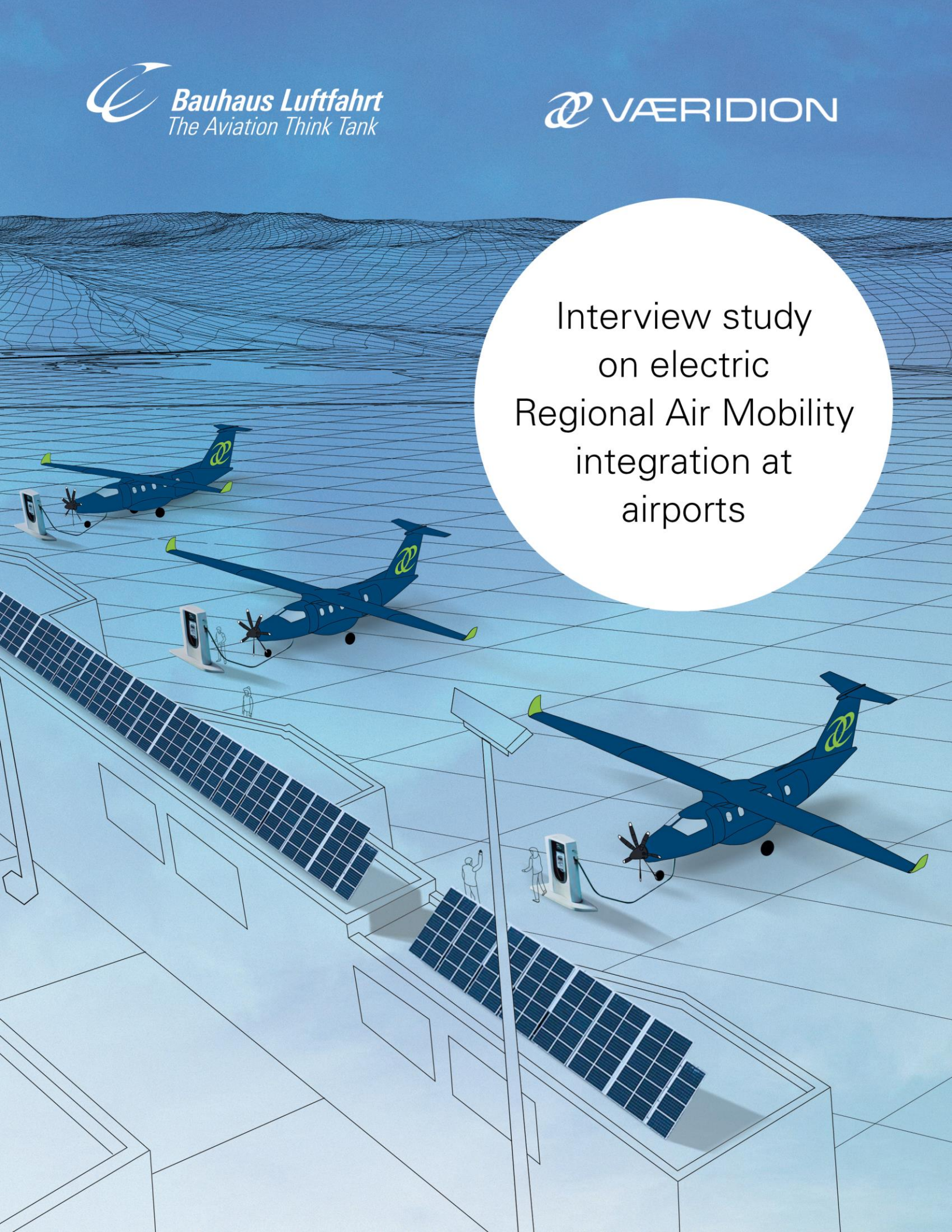
Bauhaus Luftfahrt
The Aviation Think Tank

VÆRIDION

Interview study on electric Regional Air Mobility integration at airports



Executive Summary

Electric Regional Air Mobility (RAM) enabled by fully electric aircraft can leverage underutilized airports to enhance regional connectivity. This study assesses the readiness of airports to adopt electric aircraft through interviews with airport representatives from Germany and its neighbouring countries.

Insights from the interviews highlight airports' infrastructural opportunities and challenges to adopting electric aircraft. The study informs actionable strategies for airports to become sustainable energy hubs and aligns aircraft design with operational needs.

Key opportunities:

- Airports have significant opportunities to transform into energy hubs by investing in sustainable charging infrastructure like photovoltaics and battery storage.
- On-site energy production offers substantial potential for airports to achieve energy independence, reducing operational costs and supporting electric aviation.

Key challenges:

- The development of charging infrastructure faces high initial costs, standardization needs across manufacturers, substantial power grid upgrades, and complex regulatory and logistical hurdles.
- Large-scale battery storage systems and indoor charging facilities require thorough planning and significant investment due to their technical complexities and safety requirements.

Key recommendations:

- Airports should invest strategically in renewable energy sources and battery storage systems to support the operational demands of electric aircraft.
- Implement robust fire safety measures for battery storage and charging areas, and streamline airport operations by separating RAM traffic and optimizing security procedures. Use mobile superchargers for flexibility in smaller airports.
- Engaging with government bodies, private investors, and the public is crucial for securing financial support and fostering community buy-in for transitioning to sustainable aviation practices.

The study establishes a foundation for understanding how electric RAM can integrate into existing airport infrastructures. RAM could soon become an operational reality, presenting a unique opportunity to enhance

connectivity in less-connected regions across Germany and beyond. Ensuring seamless integration of RAM into the current airport ecosystem and the broader transportation landscape is essential for its success and sustainability.

