ALIGHT
SUSTAINABLE AVIATION

Report on “Bold Vision 2050 workshop”

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Content

1 Executive summary

The EU Horizon 2020 project ALIGHT addresses the environmental challenges facing the aviation industry by implementing innovative solutions centered on Sustainable Aviation Fuel (SAF) integration and smart energy management at airports. Through demonstrations at Copenhagen Airport and the development of comprehensive tools, the project aims to reduce greenhouse gas emissions, meet international environmental targets, and set the stage for sustainable airport operations. To extend its impact beyond the participating airports and the project's timeframe, ALIGHT includes the development of a "Bold Vision for Airports in 2050" as part of Task 8.4.

Recognizing the substantial challenges posed by climate change, the Bold Vision framework emphasizes the need for transformative technologies such as hydrogen-powered and electric aircraft, as well as SAF. These innovations are expected to significantly impact airport systems, requiring leaders to adopt long-term strategies. The Bold Vision framework, grounded in economic, environmental, and social sustainability, identifies nine key pillars to guide future airport planning and operations. Collaborations with sister projects (TULIPS, Stargate, and OLGA) and external experts ensure a holistic and inclusive approach.

The Bold Vision Workshop

The "Bold Vision for Airports in 2050" workshop, held on October 29-30, 2024, was a key milestone in ALIGHT's development of this vision. The workshop brought together 56 participants from the ALIGHT consortium, sister projects, and external stakeholders, representing airports, research institutions, regulatory bodies, and technology providers across nine European countries. This diverse group engaged in forward-looking discussions aimed at identifying the challenges, opportunities, and strategies for climate-neutral aviation by 2050.

Held at Copenhagen Airport, the event featured presentations, panel discussions, and interactive World Café sessions. Topics included SAF adoption, the integration of new propulsion technologies, digitalization, and the role of airports as energy and mobility hubs. Participants explored questions such as how future propulsion technologies will impact airport infrastructure and how airports can adapt to evolving energy systems and mobility needs.

Key Outcomes

1. **Sustainable Aviation Fuel (SAF):** SAF was identified as a cornerstone for reducing aviation emissions, with an urgent need for policy support, infrastructure investment, and international alignment to scale production. The development of e-SAF and the efficient use of diverse feedstocks were emphasized.
2. **Airports as Energy Hubs:** Airports will need to accommodate hydrogen and electric aviation, requiring updates to energy systems and infrastructure. This transformation presents opportunities for new business models, such as energy provisioning to airlines and local communities.

3. **Airports as Mobility Hubs:** Seamless integration with rail and other transport modes was highlighted as essential for future airports, addressing the anticipated growth in global passengers and flights.
4. **Non-CO_2 Emissions:** Targeted use of SAF to mitigate contrail formation was discussed, alongside the importance of collaboration and regulatory clarity for addressing non-CO_2 emissions.
5. **Collaboration and Innovation:** Cross-sector cooperation, as demonstrated through the involvement of sister projects, is essential to align efforts, share best practices, and address sustainability challenges holistically.

Future Work and Implications for WP8

The workshop outcomes provide a foundation for WP8's Bold Vision 2050 deliverable, which will develop guidelines for transitioning airports toward sustainability in both existing and new-build contexts. These guidelines will reflect the insights gained from ALIGHT and its sister projects, aiming to facilitate the replication and scaling of successful solutions.

The final deliverable, due in May 2025, will be refined through ongoing collaboration and the upcoming Policy Maker Workshop, ensuring alignment with evolving policy frameworks and large-scale implementation strategies.

The ALIGHT Bold Vision represents a transformative roadmap for airports, addressing the critical environmental, technical, and operational challenges of the future while promoting collaboration, innovation, and sustainability across the aviation industry.

2 Introduction

The EU Horizon 2020 project ALIGHT is dedicated to addressing environmental challenges in the aviation industry by implementing and demonstrating innovative solutions focused on Sustainable Aviation Fuel (SAF) integration and smart energy management at airports. Through demonstrations at its lighthouse airport, Copenhagen, and the development of comprehensive tools, ALIGHT aims to reduce greenhouse gas emissions, align with international environmental targets, and set a vision for sustainable airports of the future. To extend its impact beyond the participating airports and beyond the project's timeframe, ALIGHT includes a dedicated task (Task 8.4) aimed at developing a "Bold Vision for Airports in 2050."

Given the substantial challenges facing the aviation industry in transitioning toward net-zero emissions amid climate change, aviation must embrace new and innovative technologies over the coming decades, including for example hydrogen and electric-powered aircraft or 100% SAF. These transformative technologies are expected to significantly impact airport systems. To ensure that aviation is resilient to future demands, airport leaders, regulators, and other decision-makers must anticipate these shifts with a long-term perspective. The Bold Vision for Airports in 2050 is intended to provide guidance by leveraging the expertise of the ALIGHT consortium alongside insights from external experts.

The Bold Vision will address the key sustainable mobility, technical, operational, economic, environmental, and social factors projected to shape future airports and their integration into the urban environment. Special emphasis will be placed on topics and technologies related to SAF, emerging propulsion methods, and advanced energy supply and management systems.

To kickstart the development of this ambitious vision, a workshop was organized as part of ALIGHT's Task 7.3 to explore these themes, drawing insights and inspiration from what 2050 might hold. In the preparation of the workshop, the primary guiding question of this workshop was formulated as follows:

"What mobility, technical, operational, economic, environmental and social aspects will shape the airports in 2050?"

Other relevant guiding questions included for example:

"What future propellants will enter the airport on a 2050-time horizon? "

"How will the adoption of these new propellants and technologies impact on the airport system?"

The outcomes of the workshop will contribute to formulating the Bold Vision as part of ALIGHT's Task 8.4. It is important to note that the Bold Vision Workshop was one of three dedicated workshops organized within the ALIGHT project, each with a distinct focus and objective:

- **The ALIGHT "State of the Art Workshop" (June 2022)**
  This workshop concentrated on short-term goals, aiming to address immediate challenges and identify emerging solutions, particularly in the areas of SAF integration and smart energy management at airports.

- **The ALIGHT "Bold Vision Workshop" (October 2024)**
  Focusing on long-term goals, this workshop sought to explore future solutions that could enable climate-neutral aviation. It also aimed to anticipate how these innovations might impact airport systems and to develop strategies for airports to adapt proactively.

- **The ALIGHT "Policy Maker Workshop" (planned for May 2025)**
  This upcoming workshop will present key findings from the ALIGHT project and the Bold Vision process to policymakers. The goal is to discuss how large-scale implementation of future aviation and airport solutions can be effectively supported through policy measures.

Together, these workshops form a comprehensive framework under ALIGHT's work package 7 – *Cooperation Activities*, addressing both immediate and long-term challenges while ensuring that insights are translated into actionable strategies supported by policy initiatives.

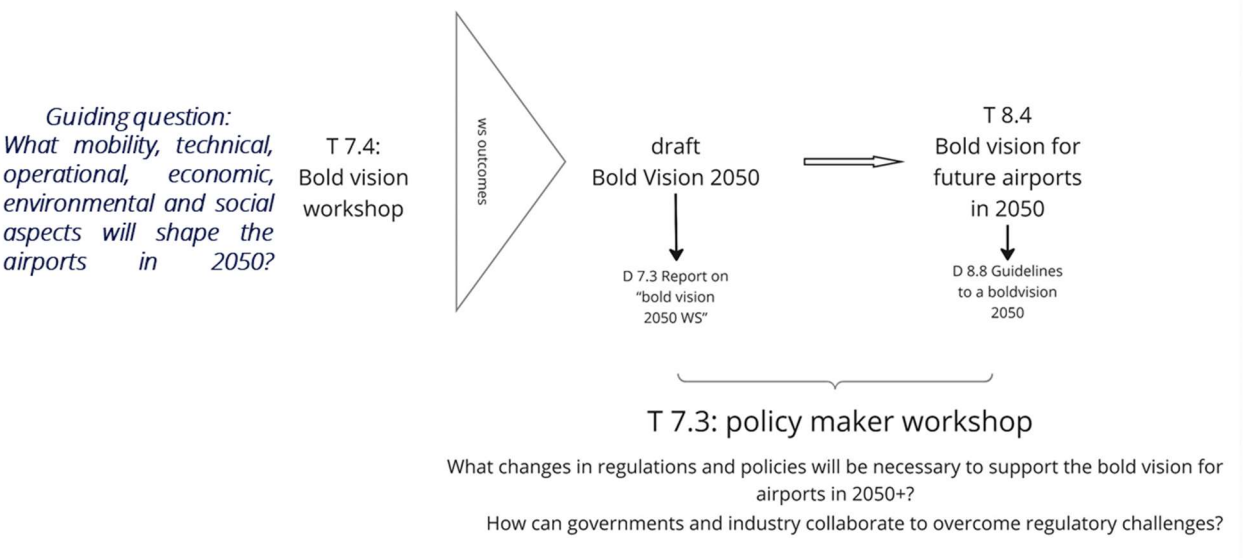


Figure 1 Structure and interconnection of the Workshops in WP7

2.1 ALIGHT Bold Vision framework

Due to the strong connection between the Bold Vision Workshop and the formulation of the Bold Vision within ALIGHT's Work Package 8, close collaboration between these two activities was essential during the workshop's preparation. This ensured that both efforts produced aligned and relevant outputs. The preparation process began with an initial brainstorming session to identify key topics for a Bold Vision for Airports, which culminated in a draft framework for the ALIGHT Bold Vision. This framework is structured around key "pillars." Input and feedback on these pillars were collected through two consecutive feedback rounds involving ALIGHT partners and the EU H2020 sister projects (see also Section 3.2.1). The finalized framework and pillars served as a guide for selecting the required speakers and experts for the workshop.

The core concept of the ALIGHT Bold Vision framework recognizes airports as complex, dynamic entities that play a crucial societal role by facilitating the movement of people and goods while acting as vital economic stakeholders. However, this dynamic nature comes with significant environmental impacts, including air and noise pollution, waste production, and high energy and water consumption. As such, future airports will need to navigate a range of complex challenges on their path toward carbon neutrality and sustainability.

