016/j.respol.2016.04.004

Rolls Royce. (2022). *Embraer, Widerøe and Rolls-Royce announce partnership to research innovative technologies for sustainable regional aircraft*. https://www.rolls-royce.com/media/press-releases/2022/17-02-2022-embraer-wideroe-and-rolls-royce-announce-partnership-to-research-innovative-technologies.aspx

Schäfer, A. W., Evans, A. D., Reynolds, T. G., & Dray, L. M. (2016). Costs of mitigating CO_2 emissions from passenger aircraft. *Nature Climate Change, 9*, 505-509. https://doi.org/10.1038/nclimate2865

Surgenor, C. (2025). *New Deloitte study for A4E finds Europe's airlines at competitive risk over SAF mandate*. GreenAir News. https://www.greenairnews.com/?p=7625

Transavia. (2025). *Sustainability*. https://www.transavia.com/en-EU/sustainability

Van Dyk, S., & Saddler, J. (2024). *Progress in commercialization of biojet/sustainable aviation fuels (SAF): Technologies and policies* (IEA Bioenergy Task 39 Report). https://www.ieabioenergy.com/wp-content/uploads/2024/06/IEA-Bioenergy-Task-39-SAF-report.pdf

Widerøe. (2025). *Sustainability: Using sustainable aviation fuel*. from https://www.wideroe.no/en/sustainability

Yin, R. K. (2018). *Case study research and applications: Design and methods* (6th ed.). SAGE Publications. https://uk.sagepub.com/en-gb/eur/case-study-research-and-applications/book250150