Definitions

BERTL: Batterieflügel für Elektrische Regionale Transport-Luftfahrtzeuge

CEOs: Chief Executive Officers

COOs: Chief Operating Officers

EASA: European Union Aviation Safety Agency

eGPU: electric Ground Power Unit

GPS: Global Positioning System

IDRF: Interessengemeinschaft der regionalen Flugplätze

IFR: Instrument Flight Rules

ILS: Instrument Landing Systems

PBN: Performance-Based Navigation

PPAs: Power Purchase Agreements

PPPs: Public-Private Partnerships

PV: photovoltaic

RAM: Regional Air Mobility

SBAS: Satellite Based Augmentation System

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1. Introduction

The BERTL project (short for Batterieflügel für Elektrische Regionale Transport-Luftfahrtzeuge), undertaken in collaboration between Vaeridion GmbH, Technical University of Munich and Bauhart Luftfahrt e. V., aims to demonstrate the technical feasibility of high aspect ratio wings with a structurally integrated battery system to enable the development of fully electric aircraft. The reference aircraft is designed to accommodate 9 to 19 passengers and achieve a range of up to 500 kilometres. The project also investigates the scalability of smaller and larger aircraft. These fully electric aircraft enable the business concept of "Regional Air Mobility" (RAM), which seeks to enhance regional connectivity by leveraging underutilized airports and airfields to improve transportation between cities and regions.

To evaluate the economic feasibility of this innovative technical concept, 16 in-depth interviews were conducted with experts and representatives from airports and airfields of various sizes and locations across Germany and its neighbouring countries. The objectives of these interviews were to assess the willingness of airports to adopt RAM and integrate electric aircraft into their operations. The discussions aimed to identify opportunities and challenges related to airport infrastructure, ensuring a holistic understanding of the requirements for incorporating electric aviation into airport ecosystems.

The findings of this study provide valuable insights into the opportunities and challenges that airports and airfields face in accommodating electric aircraft, with a particular focus on infrastructure readiness. By highlighting key areas for improvement and potential strategies, this study offers actionable recommendations to support airports in embracing RAM and overcoming operational barriers. Furthermore, the insights gained contribute directly to refining aircraft design, ensuring that the technical solutions align with the practical realities and needs of airport operations. This collaborative approach benefits both the aviation industry and airports, fostering a smoother transition toward sustainable and efficient electric RAM.

2. Interviews with airports

2.1. Airport participants and interviewees

Between November 2023 and June 2024, we conducted interviews with representatives from 16 airports. We recruited participants by sending invitations through email and LinkedIn to airports within our network, as well as to those listed by Interessengemeinschaft der regionalen Flugplätze e. V. (IDRF e. V.). A majority of these airports, specifically 13, are situated within Germany, demonstrating a broad representation across various regions of the country. Of the German airports, eight are positioned in the southern states, four airports are

based in the northern states, and one airport is located in the eastern region, ensuring a diverse geographic sampling within Germany. Beyond the German borders, the remaining three airports participating in this study are located in neighbouring countries: Switzerland, Austria, and Slovakia. The geographical distribution of the participating airports is depicted in Figure 1.

A significant portion of the experts who were interviewed for this study occupy high-ranking leadership roles within their respective organizations. These positions include titles such as Managing Directors, Chief Executive Officers (CEOs), and Chief Operating Officers (COOs), highlighting the seniority and expertise of the participants involved in our research. A detailed overview of the interviewee roles is presented in Figure 2.

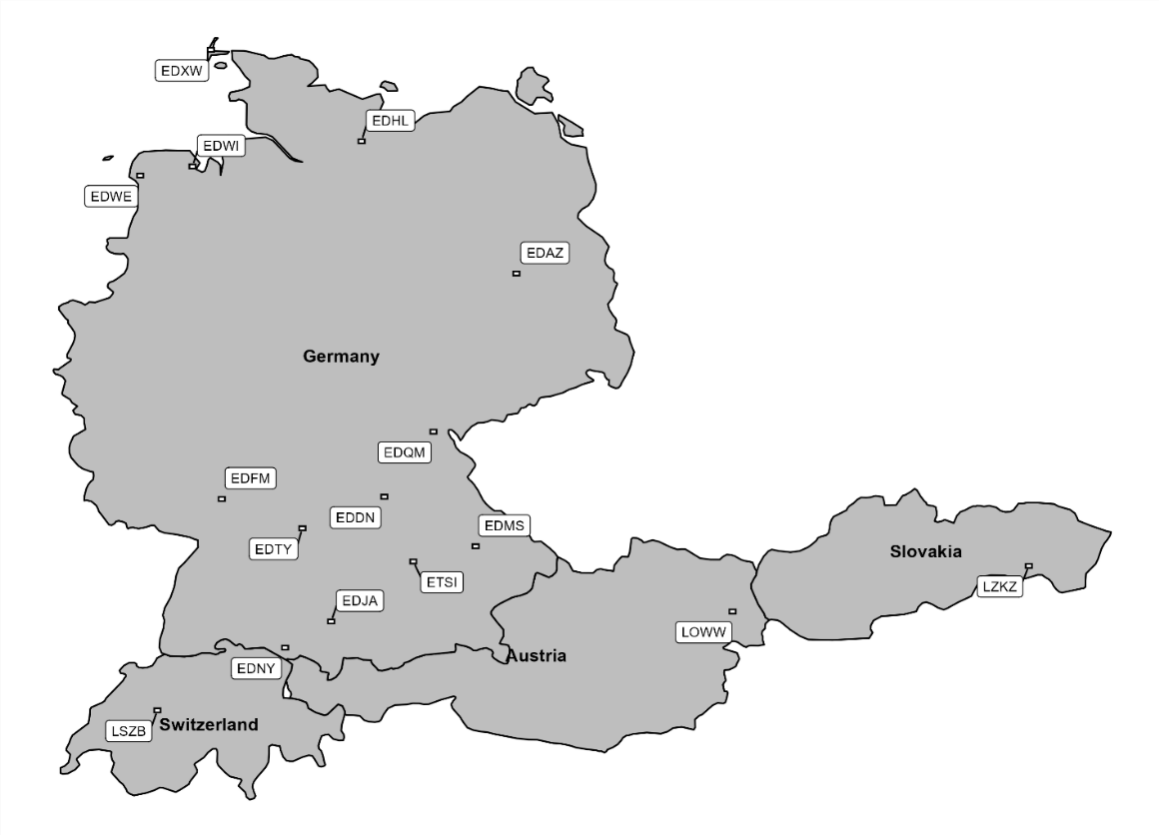


Figure 1. Geographical locations of the interviewed airports

Figure 2. The seniority level of the interviewed experts

Considering the size and annual flight movement of each airport, our study includes one large hub airport, three medium-sized regional airports, and 12 smaller regional airports and airfields. Table *1* provides detailed information on each airport's runway lengths and annual flight movements, with runways ranging from 1,066 to 3,600 metres. All participating airports meet the runway length requirement of 1,000 metres necessary to accommodate the BERTL all-electric aircraft.