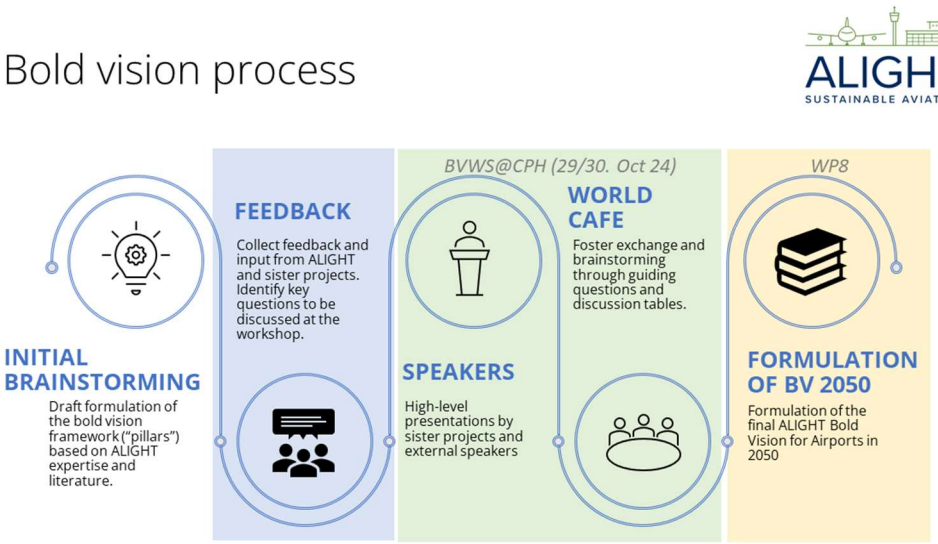


Figure 2 Bold Vision Process

ALIGHT and its sister projects propose a Bold Vision framework grounded in three core sustainability concepts: economic, environmental, and social. The vision statement is informed by public documents addressing relevant sustainability strategies and EU policy targets. These core concepts are further divided into nine pillars that are to be addressed holistically. The first seven pillars represent concrete areas of action, reflecting EU and global commitments, challenges, and priorities. The final two pillars function as enablers, directly supporting the implementation of the other seven. An overview of the proposed framework is provided in Figure 3.

As the ALIGHT project does not directly address all nine pillars, the framework is being developed in collaboration with other initiatives, particularly the Horizon 2020 sister projects OLGA, Stargate, and TULIPS. For example, a summary of Pillar 1—*Net-Zero Emissions*—is presented in Figure 4.

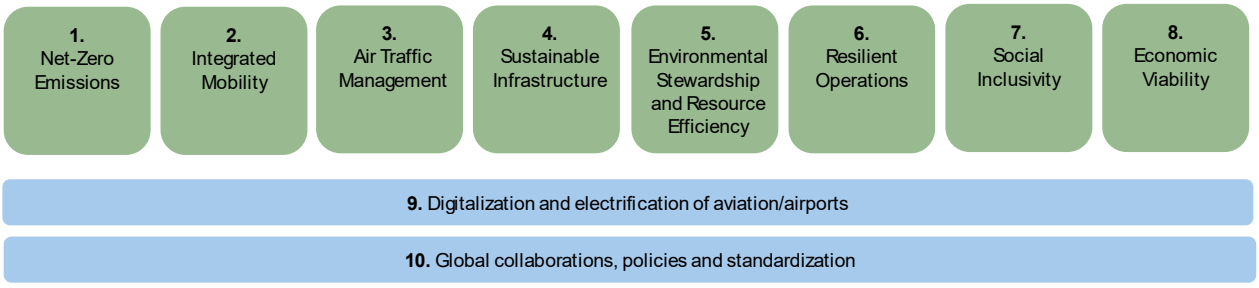


Figure 3 Proposed Pillars for the Bold Vision 2050

Figure 4 Example for Pillar 1

3 Organization of the Bold Vision workshop

3.1 Venue

The ALIGHT workshop "A Bold Vision for Airports in 2050" was held as an in-person event on October 29th and 30th, 2024, with the aim of fostering a robust exchange of ideas, encouraging fruitful discussions, and promoting collaboration and networking among participants. To accommodate travel constraints faced by a few presenters, the agenda also included three online presentations.

The event took place at the main auditorium of the ALIGHT Lighthouse airport in Copenhagen. Situated directly next to the airport apron, the venue provided a unique vantage point, offering attendees a direct view of airport operations. This strategic location served to enhance the discussions by linking theoretical deliberations with real-world airport activities.

Figure 5 Venue at Copenhagen Airport

3.2 Participants

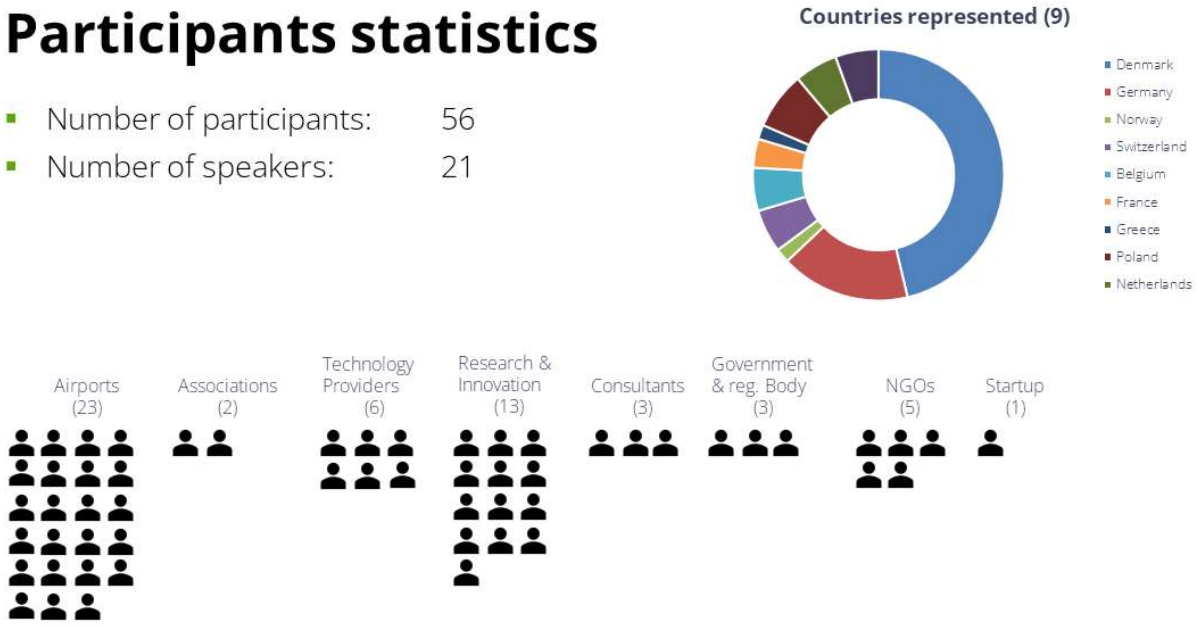
The participants of the Bold Vision workshop were invited through four main channels:

- Partners of the ALIGHT consortium
- Partners of the EU H2020 sister project consortia (see Section 3.2.1)
- The network of relevant stakeholders established within ALIGHT's Task 7.1
- A post on the ALIGHT LinkedIn page advertising the event

This approach resulted in a diverse group of participants, comprising 36 individuals from the ALIGHT consortium, 6 from the EU H2020 sister projects, and 14 external participants. Notably, approximately 40% of the participants came from outside the ALIGHT project, bringing fresh perspectives and new ideas to the discussions. Given the Bold Vision 2050's focus on airports, the largest stakeholder group represented was from the airport sector. The second-largest group consisted of representatives from research and innovation, ensuring the workshop maintained a forward-thinking approach beyond the current state of the art.

Other stakeholder groups included technology providers, associations, NGOs, and regulatory bodies. Participants represented nine European countries, and an online presentation by the National Civil Aviation Agency of Brazil (ANAC) added a valuable global dimension, broadening the perspective beyond Europe.

Figure 6 Group photo with all participants



3.2.1 **Involvement of the H2020 sister projects**

Given the broad scope of the Bold Vision for Airports in 2050, it was evident that not all relevant topics could be addressed solely within the expertise of the ALIGHT consortium. To ensure a comprehensive approach, the EU Horizon 2020 airport sister projects—TULIPS, Stargate, and OLGA—were integrated as a core element of the workshop. This integration built upon the exchange activities between the projects that had been established as part of ALIGHT's Task 7.1. Integrating the H2020 sister project not only brought additional airports into the discussions but also provided an opportunity to validate the ALIGHT perspective on the bold vision through a broader range of experiences and insights. Moreover, the two-day in-person format presented an excellent opportunity to actively foster collaboration and exchange among the four airport projects, particularly at the working level.

The sister projects were involved early in the workshop's planning through a series of online meetings. These sessions helped identify areas of overlap, additional expertise, and opportunities for feedback on the Bold Vision framework. They also facilitated the identification of the alignment of each project's activities with respect to the Bold Vision pillars. An example is illustrated in Figure 7. Communication efforts were also coordinated to ensure that the workshop highlighted the collaboration and raised the visibility of all sister projects.

During the event, the sister projects enriched the discussions with airport showcases from Schiphol (TULIPS) and Brussels Airport (Stargate), a technical showcase from IFPen (OLGA), and contributions to the panel discussion. They also moderated selected World Café discussion tables and, most importantly, brought six highly engaged participants who played a key role in the workshop's success.