Furthermore, the majority of these airports (15 out of 16) support Instrument Flight Rules (IFR) operations and are equipped with the necessary instrument flight systems, which are essential for the commercialization of RAM as they allow continued operations during adverse weather conditions. Despite some airports not offering scheduled flight services, all are capable of accommodating business jets and single-engine propeller aircraft for short-haul and feeder flights. This capability is crucial for supporting the business model of electric RAM.

	Median	Min.	Max.
Airfield/airport configurations			
Runway length [m]	1,916	1,066	3,600
Runway width [m]	38	23	60
Traffic type (VFR/IFR)	15 airports VFR & IFR; 1 airport VFR only		
Flight			
Movement/year	28,750	6,400	255,500
Scheduled flight (yes/no)	10 airports currently have scheduled flights while 6 do not		

Table 1. Statistics of the interviewed airports

2.2. Interview design

To ensure objective responses, we designed open-ended interview questions that allowed for individual assessments and consideration of local conditions. The interviews started with broad questions regarding general attitudes towards airport infrastructure adaptation and understanding key aspects affecting this. Based on previous research, we have identified five critical categories for analyzing airport infrastructure in relation to electric aviation: *design*, *operations*, *finance and investment*, *regulation*, and *societal and environmental impacts*. The questions particularly emphasized design and operations to align with the BERTL project goals, while financial and investment issues were discussed only if raised by respondents.

Each interview, conducted via Microsoft Teams with recording consent, lasted approximately one hour. This included a 15-minute introduction to the BERTL project, a 35-40 minute focused interview, and a concluding 10-minute open discussion session. Responses were dynamically tailored based on prior answers, and participants were asked to rate the importance of the relevant five aspects on a scale of 1 to 10 after the interview. The full set of interview questions is included at the end of the report.

2.3. Interview analysis

To effectively structure and analyze the interview responses, we employed a top-down approach. After cleaning the transcript, each sentence from the transcript was entered into an Excel spreadsheet. We then applied coding to categorize each sentence under one of the five main categories listed in Table 2. After the first interviews, we reviewed and refined these codes for relevance and clarity. The finalized coding system, detailed in Table 2 was consistently applied to all subsequent interview transcripts.

Category	Coding
Design	Charging infrastructure Parking lots Airfield & hangar size Runway length Energy & grid requirements Storage system
Operations	Instrument approach procedure Charging process Fixed or mobile chargers Operational restrictions Slot restrictions
Finance and investment	Operational costs Long-term investment Construction & renovation Chance & revenue Energy generation system Financial limitations
Regulation	Safety Open ticket system Security checks & special areas Standardization
Society and environment	Establishment of RAM Significance for society On-site energy generation Green electricity Public accessibility

Table 2. Categories and codings

3. Interview results

3.1. A positive attitude to serve electric RAM of all airport participants

All participating airports express a willingness to accommodate electric RAM within the next five years. Notably, 75% of the airports confidently state their capability to support electric RAM operations within this timeframe, highlighting preparedness in infrastructure and strategic planning. Conversely, the remaining 25% express some uncertainty about their readiness, addressing potential challenges that could impact their ability to meet the requirements by the projected timeline. Nevertheless, none of the airports indicate a complete incapacity to serve electric RAM, suggesting a general openness and a positive outlook towards adopting sustainable aviation solutions.

3.2. Key factors driving the integration of electric RAM

As shown in Figure 3, the *Society and Environment* aspect is the most frequently discussed among the respondents, particularly focusing on the establishment of RAM, public accessibility of the airports, and their regional status. The *Design* aspect constitutes an equally significant proportion, where significant attention is given to factors such as airfield and hangar dimensions, as well as the energy and grid requirements necessary for operations.

The *Operations* aspect follows closely, addressing specific operational constraints and the instruments required for approach procedures at the airports. In the fourth-ranked *Finance and Investment* aspect, respondents emphasize the potential opportunities and revenue generation from integrating RAM.

Although the *Regulatory* aspect receives less direct emphasis due to the absence of specific targeted questions, a considerable portion of the open discussion phase has been devoted to it, highlighting its underlying significance. Within this category, respondents particularly note challenges related to security procedures at regional airports, underscoring the complexity and importance of regulatory considerations in implementing RAM.

Figure 4 indicates that all five aspects are relevant. Among them, *finance and investment* and *regulatory* aspects emerge as the key drivers. The participants highlight that securing sufficient financial resources and making sound investment decisions are crucial for facilitating the necessary infrastructure modifications and technology adoptions needed for electric RAM. Moreover, navigating the regulatory landscape effectively is vital, as it shapes the legal and operational framework within which airports and airfields must operate to support RAM. On the other hand, *operations*, while still important, are perceived as slightly less critical compared to the other dimensions. This perception might be influenced by the fact that operational changes can be more directly managed and implemented once the financial and regulatory conditions are adequately addressed. Moreover, the operational aspect is also perceived as more relevant to the operators rather than to the airports or airfields themselves.