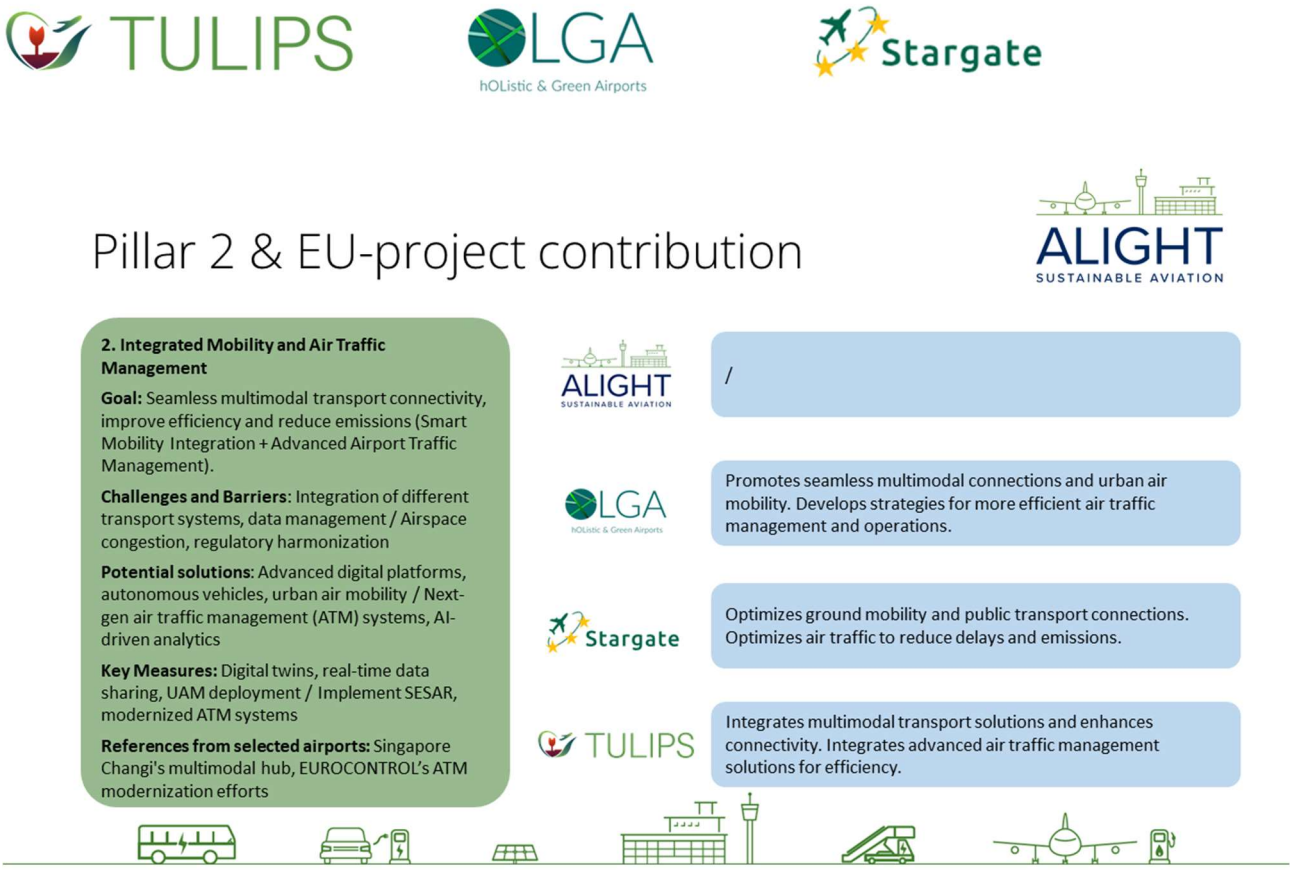


Figure 7 Example for contributions from the Sister Projects

3.3 Workshop structure and program

Given the broad scope of the topic "Bold Vision for Airports in 2050," it was acknowledged during the workshop's planning phase that a comprehensive exploration of all aspects would not be feasible within a two-day timeframe. Consequently, the approach was to examine key topics from a high-level "chopper view," providing an overarching perspective. This method allowed for a focused analysis of each topic's potential impact on the airport system, ensuring that the discussions remained both strategic and impactful. Participants were encouraged to adopt a forward-looking mindset, speculating on future possibilities, raising thought-provoking questions, and identifying opportunities within the 2050-time horizon. The emphasis was placed on exploring potential advancements and transformative ideas, rather than dwelling on challenges and barriers, to foster an atmosphere of innovation and open dialogue.

The workshop structure combined traditional presentations with interactive elements, including World Café-style discussion rounds (see Section 3.4) and a panel discussion featuring representatives from various airports. To gather real-time responses and feedback from participants, MentiMeter was utilized throughout the workshop. This tool facilitated interactive engagement via smartphones, enabling participants to share their thoughts, answer questions, and provide input dynamically during the sessions. Networking and informal discussion

opportunities were integral to the event, facilitated through breaks and a casual tapas-style dinner on the first day, encouraging participants to connect and share ideas in a relaxed setting.

To set the stage for forward-looking discussions, the Workshop began by exploring the potential future of aviation in 2050, including relevant policy frameworks for that time horizon. This was followed by presentations on the Bold Vision framework, airport showcases, and links to sister projects, providing a comprehensive context for the discussions. Following the presentations, a World Café discussion session was conducted to explore the implications of the topics presented. This interactive format allowed participants to engage in small-group discussions, fostering deeper insights and diverse perspectives on the potential impacts of the key themes.

The morning of day 2 focused on two pivotal topics: the potential of airports to transform into energy hubs and their evolution as enhanced mobility hubs. In the afternoon, the Sustainable Airports Platform (SAP) meeting (potentially linked to T7.5) centered on sustainable aviation fuel (SAF) and non-CO_2 emissions.

Day 1 – 29.10.2024

Time	Session Name	Speaker	Title
09:00 – 09:30	Registration & Coffee		
09:30 – 10:30	Introduction	Louise Krohn, CPH Airport, ALIGHT Coordinator	Welcome & ALIGHT at a glance
		Benedict Enderle, DLR	Introduction to the workshop
		Nico Flüthmann, DLR	Setting the scene: Aviation in 2050
		Alexis Chausteur, Europeen Commission, DG Move	EU policy for 2050
10:30 – 10:45	Coffee break		
10:45 – 12:15	Bold Vision 2050 and H2020 Sister Projects	Bernard Gindroz, BMGI Consulting	ALIGHT Bold Vision framework
		Maria Skote, CPH Airport, Head of Sustainability	CPH's Net Zero 2050 plan
		Fokko Kroesen, Schipohl Airport, TULIPS Coordinator	TULIPS & Schipohl airport perspective
		Charlotte Verreydt, Brussels Airport, STARGATE Coord.	STARGATE & Brussels airport perspective
12:15 - 13:30	Lunch and Networking Break		
13:30 – 14:00	Panel discussion	Bernard Gindroz (ALIGHT), Fokko Kroesen (AMS, TULIPS), Sergi Alegre (ARC, OLGA), Charlotte Verreydt (BRU, STARGATE)	Airport perspectives on 2050
14:00 – 15:30	Sustainable and Resilient Airports	Guillaume Sabiron, IFP Energies Nouvelles	OLGA example: air quality simulation
		Henrique Tavarez, ANAC Brasil	Resilient infrastructure for airports
		Esther Hegel, RSB	World Café introduction
15:00 – 15:30	Coffee break		
15:30 – 17:00	World Café Workshop on Bold Vision 2050	All participants	Table discussion round 1
		All participants	Table discussion round 2
		Table hosts	Presentations of findings by Table hosts
17:00 – 19:00	Networking with light meal		

Day 2 – 30.10.2024

Time	Session Name	Speaker	Title
09:00 – 09:10	Welcome & Agenda	Benedict Enderle, DLR	
09:10 – 10:10	Airports as Energy Hubs	Irwin Kerboriou, Beyond Aero	H_2 aviation and impacts on airports
		Thorsten Luft, Vaeridion	Electric aviation and impacts on airports
		Rasmus Moesbaek, Hybrid Greentech	Smart use of energy at airports
10:10 – 10:50	Airports as Mobility Hubs	Kay Plötner, Bauhaus Luftfahrt	Navigating the Future of Airport Mobility
		Lukasz Gubanski, CPK Airport	CPK – Integrating Air and Rail Transport
10:50 – 11:00	go to tables, grab a coffee		
11:00 – 12:00	World Café Workshop on energy & mobility hubs	All participants	Table discussion round 1
		Table hosts	Presentations of findings by Table hosts
12:00 – 13:00	Lunch and Networking Break		
13:00 – 14:30	The sustainable airports platform	Blanca Ulibari, Roundtable on Sustainable Biomaterials	Welcome & Agenda Sustainable Airports Platform
		Daisy de Hoop, SkyNRG	SAF outlook 2050
		Ulf Neuling, Agora Verkehrswende	e-SAF
		Roland Eichinger, DLR	Non-CO_2 effects and role of SAF
		Vincent Deshaes, To70	Non CO_2 climate impacts
14:30 – 14:40	go to tables, grab a coffee		
14:40 – 15:40	World Café Workshop on SAF & Non-CO2	All participants	Table discussion round 1
		Table hosts	Presentations of findings by Table hosts
15:40 – 16:00	Wrap-up, outlook and closing words	Workshop organizing comittee	

3.4 World Café methodology

Complementing the presentations, World Café-style discussion rounds were integrated as a key component of the workshop. This well-established methodology involves small groups of participants discussing specific topics at tables, structured around predefined key questions and statements. Each table is facilitated by a host, typically an expert who had earlier delivered a related presentation. After a set time (e.g., 20 minutes), participants rotate to different tables, allowing them to engage in discussions on multiple topics during the session. This format fosters a rich exchange of knowledge and perspectives. At the end of the World Café session, the table hosts present the key findings from their discussions.

Three World Café sessions were included in the Bold Vision Workshop:

- The first session focused on the overarching topic of the Bold Vision pillars.
- The second session explored the guiding themes of "Airports as Energy Hubs" and "Airports as Mobility Hubs."
- The third session addressed SAF and non-CO_2 emissions.

To ensure the discussions were well-structured and relevant, the presentation speakers and table hosts were asked during the workshop preparation phase to provide guiding questions and statements from their respective fields of expertise. These inputs were then used to design and refine the World Café sessions, ensuring that the discussions were grounded in expert insights and aligned with the workshop's objectives.

Participants provided very positive feedback on the World Café sessions, emphasizing that the approach ensured high levels of interaction and active participation in the discussions.

An example facilitation sheet provided to a table host is shown in Figure 10. For the topic of hydrogen in aviation, two statements are included, with corresponding guiding questions highlighted in green to structure the discussion.