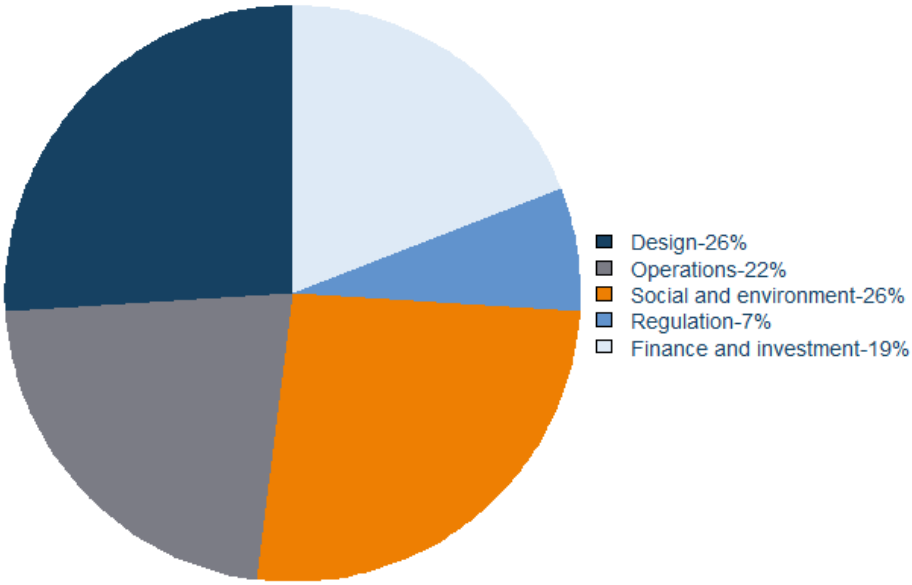


Figure 3. Frequency of each mentioned category

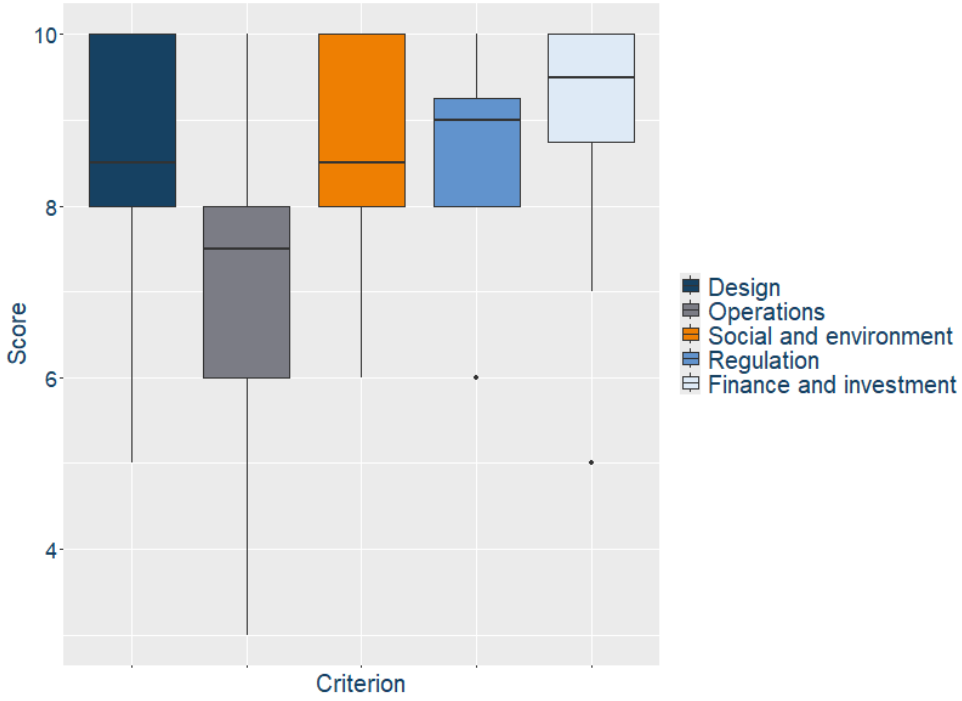


Figure 4. Importance of each mentioned category

Design

The interviewed airports generally report that runway length and aircraft handling capacity meet current needs, with existing weight limits not posing significant issues. However, concerns arise with aircraft having large wingspans, particularly in terms of fitting within the current narrow gate widths at hangar parking positions. The high-wing design of the aircraft has been viewed positively, offering potential operational advantages, especially as low-wing designs currently dominate regional aviation.

On the infrastructure side, most airports lack sufficient power supply to support the operation of multiple electric aircraft. Only a few airports are currently equipped with the first charging stations and have grid capacity. Furthermore, the majority of the airports acknowledge that upgrades to the grid and transformation capacity are necessary. Less than half believe they can generate enough green energy on-site to support electric aircraft operations.

The consensus is that long-term success in operating an electric aircraft fleet would depend on adequate storage systems, like battery or hydrogen storage. However, the absence of such infrastructure and definitive development plans suggests that establishing this capacity requires extended effort.

Finance and investment

The respondents highlight significant financial challenges primarily associated with infrastructure adaptations, including upgrading old building roofs for photovoltaic (PV) system installations and developing new electricity grids. Most airports currently lack the power supply needed to integrate electric aircraft into their operations smoothly. However, there is keen interest among the airports in producing their own green electricity on-site using PV systems, not just to meet emissions targets but also to store and use this energy for charging electric aircraft or other electric vehicles. As mentioned earlier, finance and investment and regulatory aspects are perceived as the top drivers for the successful integration of electric aircraft. We believe that obtaining sufficient funding and making wise investment decisions are critical steps in facilitating the necessary upgrades to infrastructure and the adoption of new technologies required for electric RAM.

Operations

Considering the BERTL aircraft configurations, airports do not view the aircraft's weight or the anticipated noise reduction from electric motors as significant issues. Discussions on instrument approach procedures highlighted the availability of Instrument Landing Systems (ILS) and future plans for Global Positioning

System (GPS) based procedures. Due to cost considerations, some regional airports may choose not to implement ILS, but there is a consensus on adopting GPS procedures for their cost efficiency and precision.

Regarding charging, flexibility is key during the transition to electric aircraft. Respondents favour mobile superchargers for their flexibility and lower costs, and some suggest using an electric Ground Power Unit (eGPU) for combined storage and mobile charging, at least for the transition phase. While charging time could potentially delay operations, this is generally not considered a critical issue by the interviewees.

Lastly, while the addition of a few slots for electric aircraft is currently manageable, regularly scheduled operations could eventually lead to slot bottlenecks at some airports.

Regulations

A point raised by the interviewees is the urgent need for standardizing charging plugs. The current lack of uniform standards for charging stations, plugs, and power requirements makes airports hesitant to invest due to uncertainties about which technology will dominate the market.

Airport security checks and designated security areas have also been addressed. Several interviewees indicate their lack of capacity to provide official security lines, which become necessary for scheduled flights using an open ticket system once a certain passenger threshold is reached. Many of the airports typically serve aircraft types that do not require such security checks, leading to reliance on temporary security services from external providers or the complete absence of permanent security facilities.

Society and environment

Interviewees highlight two main benefits of RAM. Firstly, RAM offers market opportunities by providing direct connections between regional airports, offering a time-efficient travel alternative for business travellers and enhancing connectivity to remote regions. Secondly, environmental advantages include reduced emissions and lower noise levels at airports compared to conventional aircraft.

Regarding public accessibility, some airports have excellent connections to major highways, ICE trains, and regional bus services, while others have limited parking for private cars and taxis. Additionally, almost all airports are committed to reducing environmental impact and addressing the growing demand for green electricity by initiating large PV projects in the coming years.

3.3. Opportunities and challenges for airport infrastructure

Based on input from the interviewees, we categorized the mentioned aspects and factors according to their relevance, opportunities, and challenges. We established a five-point scale—ranging from very low to very high—to evaluate each factor. The categorization matrix is detailed in Figure 5 with a focus on regional airports or airfields. Opportunities arise if airports can improve or adapt their current infrastructure with minimal effort, or view the development of new systems and infrastructure for RAM as a beneficial economic and environmental investment for both the airport and the surrounding area. Challenges or risks are anticipated if airports expect significant efforts or face difficulties in improving or adapting current infrastructure. This includes difficulties related to finances, gaining support for new developments, or potential risks such as safety and noise concerns associated with introducing RAM.

Aspects with high impacts, opportunities, and challenges/risks

Charging infrastructure

Opportunities: Airports recognize the potential to become energy hubs by investing in sustainable charging infrastructure and integrating renewable energy solutions. This aligns with societal demands for greener transport and positions them as pioneers in sustainable aviation, potentially attracting new operators and fostering long-term growth.

Challenges: Developing charging infrastructure presents several challenges, including high initial costs, the need for standardization across different manufacturers, substantial power grid upgrades, and regulatory and logistical hurdles. These factors make it a significant issue for many airports, even those with some existing infrastructure readiness.

Power grids/transformer capacities

Opportunities: Airports see substantial opportunities in expanding and upgrading their power grids and transformer capacities to support electric aviation and integrate renewable energy. These enhancements can position them as leaders in sustainable aviation. However, success relies on considerable investments, effective regulatory management, and collaboration with external partners.

Challenges: Despite being technically feasible, upgrading power grids and transformer capacities poses significant challenges due to high costs, logistical complexities, dependence on local energy providers,

lengthy planning processes, and current capacity limitations that may hinder scaling to meet future electric aviation demands.

Own/on-site electricity production

Opportunities: Airports identify substantial opportunities in large-scale on-site energy production, including PV systems, battery storage, and hydrogen production. These initiatives can foster energy independence, cost savings, and sustainable operations, positioning airports as regional hubs for green aviation and energy distribution. Success in these areas depends on significant investment and efficient implementation.

Challenges: On-site energy production using PV systems presents challenges such as high upfront costs, space constraints, seasonal variability, and the need for integrated energy storage and distribution systems. While many airports have made advancements, careful planning and significant investment are still required to overcome these hurdles.

Battery storage system

Opportunities: Battery storage systems offer airports a significant opportunity to increase energy independence, optimize renewable energy use, and manage peak demands. This supports efficient operations, reduces grid reliance, and aligns with long-term sustainability goals, particularly when paired with expanding solar power projects.

Challenges: Despite their strategic benefits for energy optimization, implementing large-scale battery storage systems presents significant challenges. These include high upfront costs, technical complexities in capacity management and integration with renewable energy sources, and the necessity for careful planning and infrastructure upgrades.

Indoor charging possibilities

Opportunities: Indoor charging provides notable opportunities to enhance safety, protect equipment from weather, facilitate maintenance operations, and attract new customers with secure overnight storage.

Challenges: Integrating charging infrastructure into hangars is challenging due to space limitations, the high costs of modifications or new constructions, and strict compliance with safety regulations, especially fire safety. These factors make it a complex and resource-intensive issue for airports.

Fixed superchargers

Opportunities: Fixed superchargers offer airports the chance to establish reliable and cost-efficient charging infrastructure that supports electric aircraft and vehicles, enabling faster turnaround times and scalability for future demand.

Challenges: Installing fixed superchargers involves significant challenges, including high upfront costs, substantial power grid upgrades, and logistical constraints on operational flexibility, especially when compared to mobile solutions.

Infrastructural investments

Opportunities: Airports have substantial opportunities to invest in sustainable infrastructure, including solar energy, battery storage, electric GPUs, and charging systems. These investments can establish them as pioneers in sustainable operations, modernize facilities, attract new operators, and facilitate long-term efficiency and revenue potential.

Challenges: Infrastructure investment might be hindered by fiscal constraints, regulatory delays, ageing facilities, energy transition demands, economic uncertainties, and political instability. Addressing these challenges requires policy reforms, streamlined regulations, and strategic planning.

New business models

Opportunities: Airports see potential in CO2-neutral regional aviation, niche routes, on-demand electric flights, renewable energy integration, and diversified services. These innovations can attract new operators, create revenue streams, and position airports as pioneers in sustainable RAM.

Challenges: Implementing new business models faces obstacles such as high initial costs, regulatory barriers, infrastructure needs, and market uncertainties.

Security checks

Opportunities: Enhancing security processes presents moderate opportunities to attract larger commercial operators, manage increased passenger traffic, and align with industry standards. Cost-efficient models and faster processing also add value to RAM services.