Figure 8 World Cafe discussion round

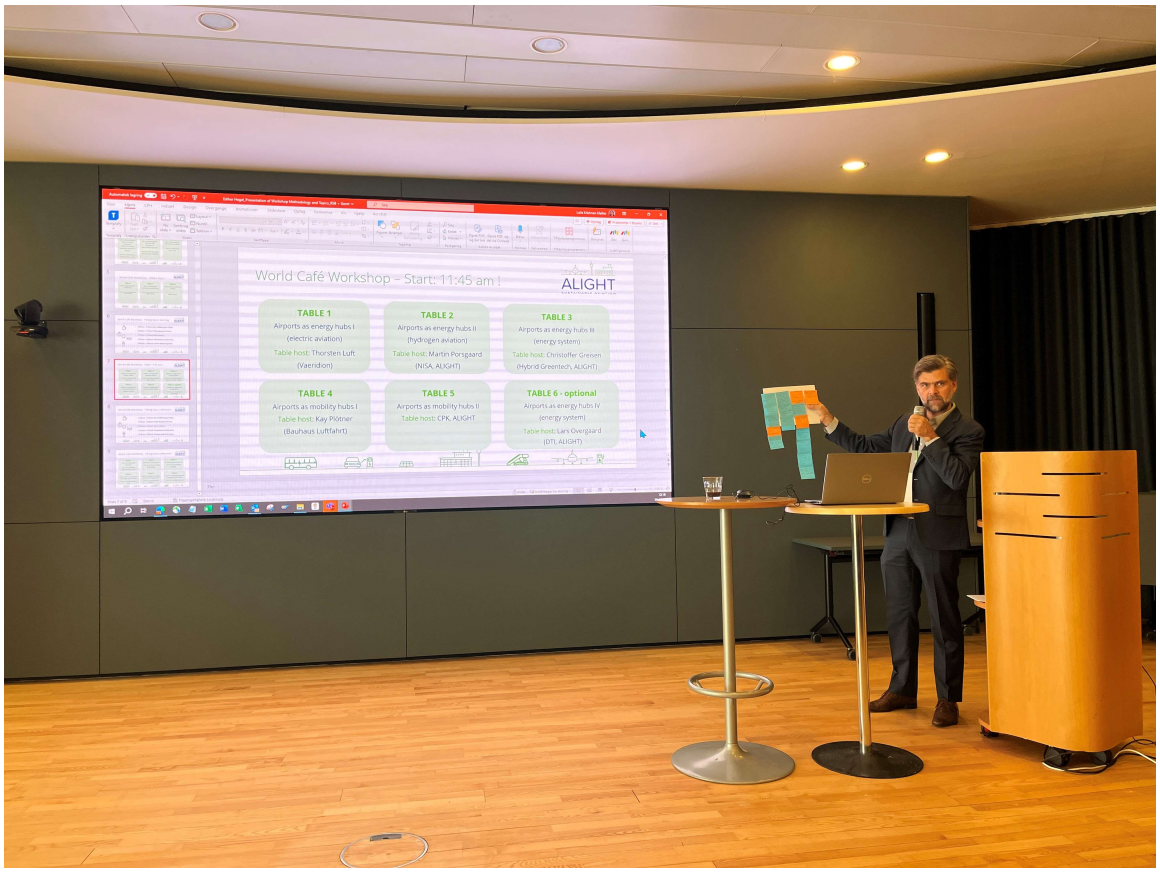


Figure 9 Presentation of discussion findings by the table host

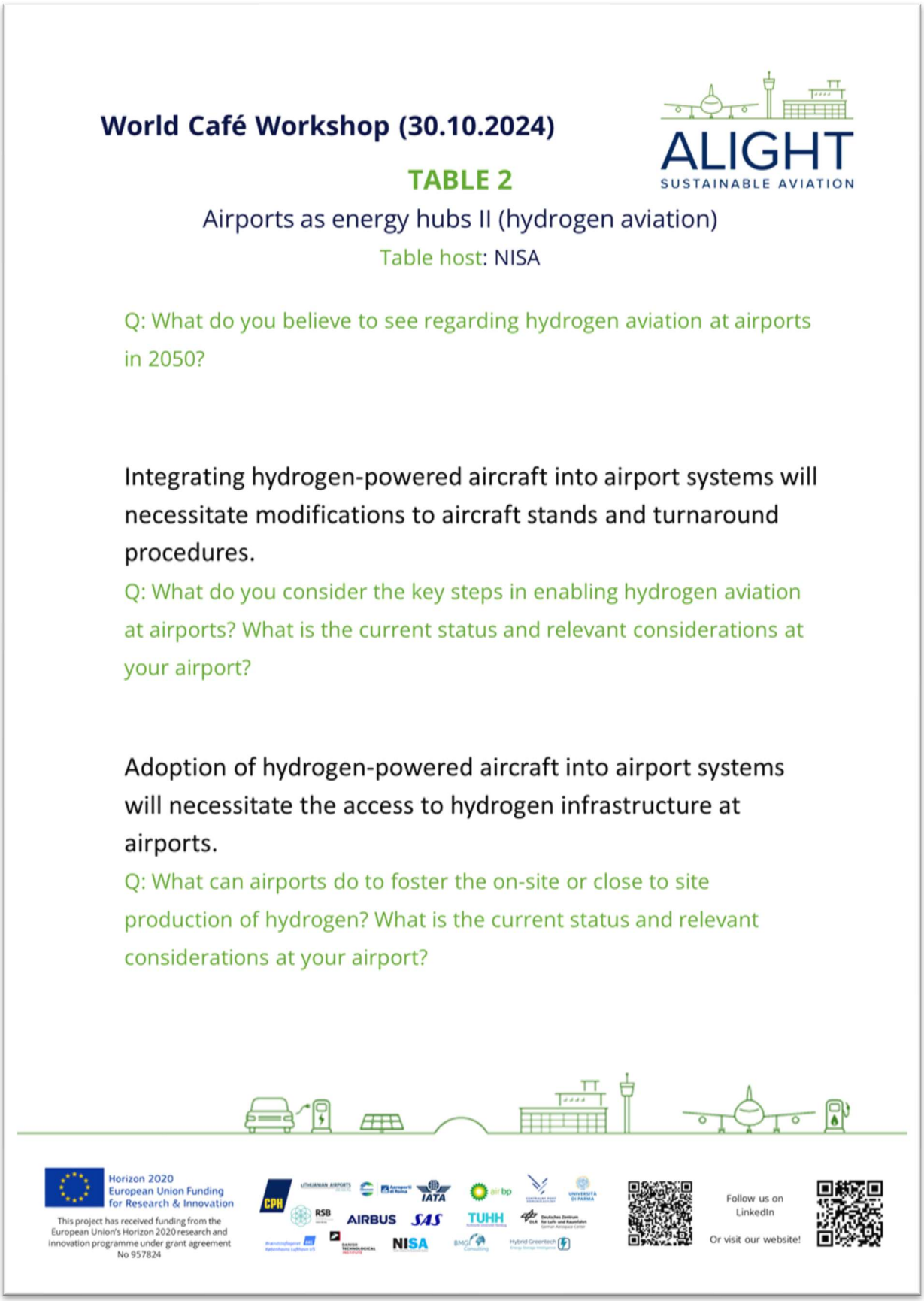


Figure 10 World Cafe facilitation sheet

4 Summary of workshop outcomes

4.1 Day 1

The first day began by setting the scene with a brief overview of the current status of the ALIGHT project, followed by an introduction to the structure and focal topics of the workshop. This was complemented by an outlook on aviation in 2050, drawing on a study by DLR, which highlighted three key drivers for aviation over the coming decades:

- A continuing growth in global passengers, projected to rise from 4.4 billion in 2019 to an estimated 21 billion by 2070.
- An increase in the number of flights globally, from 36 million to over 76 million.
- A shift towards larger aircraft due to limited potential for expansion at several key airports, such as London Heathrow.

Among the three transformative technologies critical to achieving net-zero aviation—Sustainable Aviation Fuel (SAF), hydrogen, and electric aviation—SAF was emphasized as particularly vital. It is seen as a cornerstone for enabling greener airport operations and ensuring a sustainable future for aviation by 2050.

An outlook on EU policymaking for aviation towards the 2050 horizon complemented the first part of the day. This session elaborated on the implementation of RefuelEU and the complexities surrounding SAF accountability, particularly with suppliers often being based outside the EU. These discussions provided critical insights into the policy landscape shaping the future of sustainable aviation.

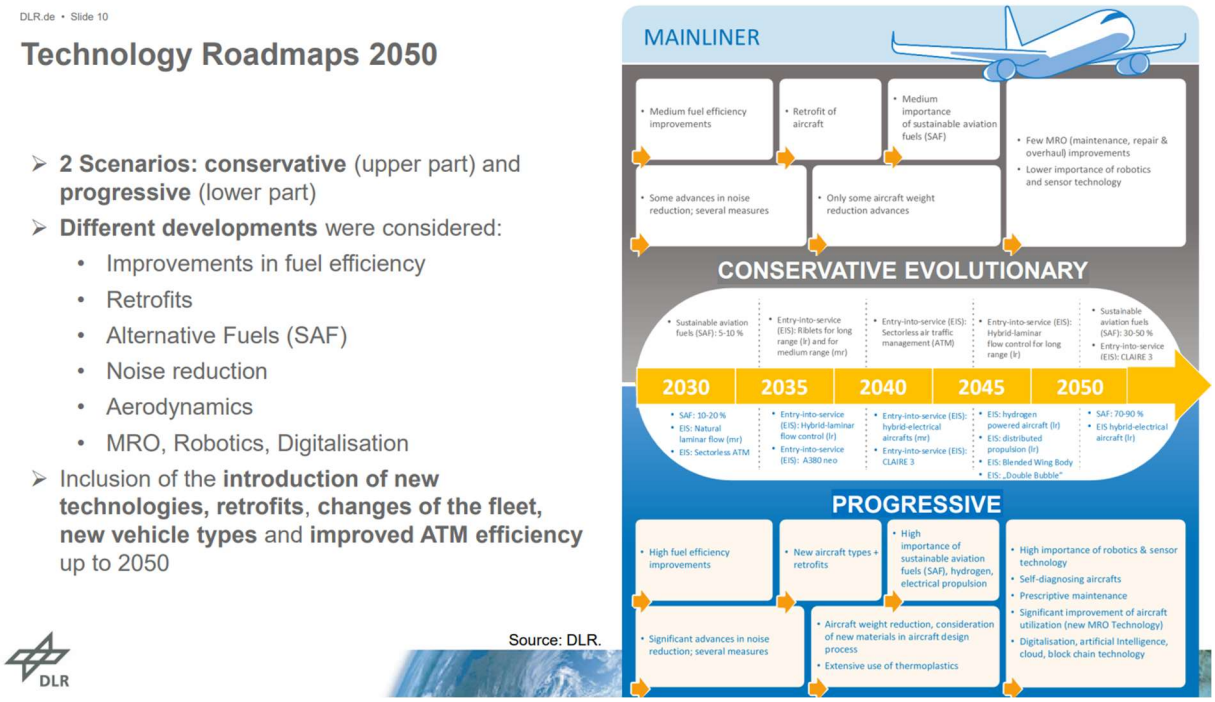


Figure 11 Example Technology Roadmap towards 2050 from the Setting the Scene presentation

Figure 12 A scene from the Workshop

The day continued with presentations highlighting net-zero emission strategies from various airports, including Copenhagen, Brussels, and Schiphol, and their connections to EU Horizon Europe airport projects. A key focus of Brussels Airport's presentation was the challenges associated with reducing Scope 3 emissions, which account for a significant portion of an airport's overall emissions footprint.

A subsequent panel debate featured participants from the EU Horizon Europe projects and centered, inter alia, on communication strategies for airports. The panel emphasized that effective communication must highlight verifiable achievements to mitigate the risks of greenwashing. Striking a balance between transparency and evidence is essential, as showcasing sustainable progress without fully verified test results can lead to reputational risks, such as being labeled as engaging in greenwashing. In this context, demonstration activities, like those conducted in all EU airport projects, were identified as critical to verifying technical solutions at an operational level.

The debate also explored the broader themes of digitalization and automation, with a specific example being the automation of the de-icing process, where robots control the de-icing machines instead of humans. This shift addresses challenges stemming from the COVID-19 pandemic, which led to the layoff of skilled de-icing staff. Automation reduces the need for extensive retraining but also raises considerations of social sustainability. The panel stressed the importance of balancing operational efficiency with the social impacts of automation, ensuring the workforce transition is handled equitably and responsibly.

Figure 13 Panel discussion with the Sister Projects

4.2 Day 2

The first half of the second day focused on the two guiding themes of "Airports as Energy Hubs" and "Airports as Mobility Hubs." The first theme explored the potential transformation of airports into hubs for diverse energy carriers. This shift is driven by the possible adoption of hydrogen- and electric-powered aircraft, coupled with an increasing complexity of the airport energy system. The second theme highlighted the anticipated growth in air traffic and the ambition to better integrate and connect different transport modes, such as rail and air, positioning airports as central mobility hubs.

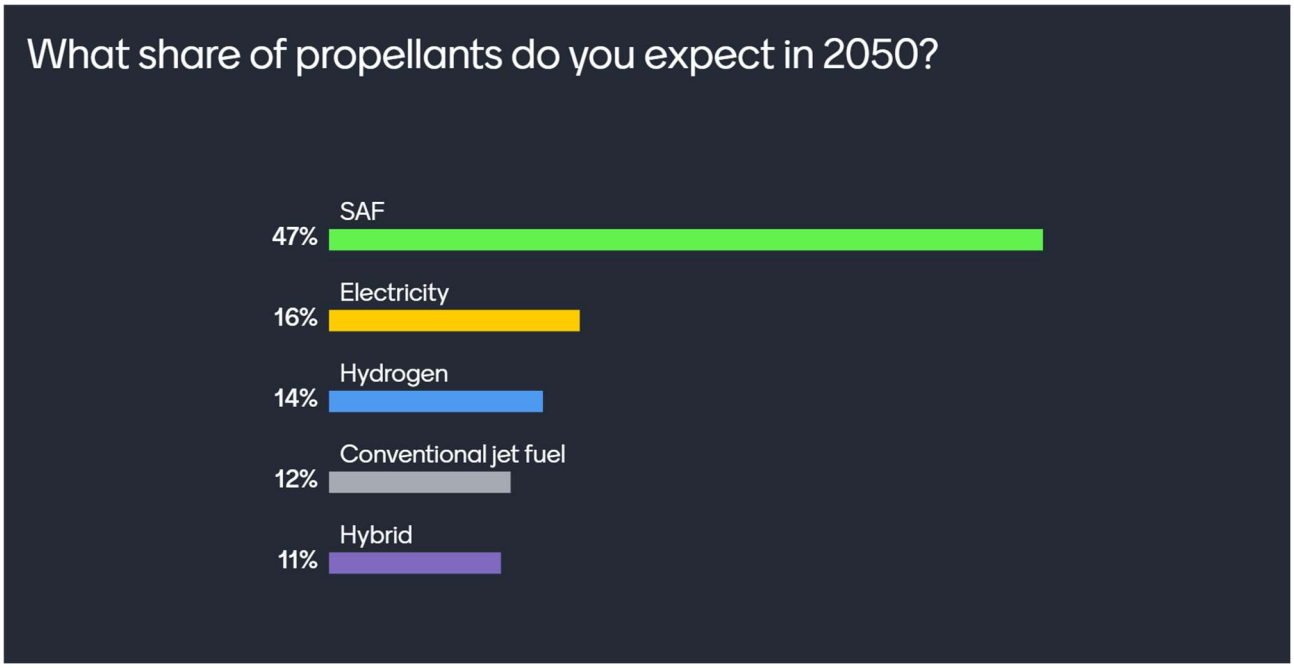


Figure 14 Mentimeter results on future propellants

The session began with a Mentimeter question to the audience, asking them to predict the share of various aircraft propellants at airports in 2050. The results, shown in Figure 14,revealed an expectation of a significant shift away from conventional jet fuel towards Sustainable Aviation Fuel (SAF), as well as the adoption of hydrogen and electric aviation.

The discussion proceeded with three examples of disruptive technologies related to energy carriers at airports:

- **Hydrogen-powered aircraft**, illustrated by the first hydrogen-powered business jet.
- **Electric aviation**, demonstrated with an example of an electric microliner.
- **Intelligent energy management systems**, showcasing how advanced management could optimize the energy system of an airport.

The presentations underscored that integrating these technologies into the airport system poses significant infrastructure challenges but also offers transformative opportunities. These innovations not only contribute to reducing the climate impact of aviation and airports but also

open new avenues for business models and revenue streams. Airports could evolve into energy providers, supplying electric energy and hydrogen to airlines, and offering services to the surrounding energy community, thereby expanding their role beyond traditional aviation operations.

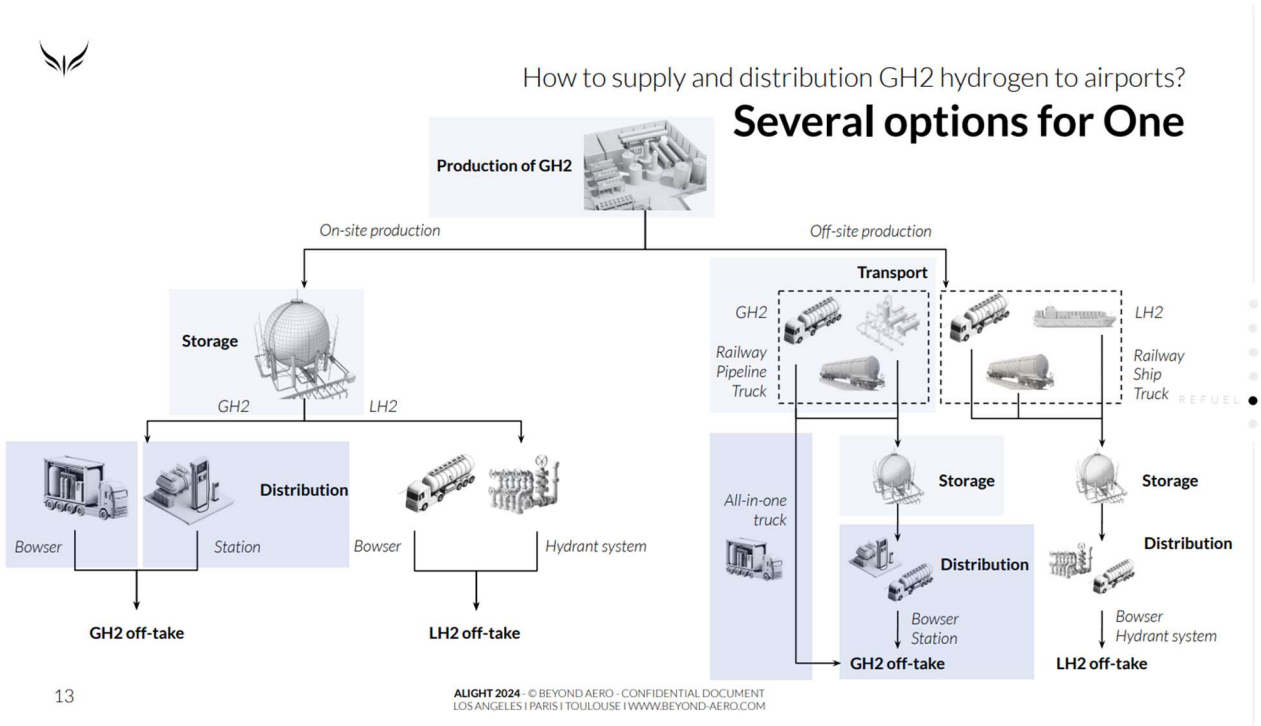


Figure 15 Integration of hydrogen into the airport infrastructure

However, for airports to fully capitalize on these opportunities, they must proactively prepare for the integration of new energy carriers. This preparation involves incorporating the necessary infrastructure and technological installations into their master planning for the coming decades. Long-term strategic planning will be essential to ensure airports can accommodate hydrogen and electric aviation, manage more complex energy systems, and support their transformation into hubs for diverse energy carriers and sustainable operations.

The session on Mobility Hubs began with a presentation of the EU SESAR project MultiModX, which explores future air-rail integration scenarios. The project focuses on developing innovative solutions such as a Schedule Design Solution for the integrated planning of air and rail networks and a Disruption Management Solution that coordinates passenger reallocations and tactical schedule adjustments in response to disruptions. These advancements aim to enhance seamless connectivity and improve passenger experience across transport modes.

In a subsequent presentation, CPK shared the current status of planning for the newly designed CPK airport, which is envisioned as a key mobility hub integrating air, rail, and road travel. The presentation featured inspiring renderings of the new terminal buildings, highlighting the multimodal design aspects of the airport layout. These designs emphasized how the infrastructure

would facilitate smooth connections between different transportation modes, reinforcing the airport's role as a central node in the mobility network.

Figure 16 Rendering of the future CPK airport with a focus on air-rail connection

The second part of the day leveraged the network established through the Sustainable Airports Platform, developed as part of ALIGHT's Task 7.5, to delve into long-term perspectives on Sustainable Aviation Fuels (SAF) and aviation's non-CO_2 emissions. Discussions centered on how these emissions could be mitigated and the pivotal role airports can play in this process.

Building on the earlier conclusion that SAF will be a key driver in aviation's transition towards net-zero emissions, SkyNRG presented a long-term outlook on SAF market development, focusing on required production capacities and anticipated price trends. The presentation underscored the need for pathway diversification and efficient, flexible feedstock use to meet long-term targets. It was emphasized that the development of e-SAF production pathways will require significant policy support. To scale up production, the SAF market will need investments, innovation, and collaboration among key stakeholders.