Challenges: Current infrastructure limits immediate expansion needs. Upgrading security infrastructure requires substantial investments in equipment, personnel, and facilities to handle higher passenger volumes and meet regulations.

Public support

Opportunities: Strong public support enables airports to secure funding, advance sustainability initiatives, and enhance their reputation as environmentally responsible, fostering smoother project execution, increased demand for green aviation, and stronger community relations to drive long-term growth and connectivity.

Challenges: Maintaining public support poses moderate challenges due to concerns about noise, environmental impact, and infrastructure changes. This requires effective and transparent communication, community engagement, and visible investments in sustainable initiatives to meet public and political expectations.

Other opportunities

Environmental role model function

Airports have the opportunity to become environmental role models by adopting green initiatives such as electric GPUs, renewable energy, and carbon-neutral operations. These efforts can enhance their reputation, attract eco-conscious stakeholders, secure government support, and set industry standards, aligning with regulatory and societal trends toward sustainability.

Mobile superchargers

Mobile superchargers provide airports with flexible, adaptable charging options during the transition to electric aviation, ideal for managing variable traffic and pilot operations. However, their restricted long-term viability may diminish their appeal compared to fixed infrastructure.

Hangar size

Expanding hangar facilities offers a moderate opportunity for airports to support future growth, attract operators, and accommodate larger or electric aircraft. However, the immediate need is limited by current demand and financial constraints, with expansion potential linked to long-term fleet and operational growth.

Runway length

The current runway is sufficient for existing operations and supports the immediate needs of RAM. Opportunities for expansion or upgrades are moderate, mainly linked to potential future growth, such as accommodating larger electric aircraft or increased traffic volume.

Terminal capacity

The current infrastructure adequately meets existing operations and short-term needs of RAM. Expanding terminal capacity offers a moderate opportunity to support growth in regional and electric air mobility, attract more operators, and manage increased traffic volumes, especially during seasonal peaks.

Aircraft parking spaces at the apron

Currently, there are only a limited number of apron spaces available for aircraft with large wingspans, such as those analyzed in the BERTL project. Expanding and optimizing apron parking significantly enhances the airport's capacity to accommodate more aircraft, including electric and larger models. This improvement boosts operational efficiency, turnaround efficiency, and revenue potential while supporting growth in RAM and aligning with long-term aviation trends.

Instrumental approach systems

Upgrading and modernizing navigation systems, such as implementing CAT IIIb or enhanced GPS-based approaches, offers significant opportunities to improve safety, reliability, and operational efficiency, particularly in poor weather conditions. These enhancements support future growth in electric air mobility and attract more commercial operations.

Slot restrictions

The absence of slot restrictions provides moderate opportunities for growth and flexibility, allowing the airport to attract more operators, prioritize electric flights, and scale up regional air mobility with minimal cost or planning effort. Although existing measures currently satisfy demand, the potential for new regional connections could lead to a substantial increase in future requirements.

Public accessibility

Improving public transport connections and accessibility presents a strong opportunity to attract more passengers and support RAM. This can be achieved through enhanced shuttle services, integration with new mobility options, and infrastructure developments like the ICE station. However, major upgrades may rely on regional infrastructure developments outside the airport's control.