The topic of e-SAF was further explored in a subsequent presentation, which stressed the urgency of ramping up e-fuel production, particularly for hard-to-decarbonize sectors such as aviation and maritime transport. Achieving this goal will require internationally aligned, comprehensive sustainability criteria, regulatory clarity, and financial frameworks to provide the security needed for massive investments.

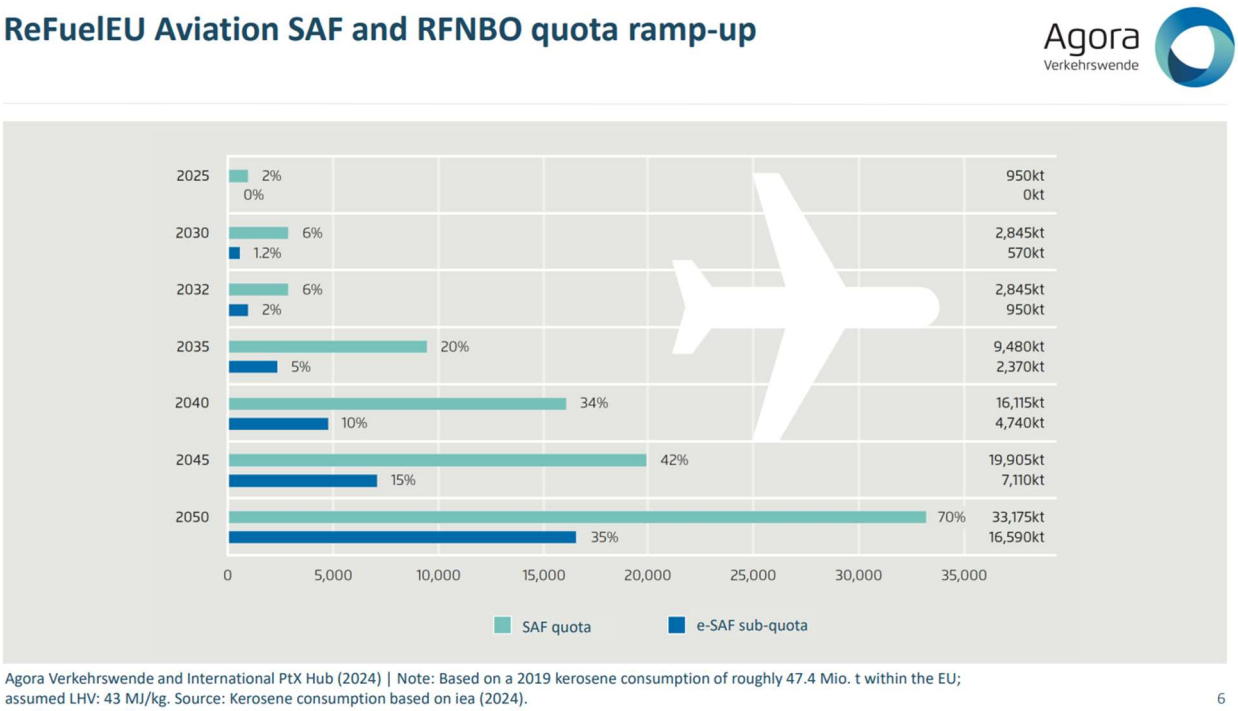


Figure 17 Expected ramp-up of SAF until 2050

Recent scientific findings on aviation's non-CO_2 emissions, particularly contrail formation and its climate impact, were presented by DLR. One mitigation strategy highlighted was the targeted use of Sustainable Aviation Fuels (SAF) for flight missions with a high probability of contrail formation. First promising results from a simulation study on the targeted use of SAF at Copenhagen Airport, conducted under ALIGHT's Task 3.6, were shared. These findings sparked a discussion with the audience on the implications for airport fueling infrastructure and operational strategies.

A subsequent presentation addressed recent policy developments concerning non-CO_2 emissions, focusing on the upcoming EU non-CO_2 MRV (Monitoring, Verification, and Reporting) scheme. The complexity of aviation's non-CO_2 emissions and their climate impacts was emphasized, along with the importance of stakeholders staying informed on the latest scientific developments. The session concluded with a call for enhanced collaboration across different stakeholder groups and domains of expertise as a critical step toward effectively addressing and reducing aviation's non-CO_2 emissions.

5 Key findings from the World Café discussions

After each World Café session, the table hosts provided a summary of the discussions, capturing key insights and takeaways. These detailed summaries are included in the Appendix. For conciseness, this section highlights the most important findings for each focus area discussed during the sessions.

Integrated Mobility

Airports have the potential to become intermodal hubs, enhancing connectivity between air travel and other transport modes. However, challenges such as passenger preference for personal vehicles, fragmented ticketing systems, and limited public transport access hinder progress. Proposed solutions include integrated ticketing systems, improved wayfinding, and fostering partnerships between airports and public transport providers. Behavioral shifts and economic incentives are crucial to encouraging sustainable travel options.

Net Zero Emissions

Achieving net zero emissions requires strategic coordination across infrastructure, energy carriers, and stakeholders. Hydrogen and SAF (Sustainable Aviation Fuel) were identified as key technologies, with SAF serving as a near-term solution while hydrogen remains a long-term goal requiring substantial investment. Timing and shared responsibility for infrastructure investments are critical, as is ensuring equitable energy distribution through revised green certificate frameworks.

Digitalization and Electrification

Electrification of airports is hindered by infrastructure gaps, technical challenges, and stakeholder misalignment on ownership and costs. Digitalization offers promising solutions, such as automated de-icing and data-driven operational optimizations, but requires robust data quality and legal frameworks for data access. Proactive infrastructure management and tailored strategies for large and small airports can accelerate adoption of electric aviation and AI-driven technologies.

Global Collaboration and Standardization

Global sustainability targets remain undefined, making standardization and collaboration challenging. Learning from the maritime sector's green corridors, aviation can implement similar initiatives. Governments play a crucial role in fostering collaboration through regulations and incentives. Emerging technologies like hydrogen and electrification necessitate the development of new standards alongside adapting existing ones. Aligning sustainability efforts with economic models ensures financial viability while driving innovation.

Airports as Energy and Mobility Hubs

As energy hubs, airports must integrate AI and digitalization to manage increased electricity demand from electric and hydrogen-powered aviation. Organizational changes and infrastructure updates are essential to support this transformation. As mobility hubs, airports must prioritize seamless integration of transport modes, improve infrastructure for the "last mile," and promote cooperation between public and private stakeholders.

6 Findings and implications for WP8

The objectives of the Bold Vision 2050 deliverable, to be developed within WP8, are to address the sustainable mobility, technical, operational, economic, environmental, and social aspects that will shape the airports of the future and their integration into the urban hinterland. In this context, ALIGHT will develop specific guidelines on how to transition from planning to implementation, replication, and scaling up of successfully demonstrated solutions in two distinct contexts:

1. Existing airports
2. Newly built airports

A strengthened collaboration with WP7 (Cooperation activities) and WP9 (fellow airports and the new Warsaw airport hub), as well as engagement with the Advisory Board and incorporation of outcomes from the Bold Vision dedicated workshops, is essential to inform and shape the development of these guidelines.

The Bold Vision workshops serve as a unique opportunity to identify gaps and barriers and to collect use cases and best practices from all stakeholder categories, including contributions from the lighthouse sister projects OLGA, TULIPS, and Stargate.

Task 8.4, “Bold Vision for Future Airports in 2050,” within WP8, begins its activities with this collection of inputs, prioritizing the goal of leveraging existing initiatives and success stories from other airports in a collaborative manner rather than reinventing the wheel.

The outcomes of the ALIGHT “Bold Vision Workshop” (October 2024) have been a pivotal step in focusing and aligning on long-term goals while exploring future solutions to achieve climate-neutral aviation. These outcomes also enabled the anticipation of innovations and their broader impact on airport systems, forming the foundation for robust Airports 2050 strategies.

Thanks to these inputs, WP8 Task 8.4 can proceed with drafting the Bold Vision 2050 deliverable in a coherent and strategic manner. This deliverable will reflect the identified challenges, opportunities, gaps, and solutions while supporting the replication of best practices aimed at achieving carbon neutrality.

The next ALIGHT “Policy Maker Workshop,” organized by WP7 and scheduled for May 2025, will further refine and align Deliverable D8.8, “Guidelines to a Bold Vision 2050,” with the evolving policy context. This workshop will ensure that the deliverable supports the large-scale implementation of future aviation and airport solutions effectively through policy measures.

7 Conclusions

The ALIGHT "Bold Vision for Airports in 2050" workshop was a resounding success, offering valuable insights and contributions to the development of the project's long-term vision. The diverse participation from the ALIGHT consortium, sister projects, and external stakeholders fostered meaningful discussions, enabling the identification of critical challenges, opportunities, and strategies for airports.

The workshop also significantly strengthened collaboration with the Horizon 2020 sister projects—TULIPS, Stargate, and OLGA—by facilitating knowledge exchange and in-person discussions. The outcomes from the workshop provide a strong foundation for the Bold Vision 2050 deliverable and support the overall objectives of the ALIGHT project, ensuring its relevance and impact beyond the project's timeframe.

Key Outcomes of the Workshop

1. **Sustainable Aviation Fuel (SAF):** SAF was identified as a cornerstone for reducing aviation emissions, with an urgent need for policy support, infrastructure investment, and international alignment to scale production. The development of e-SAF and the efficient use of diverse feedstocks were emphasized.
2. **Airports as Energy Hubs:** Airports will need to accommodate hydrogen and electric aviation, requiring updates to energy systems and infrastructure. This transformation presents opportunities for new business models, such as energy provisioning to airlines and local communities.
3. **Airports as Mobility Hubs:** Seamless integration with rail and other transport modes was highlighted as essential for future airports, addressing the anticipated growth in global passengers and flights.
4. **Non-CO_2 Emissions:** Targeted use of SAF to mitigate contrail formation was discussed, alongside the importance of collaboration and regulatory clarity for addressing non-CO_2 emissions.
5. **Collaboration and Innovation:** Cross-sector cooperation, as demonstrated through the involvement of sister projects, is essential to align efforts, share best practices, and address sustainability challenges holistically.

8 Appendix

8.1 List of participants

ADR - Aeorporti di Roma	https://www.adr.it/fiumicino
Agora Verkehrswende	https://www.agora-verkehrswende.de/en/
Airport Regions Council	https://www.airportregions.org/
Athens International Airport	http://www.aia.gr/
Beyond Aero	https://www.beyond-aero.com/
Bauhaus Luftfahrt - The Aviation Think Tank	https://www.bauhaus-luftfahrt.net/en
BMGI Consulting	https://www.linkedin.com/company/bmgi-consulting/
Brussels Airport	http://www.brusselsairport.be/en
Københavns Lufthavn	https://www.cph.dk/
Centralny Port Komunikacyjny (CPK)	https://www.cpk.pl/en/
EU Directorate-General Move	https://commission.europa.eu/
German Aerospace Center - DLR	https://www.dlr.de/en
Danish Technological Institute	https://www.dti.dk
Estuaire	https://estuaire.dev/
Hybrid Greentech - Energy Storage Intelligence	https://www.hybridgreentech.com/
International Air Transport Association (IATA)	https://www.iata.org/
IFP Énergies nouvelles	http://www.ifpenergiesnouvelles.com/
Naviair	https://www.naviair.dk/
NIRAS	https://www.niras.com
Nordic Initiative for Sustainable Aviation (NISA)	https://nisa.dk/
Roundtable on Sustainable Biomaterials (RSB)	https://rsb.org/
Luchthaven Schiphol	https://www.schiphol.nl/
SkyNRG	https://skynrg.com/
to70	https://to70.com/
Università degli Studi di Parma	https://www.unipr.it/en/ugov/organization-unit/259638
Vaeridion	https://vaeridion.com/

8.2 Findings from the World Café sessions

Day 1

Topic: Integrated Mobility (Pillar 2)

Opportunities for Airports as Intermodal Hubs

- Airports have the potential to evolve into intermodal hubs, connecting various transport modes for passengers and staff.
- Integrated mobility presents opportunities for sustainability and enhanced passenger convenience but comes with significant barriers and challenges.

Barriers and Challenges

1. **Passenger Behavior and Convenience**:
    - Passengers often choose personal cars due to perceived convenience and lack of trust in public transport reliability (e.g., delays, cancellations).
    - Changing passenger behavior is a long-term challenge, especially in regions with limited public transport options.
2. **Limited Public Transport Access**:
    - Night trains, early trains, and night buses are often unavailable or poorly synchronized with airport schedules.
    - Staff working in shifts and passengers taking early flights frequently lack viable public transport options.
    - In cases like Athens, the absence of bike-friendly routes or alternatives highlights gaps in accessibility.
3. **Fragmented Ticketing Systems**:
    - A lack of integrated ticketing for flights and public transport creates inconvenience for passengers:
        - Multiple ticket machines and systems can confuse passengers.
        - Clear, intuitive ticketing options (e.g., "city center" instead of "zone four") are lacking.
4. **Data Sharing and Schedule Synchronization**:
    - Transport companies and airports struggle to share data, resulting in poorly coordinated schedules for flights and public transport.
    - Collaboration and interoperability between systems are limited, exacerbating passenger inconvenience.
5. **Economic Conflicts**:
    - Parking revenue remains a significant income source for airports, making it challenging to prioritize public transport incentives without financial repercussions.
6. **Infrastructure and Spatial Constraints**:
    - Airports often lack space and infrastructure to support seamless intermodal transitions.
    - Current layouts prioritize terminal access, making connections to other transport modes cumbersome.

Proposed Solutions

Improving Passenger Experience

- Develop integrated ticketing systems:
  - Unified tickets covering flights, trains, buses, and metros.
  - Consolidate ticketing machines to provide clear, accessible options for all transport modes.
- Enhance wayfinding:
  - Redesign signage to guide passengers efficiently to destinations beyond the terminal.

Strengthening Collaboration

- Foster partnerships between airports, public transport providers, and local authorities:
  - Synchronize flight and public transport schedules to minimize wait times.
  - Implement clear legislation to support seamless coordination and data sharing.

Economic and Environmental Innovations

- Introduce dynamic pricing models:
  - Offer differentiated pricing for diesel versus electric taxis.
  - Explore using parked electric vehicles as energy sources, compensating passengers for their contributions.
- Partner with OEMs to enable energy-sharing models using parked cars.

Infrastructure and Planning

- Rethink airport design to support intermodal connectivity:
  - Facilitate smooth transitions between trains, metros, and buses without requiring terminal access.
- Address spatial planning challenges:
  - Identify creative solutions for constrained spaces to enable intermodal functionality.

Behavioral and Policy Shifts

- Incentivize public transport usage:
  - Subsidize train tickets for airport visitors, similar to parking ticket subsidies.
  - Promote awareness of integrated mobility options to shift passenger behavior.

Topic: Net Zero Emissions (Pillar 1)

Interconnected Pillars

- The discussion addressed three key pillars:
    1. **Net Zero Goals**: Examining the requirements to achieve sustainable operations.
    2. **Infrastructure**: Exploring whether sustainable upgrades to existing airports are more viable than building new facilities.
    3. **Stewardship**: Emphasizing the need for strategic coordination across sustainability efforts.
- Significant overlap and connections between these pillars highlighted the complexity of achieving sustainability in aviation.

Timing and Responsibility for Infrastructure Investments

- **Investment Timing**:
    - The critical question is when to invest in infrastructure for emerging technologies like hydrogen-powered aircraft, which may become viable by 2035.
    - Airports must balance the risk of premature investments against the risk of being unprepared for new technologies.
- **Shared Responsibility**:
    - The introduction of multiple energy carriers (e.g., hydrogen, SAF, electric) necessitates substantial and costly infrastructure investments.
    - Responsibility for these investments—whether airports, airlines, or governments—remains unclear.

Energy Carriers and Sustainable Infrastructure

- **Hydrogen**:
    - Hydrogen infrastructure presents significant challenges:
        - Storage capacity for extremely low-temperature conditions.
        - Installation of additional pipelines and refueling systems.
    - Hydrogen often remains a "future" solution, requiring long-term master planning to be "hydrogen-ready."
- **SAF (Sustainable Aviation Fuel)**:
    - SAF is considered a near-term solution due to its existing technology and relative feasibility knowing that it is crucial to distinguish between existing pathways and efuels/RFNBO in the slightly longer term.
    - Investments in SAF infrastructure are prioritized while long-term plans for hydrogen and electric systems are developed.

Green Certificates and Energy Equality

- Current reliance on green certificates to offset emissions was discussed:
    - Concerns about whether these certificates fairly allocate green energy across Europe.

- Impacts on energy equity and the broader distribution of renewable resources were highlighted as areas requiring further evaluation.

Recommendations and Considerations

Strategic Infrastructure Planning

- **Master Plans**:
  - Integrating electric aircraft and hydrogen-readiness and other sustainable solutions into airport master plans is essential.
  - Avoid treating these solutions as afterthoughts; include them in early planning and design phases.
- **Micro-Planning**:
  - Timing is crucial—align infrastructure development with expected technological advancements (e.g., hydrogen aircraft by 2035).
  - Consider critical paths to ensure readiness for operational deadlines, as illustrated by CPK's revised timeline from 2028 to 2032.

Collaborative Responsibility

- Airports, airlines, governments, and energy providers must collectively share the burden of infrastructure investments.
- Coordination among stakeholders is necessary to create a unified strategy for sustainable energy integration.

Focus on Feasible Short-Term Solutions

- SAF remains a practical short-term solution due to existing technology and infrastructure.
- Simultaneously, airports should invest in scalable hydrogen and electric infrastructure to prepare for future requirements.

Energy Equity and Certification

- Review the effectiveness and fairness of green certificates in offsetting emissions.
- Collaborate at a European level to ensure equitable distribution of renewable energy resources.

Topic: Digitalization and Electrification of Airports/Aviation

Key Themes and Challenges

Electrification in Airports

- **Infrastructure Gaps**:
  - A significant lack of infrastructure exists due to varied reasons and a lack of common understanding between stakeholders such as airports, handlers, and suppliers.
  - Key challenges include uncertainty around timing, ownership, total cost of ownership, and the business case, which contribute to delays in implementation.
- **Technical and Operational Challenges**:
  - Integration of larger equipment with lower Technology Readiness Levels (TRLs) requires further experience, as seen in lighthouse projects, before mass adoption is feasible.
  - Differing needs between large and small airports:
    - Large airports focus on high-capacity gates and different grid requirements.
    - Smaller airports are anticipated to see higher adoption of electric aviation, necessitating tailored grid planning and roadmaps.
- **Proposed Solutions**:
  - Airports could adopt a more proactive approach in managing infrastructure, similar to models seen in other transport modes.
  - Centralized management of charging infrastructure:
    - Airports could serve as a single point of contact for electricity and charger needs, streamlining costs and reducing complexity.
    - This model might require new legal arrangements in some countries.
  - Drawing parallels with fuel supply systems (e.g., SAF), a centralized model could ensure consistent infrastructure across stakeholders.

Digitalization in Airports

- **Innovative Applications**:
  - Automation in de-icing:
    - New models use sensors to automate de-icing processes, significantly reducing fluid usage.
    - Automated solutions are increasingly important given the industry's labor shortages post-COVID, offering a potential alternative to skilled operators.
  - Data-Driven Tow Trucks:
    - Data collection optimizes operations, such as calculating the most efficient movement and throttle usage to improve efficiency.
- **Data, AI, and Modeling**:
  - The importance of high-quality data and sensors is critical for effective AI-driven solutions.

- AI and data models have significant potential for optimizing operations but require careful consideration of associated risks.
- Emphasis was placed on understanding the limitations and ensuring robust data inputs to maximize AI effectiveness.

- **Access to Data**:
  - A single-payer model for accessing data was proposed as a secure and legal method to manage and utilize airport data effectively.
  - Centralized data access could improve coordination across various stakeholders.

Key Recommendations and Considerations

Electrification

- Establish centralized infrastructure management models to streamline investments and operations.
- Develop tailored strategies for large and small airports to address differing electrification needs and grid setups for example, including hybrid/electric aircraft solutions.
- Accelerate adoption of electric aviation at smaller airports, where infrastructure and operational demands may be less complex.

Digitalization

- Invest in automation and AI solutions to address labor shortages and enhance operational efficiency:
  - Focus on systems like automated de-icing and data-optimized equipment operation.
- Prioritize data quality and robust sensor systems to improve AI outcomes while mitigating risks.
- Adopt centralized or unified data access models to enhance collaboration and legal clarity.