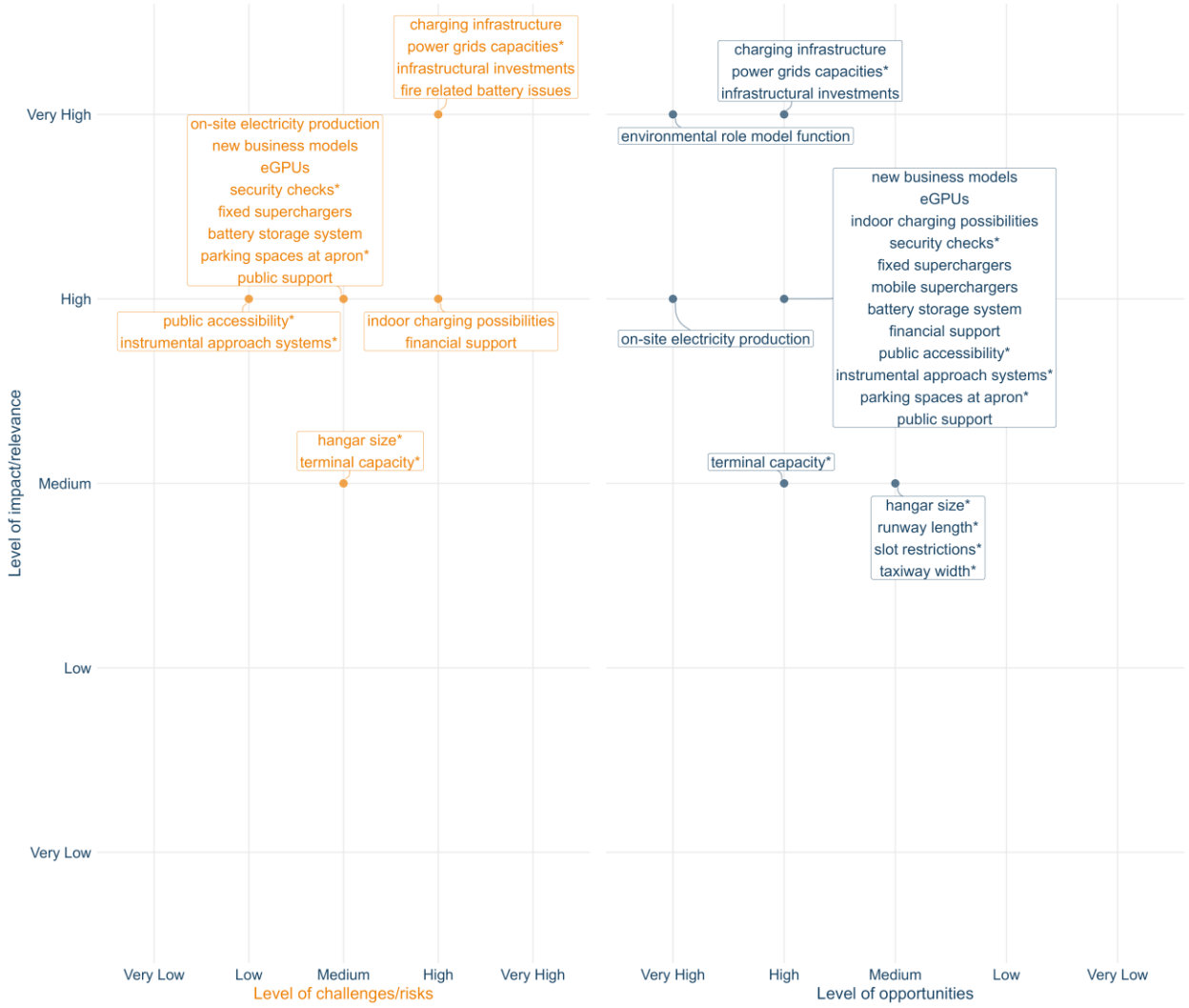
Other challenges or risks

Financial support

Securing financial support for major infrastructure and sustainability projects is challenging due to limited government grants, bureaucratic hurdles, competition with larger airports, and a preference for financial independence. This makes external funding essential but difficult to obtain.

Fire-related battery issues

Managing battery safety, particularly fire risks associated with lithium-ion batteries, is a critical challenge requiring significant upgrades in fire safety infrastructure, specialized equipment, and personnel training. Compliance with evolving safety regulations adds to the complexity, making it a resource-intensive issue for airports.



**refers to the current infrastructural or operational conditions at the airports or airfields*

Figure 5. Summary of relevant aspects, opportunities, and challenges of regional airports

4. Expectations and recommendations

In anticipation of changes in airport infrastructure, it is crucial to implement key adaptations and strategies that consider perspectives from not only airports but also other relevant stakeholders.

Adaptation of airport infrastructure

A major priority is the standardization of charging infrastructure. By establishing uniform charging standards, airports can avoid costly missteps in technology adoption and ensure that their equipment remains compatible as new technologies emerge. This is particularly crucial as electric aviation technologies continue to evolve.

Given their adaptability, mobile superchargers are a recommended solution, especially for smaller airports where installation space is limited. These mobile units offer the flexibility to adjust charging capabilities as needed, adapting quickly to changes in airport layout and aircraft parking patterns.

In addition to charging solutions, airports should proactively transform into energy hubs. This transition involves setting up on-site energy production facilities to decrease dependency on external power sources. By utilizing renewable energy sources, like solar panels combined with energy storage systems, airports can produce and store their own sustainable power. This not only supports their charging infrastructure but also contributes to broader environmental goals.

To adequately support these energy solutions, it is crucial to enhance the existing power grids and transformer capacities. In situations where it is not feasible for energy providers to directly upscale their systems, airports should consider establishing their own local grids. This step would provide more control over energy management and help mitigate potential disruptions.

Furthermore, implementing battery storage systems is vital. These systems enable airports to take advantage of lower energy costs during off-peak periods by storing power and utilizing it during peak operational hours, thereby optimizing energy consumption and alleviating grid strain.

Safety is another critical area, particularly concerning the fire risks associated with battery storage and charging. Implementing robust fire prevention strategies, such as equipping indoor charging stations and providing specialized training for fire departments, will mitigate these risks and enhance overall airport safety.

Finally, to efficiently manage the increasing mix of traditional and RAM traffic, airports should consider physically separating operations where possible. Creating separate terminals or zones can coordinate traffic flow, reduce operational conflicts, and improve the overall efficiency of airport operations.

Engagement of other stakeholders

In the meantime, a series of operational adjustments and regulatory updates are also essential. One key strategy is the implementation of smart charging strategies. By strategically scheduling flight operations and optimizing charging times for electric aircraft, airports can significantly reduce peak energy demands. This not only alleviates pressure on existing grid infrastructures but also minimizes the need for costly upgrades, thereby promoting more sustainable energy consumption patterns.

For navigation and safety, the adoption of advanced instrumental approach systems, such as GPS, plays a crucial role, especially for smaller airports. These systems improve navigational precision, significantly enhance safety during landings and take-offs, and reduce the risk of navigational errors. Smaller airports, in particular, stand to benefit from these technologies as they often lack the complex infrastructure of larger airports.

On the regulatory side, it is crucial to foster the adoption of Performance-Based Navigation (PBN) approaches, with a particular emphasis on GPS-based systems. This shift is essential as the European Union Aviation Safety Agency (EASA) has set a deadline of June 6, 2030[1], after which Satellite Based Augmentation System (SBAS) will be the standard for Category I GPS approaches and ILS Category I approaches will be phased out. Adapting to these GPS-based navigational aids will enable airports to continue accommodating scheduled commercial air transport efficiently and safely.

Additionally, simplifying security procedures for small aircraft can lead to more efficient airport operations. Streamlining these checks can drastically reduce wait times, enhancing the overall passenger experience and improving throughput during peak operational hours. This not only benefits passengers but also optimizes the use of airport resources.

Overall, coordinated planning that involves airlines, regulatory authorities, and energy providers is essential to ensure that infrastructure developments meet operational needs and comply with regulations. Engaging local communities to explain the benefits and changes brought by electric aircraft can build public support and mitigate concerns. Additionally, collaboration with various stakeholders, including government bodies, the private sector (such as private investors, companies and Power Purchase Agreements (PPAs)), and Public-Private Partnerships (PPPs), is crucial to securing the financial support needed for these initiatives.

[1] Source: https://www.easa.europa.eu/en/faq/134930

5. Conclusion

This interview-based study is the first of its kind in its scope and focus, exploring the willingness and feasibility of integrating electric RAM into existing airport infrastructure with a focus on Germany. All interviewed airports acknowledged the potential of RAM to enhance time efficiency, reduce environmental impact, and improve inter-regional connectivity. Importantly, no significant limitations were identified regarding the size of the aircraft, including considerations such as runway length, handling capacities, and weight restrictions.

Airports can be strategically positioned to evolve into critical energy hubs by investing in sustainable charging infrastructure, such as on-site energy production technologies including photovoltaics and battery storage. These initiatives not only meet the growing demands for environmentally friendly aviation but also establish airports as pioneers in sustainable aviation, potentially attracting new operators and promoting long-term growth. Despite these opportunities, airports encounter substantial challenges in developing such infrastructure, which include high initial costs, the necessity for grid capacity upgrades, and stringent regulatory requirements. On-site energy production and battery storage systems introduce additional challenges such as technical complexities, high upfront costs, and space constraints, which require careful planning and significant investment to overcome.

All participating airports expressed their interest and willingness to accommodate electric aircraft in the future. However, it is important to acknowledge that only those airports particularly interested in this subject agreed to participate in our study. Airports that declined participation may hold different perspectives. Engaging with these airports during regular meetings or networking events at local or national levels could shed light on their reasons for reluctance and enrich our understanding.

Moreover, although the current findings mainly focus on the infrastructural aspects of airports, they do not cover the operational facets of RAM. Feedback from some airports suggested that understanding the viewpoints of operators is crucial to fully assess the feasibility of integration. As a next step, we plan to explore these operational dimensions by interviewing airline operators, thus providing a more comprehensive evaluation of the potential for integrating electric RAM into the existing airport ecosystem.

Interview questions

1. Ohne Rücksicht auf die tatsächlichen lokalen Kapazitäten: ist Ihr Flughafen/Flugplatz gewillt, in Zukunft den Betrieb von Elektroflugzeugen in der kommerziellen regionalen Luftmobilität zu starten? Und welche Vorteile sehen sie darin?
2. Ist Ihr Flughafen/Flugplatz in der Lage, in den nächsten fünf Jahren tatsächlich den Betrieb von Elektroflugzeugen für die kommerzielle regionale Luftmobilität aufzunehmen?
3. Gibt es einen Plan, neue Ladeinfrastruktur zu installieren, oder ist diese bereits vorhanden?
    a. Falls Ja, in welchem Jahr erwarten Sie die Inbetriebnahme?
4. Was sind die größten Herausforderungen oder Einschränkungen in Bezug auf die Fähigkeit, Elektroflugzeuge in Betrieb nehmen zu können?
5. Welche Schlüsselfaktoren sollten bei der Planung und Investition in Ladeinfrastruktur für Elektroflugzeuge an Ihrem Flughafen berücksichtigt werden, unter der Vorraussetzung, dass sie in die bestehende Flughafeninfrastruktur integriert wird?
6. Sind Ihrer Meinung nach festinstallierte Ladestationen oder mobile Supercharger (mit einer Leistung von bis zu 600kW) besser zum Laden der Flugzeuge geeignet?
7. Sehen Sie irgendwelche Herausforderungen oder Einschränkungen im Zusammenhang mit dem bestehenden Stromnetz, wenn es darum geht, die steigende Nachfrage von Elektroflugzeugen zu decken?
    a. Sehen Sie Auswirkungen auf die vertragliche Situation in Bezug auf die vereinbarten Strom-Abnahmemengen? Könnte ein PPA (Power Purchase Agreement) eine Option sein?
    b. Halten Sie die Installation von PV-Analgen oder anderen erneuerbaren Energieerzeugern an ihrem Flughafen für eine geeignete Möglichkeit, einen Teil des Strombedarfs zu decken?
8. Sehen Sie die Notwendigkeit weiterer infrastrukturieller Änderungen an Ihrem Flughafen, um die regionale Elektromobilität, basierend auf dem oben genannten Flugzeug, zu ermöglichen? (z.B. am Rollfeld, Parkplätzen, Wartebereichen für Passagiere usw.)
9. Wie ist der aktuelle Stand Ihres Flughafens/Flugplatzes in Bezug auf Instrumentenanflugverfahren? Unterstützen Sie Präzisionsanflugverfahren? *(z.B. Ground controlled approach (GCA), GBAS landing system (GLS), Instrument landing system (ILS), etc.)*
    a. Falls nein, planen Sie, diese Verfahren in Zukunft zu implementieren?

10. Sehen Sie in Anbetracht der derzeitigen Bedingungen, wie z. B. Start- und Landebahnlängen oder Gewichtsbeschränkungen, Konflikte zwischen Ihrem Flughafen/Flugplatz und den Auslegungsparametern der einzelnen genannten Flugzeuggrößen?
11. Können sie weitere Problematiken oder Einschränkungen bezüglich des Flugzeugdesigns, ausgehend von den Gegebenheiten an Ihrem Flughafen/Flugplatz, vorhersehen?
12. Sehen Sie neben den bereits erwähnten Aspekten noch weitere Herausforderungen hinsichtlich der Etablierung der regionalen Luftmobilität?
    a. Wenn ein finanzieller Engpass erwähnt wurde
        1. Wenn Ihr Flughafen/Flugplatz finanzielle Unterstützung erhalten würde (z.B. durch staatliche Zuschüsse), in was würden Sie zuerst investieren?
        2. Wer hat Ihren Flughafen/Flugplatz bei Ihrer letzten größeren Infrastrukturinvestition unterstützt?
        3. Sind Sie von Unternehmen angesprochen worden, die in die Elektro- oder Hybridinfrastruktur Ihres Flughafens/Flugplatzes investieren oder sie mitfinanzieren wollen?
13. Gibt es darüber hinaus weitere Informationen oder Perspektiven die Sie mit uns teilen möchten?

Optionale Fragen (Zeitabhängig)

1. Haben Sie die Absicht oder Pläne, in die Infrastruktur für Elektroflugzeuge, Wasserstoffflugzeuge, nachhaltige Flugkraftstoffe (SAF), eine Mischung aus Ihnen oder gar keine zu investieren?
2. Hat Ihr Flughafen/Flugplatz Pläne für die Elektrifizierung des Bodenbetriebs oder arbeitet bereits daran?
3. Können Sie sich für Ihren Flughafen/Flugplatz vorstellen, dass Elektroautos in Parkgaragen zukünftig als Energiespeicher,-puffer agieren könnten?

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