Collaborative Action

- Foster stronger partnerships between airports, handlers, and technical suppliers to align on timing, ownership, and cost-sharing responsibilities.
- Use lighthouse projects to gain practical insights and refine strategies for broader implementation.

Topic: Global Collaborations, Standardization and Policies

Key Themes and Challenges

Global Collaboration and Sustainability Frameworks

- **Challenges in Defining a Framework**:
  - A lack of clearly defined global sustainability targets makes it difficult to establish standardized frameworks.
  - Without unified objectives, regional or national initiatives may vary, limiting global collaboration.
- **Examples from Other Sectors**:
  - Green corridors in the maritime sector were highlighted as a potential model for aviation to emulate.

Role of Government Regulations

- **Incentivizing Collaboration**:
  - Governments can craft policies to foster collaboration between airports and developers of new technologies.
  - Incentive mechanisms, such as base credits, could reward airlines practicing sustainability.
- **Regulatory Models**:
  - National initiatives, such as France's regulatory push for sustainability, were cited as examples of effective government intervention.

Economic Model of Airports

- **Balancing Sustainability and Revenue**:
  - Airports operate as economic entities, making it essential to align sustainability practices with revenue generation.
  - Greener technologies should be supported by incentives that encourage airlines and airports to adopt sustainable practices.

Standardization for Sustainable Practices

- **Existing Standards**:
  - Current standards, such as SVDDI, DAT protocol, and ACAP, are widely implemented in the airport sector.
- **Future Standards**:
  - Emerging technologies like hydrogen and electrification require the development of new standards.
  - Standards must be defined and implemented before the widespread adoption of technologies such as hydrogen refueling infrastructure and electric aviation systems.

Key Recommendations and Considerations

Strengthening Global Collaboration

- Establish globally recognized sustainability targets to create a unified framework for collaboration.
- Use successful models from other sectors, such as maritime green corridors, as a template for aviation.

Enhancing Incentives and Regulation

- Governments should introduce policies that encourage collaboration and innovation in sustainable practices.
- Reward airlines and airports that adopt sustainable practices through mechanisms like credits or subsidies.

Developing and Adapting Standards

- Ensure that new standards for emerging technologies (e.g., hydrogen and electrification) are developed and agreed upon ahead of implementation.
- Build on existing standards, adapting them to accommodate new sustainable practices.

Aligning Sustainability with Economic Models

- Design sustainability incentives to align with airports' and airlines' economic goals, ensuring financial viability while promoting greener practices.

8.3 Day 2

Topic: Airports as Energy Hubs – Energy System

Key Themes and Observations

Digitalization and AI

- Increasing reliance on digitalization and artificial intelligence for energy management.
- "Smart energy management" solutions driven by machines are expected to dominate airport operations by 2050.

Market and External Interactions

- Significant transformations in airport services:
  - Emergence of hydrogen-powered or fully electrical airports.
  - A dramatic increase in electricity consumption due to the adoption of electric aircraft.
- Airports will interact with new markets and stakeholders to adapt to these shifts.

Organization and Operational Efficiency

- **Current Challenges**:
  - Many airport functions are historically divided into siloed departments, which hinders smart energy integration.
  - Energy reduction efforts are often building-specific rather than integrated across the airport.
- **Future Trends**:
  - Changes are anticipated in how airports are organized, with potential unification of split functions such as handlers and airlines.
  - Differences in value chains between small and large airports will lead to differentiated operational strategies.
- **Efficiency Opportunities**:
  - Enhanced focus on the efficient use of infrastructure, such as gates and aircraft stands.

Infrastructure Changes

- Airports will undergo major infrastructure transformations, particularly in:
  - Hydrogen integration for storage, charging, and fueling.
  - Adapting to the demands of electric aviation, requiring substantial updates to energy systems.

Key Takeaways

- **Energy Management Evolution**:

    - Airports must integrate smart energy systems leveraging AI and digitalization to meet future energy demands effectively.
- **Service and Market Adaptation**:
    - Airport services will evolve significantly to accommodate the shift to electric and hydrogen-powered aviation, with a critical focus on managing increased energy consumption.
- **Organizational Overhaul**:
    - Traditional airport organizational models will give way to more integrated and efficient structures to adapt to modern needs.
    - Collaboration across airport functions and differentiation in strategies between large and small airports will become vital.
- **Infrastructure Transformation**:
    - Significant investment and planning are required to implement hydrogen and electric infrastructure, ensuring airports can support future energy and fueling needs.

Topic: Airports as Energy Hubs – Hydrogen Aviation

Key Challenges and Questions Regarding Hydrogen:

- **Diverse Applications of Hydrogen**:
  - Hydrogen can serve multiple purposes, including use in fuel cells and direct combustion.
  - Considerations include the form of hydrogen: liquefied versus compressed.
- **Responsibility and Readiness**:
  - Questions remain about who holds the responsibility for preparing hydrogen infrastructure.
  - Major global fuel producers are preparing for hydrogen, primarily for fuel cells, but the industry lacks readiness to integrate these solutions into broader transportation systems.

Infrastructure and Investment Considerations:

- **High Investment Requirements**:
  - Significant investment is needed to integrate hydrogen into existing infrastructure.
  - Current airport designs and spaces pose challenges for accommodating hydrogen facilities.
- **Comparative Complexity**:
  - While Sustainable Aviation Fuel (SAF) integration is relatively straightforward, incorporating hydrogen is more complex.

Recommendations for Hydrogen Implementation:

- **Phased Introduction**:
  - Start with small or regional airports to gain initial experience with hydrogen integration.
  - Use externally delivered hydrogen tanks rather than establishing on-site production initially.
- **Future Prospects**:
  - In the long term, explore the feasibility of local hydrogen production at airports, particularly if hydrogen usage expands across airport operations.
- **Strategic Planning**:
  - Airports should develop a comprehensive planning program for introducing hydrogen solutions.
  - Even if widespread adoption takes time, early preparation is advisable to align with future needs.

8.3.1 Topic: Airports as Energy Hubs – Electric Aviation

Key Themes and Challenges

Vision for 2040

- Future electric aviation must move beyond current prototypes (e.g., comparable to early Model T cars) to scalable solutions, such as 30-seat electric aircraft, expected being on the market 2029-30.
- Achieving readiness for 2040 requires proactive actions today to ensure infrastructure compatibility and operational feasibility.

Infrastructure and Grid Supply

- Grid capacity and virtual power plant innovations are expected to meet demand by 2035–2040 in regions like Denmark and Norway.
- Airports can feasibly store electricity, but planning must address large-scale usage, including electrification of logistics fleets (e.g., supply chain trucks).

Integration of Electric Aviation

- Skepticism about large airports adopting electric flying was noted, but key points included:
  - The importance of embedding electric aircraft into airport market strategies and masterplans.
  - Demonstrations like 30-seater electric flights from Gotland to Poland showcase the potential and necessity for integration into existing infrastructure.

Recommendations and Considerations

Airport Readiness

- Collaboration with grid suppliers, power providers, and other stakeholders is crucial to ensuring adequate electricity for future demands.
- Airports must incorporate infrastructure for electric ground vehicles and aircraft charging into their long-term strategic planning.

Sustainable Planning

- Aligning with CO2 reduction goals, such as those of DHL, is critical to ensuring sustainable integration of aviation and supply chain operations.

Balancing Ambition and Focus

- The Dutch saying, "don't take too much hay on your fork," highlights the importance of avoiding overambitious goals while maintaining a focused and realistic approach.

- Strategic planning should extend beyond current limitations to prepare for the infrastructure and operational needs of the next two decades.

Topic: Airports as Mobility Hubs – Table 1

Strategic Considerations for Intermodality:

- **Passenger-Centric Focus**:
  - Different passenger archetypes and needs must be considered.
  - Consumers should be made aware of intermodal travel options, emphasizing the value and flexibility of these choices.
- **Integration of Modes**:
  - Strong physical and operational links are essential between air and rail systems, particularly high-speed rail.
  - Long-term planning should focus on seamless connectivity between these modes of transport.
- **Divergent Business Models**:
  - Challenges arise from the differing operational goals of transport operators:
    - Rail operators may be publicly funded, prioritizing societal service.
    - Air operators are often private companies, focusing on profitability.
  - These differing objectives can complicate collaboration and alignment of goals.
- **Reliability and Trust**:
  - For door-to-door intermodal transport to succeed, passengers must perceive it as reliable and predictable.
  - Building trust in the interconnected system is crucial for consumer adoption.

Technical Challenges in Intermodality:

- **Service Availability**:
  - Timing issues create gaps in intermodal connectivity:
    - Aviation often operates late into the night, while rail or bus services may not.
    - Ensuring availability of connecting services during extended operating hours is essential.
- **Liability and Accountability**:
  - When disruptions occur, clear mechanisms must address:
    - Responsibility for delays and disruptions.
    - Liability for costs or inconvenience caused by these delays.
  - Establishing standardized agreements among operators, akin to aviation's codes for tracing delays and responsibilities, is recommended.

Topic: Airports as Mobility Hubs – Table 1

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Topic: Airports as Mobility Hubs – Table 2

Understanding Mobility Hubs:

- **Definition and Scope**:
  - Mobility hubs go beyond infrastructure; they involve the management and organization of transport activities.
  - Key elements include:
    - Integration of all transport modes.
    - Efficient and comfortable interchanges for users.
    - Modern systems for managing luggage transfer between transport modes.
- **Functionality and Role**:
  - Mobility hubs should address the "last mile" within airport cities, ensuring seamless movement between facilities and preventing confusion or inefficiency.
  - Not all airports are mobility hubs, and not all hubs require airports. Airports must actively position themselves as attractive hubs by fostering surrounding businesses and connections.

Challenges and Obstacles:

- **Integration and Aggregation**:
  - Coordinating ticketing and pricing across different transport modes and carriers is a significant challenge, particularly on a European scale.
  - Collaboration across multiple countries and economies intensifies the complexity of achieving unified systems.
- **Shift from Competition to Cooperation**:
  - Cooperation among transport modes (e.g., trains and airlines) is essential for the future of mobility hubs.
  - As transitions (e.g., environmental changes) may lead to fewer short-haul flights in Europe, integrating train and air transport becomes increasingly critical.
- **Support and Innovation**:
  - Airports aiming to become mobility hubs require government or organizational backing to achieve this ambition.
  - The process of innovation and scaling technologies (e.g., through projects like SESAR) highlights the need for significant development to bring concepts to operational readiness.