Feasibility study on PtL kerosene – framework conditions for an innovative industrial plant for the production of sustainable aviation fuels (hereinafter referred to as SAF) for use at Stuttgart Airport

Background to the Study

The state of Baden-Württemberg has set itself ambitious climate targets. By 2040, it aims to achieve 100% climate neutrality and, as a result, use a high percentage of sustainable aviation fuel (hereinafter “SAF”) in air transport.

As part of the feasibility study conducted jointly with partners SkyNRG and Schwenk Zement and with the support of the Baden-Württemberg Ministry of Transport, the possibility of SAF production (power-to-liquid/PtL) in Baden-Württemberg was to be evaluated. In the course of SAF production, unavoidable CO2 from cement production was also to be utilized. In view of the current EU regulatory requirements, it is not possible to establish economical SAF production in Baden-Württemberg according to current estimates. As a result, a realignment of the project and a restriction to the implementation of four studies has been jointly agreed.

As Baden-Württemberg's state airport, Stuttgart Airport has also set itself the goal of achieving net greenhouse gas neutrality by 2040. As part of its fairport strategy, Stuttgart Airport is pursuing the goal of being one of the most efficient and sustainable airports in Europe.

With an operational fuel storage facility (three fuel tanks, each with a capacity of 1,750 m^3), the airport currently has the necessary infrastructure to meet local aviation needs. The amount of kerosene ordered by the respective airline and its provision are regulated in the bilateral business relationship between the airline and its fuel supplier. Therefore, Stuttgart Airport has no direct influence on whether SAF is available locally and to what extent it is used. Although it is not within the airport's immediate sphere of influence, the airport would like to provide support in the area of SAF availability and use and contribute to positive progress. Against the backdrop of the fairport strategy and the EU's upcoming blending requirements from 2025, a study is needed to identify possible measures to increase the availability and use of SAF at Stuttgart Airport.

Studie durchgeführt:

STUTTGART AIRPORT the fairport

NACO a company of Haskoning

Partner des Konsortiums:

SKYNRG

SCHWENK

Studie gefördert durch:

Baden-Württemberg Ministerium für Verkehr

Table of Content

Executive Summary

1. **Introduction**

2. **Sustainable Aviation Fuels: Production & Distribution**
   - Production Pathways
   - Transport & Supply Methods
   - Chain of Custody
   - Policy & Regulations

3. **Future Demand Mapping**
   - Existing route analysis
   - SAF demand estimations

4. **Stakeholder Engagement Analysis**
   - Stakeholder Mapping
   - Stakeholder Analysis
   - Stakeholder Engagement Strategy

5. **Airport Roadmap**
   - Airport Sphere of Influence
   - Goals & Objectives
   - Strategy Formulation
   - Implementation Plan
   - Monitoring & Evaluation

Annex 1: Stakeholder Interview Summaries
Annex 2: Stakeholder Interview Questions

Document Title:	Stuttgart Airport – Future Fuels Feasibility Project Report
Date:	August 29, 2024
Project Name:	Stuttgart Airport Future Fuels Feasibility
Project Number:	BJ7647
Client:	Stuttgart Airport GmbH
Consultant:	**NACO, Netherlands Airport Consultants** HaskoningDHV Nederland B.V. Schenkkade 49, 2595 AR Den Haag The Netherlands
Authors:	Gopal Kandiyoor, Helena Rodriguez, Mick Werson
Document version:	Final version
Contact:	Mick Werson Project Director

Executive Summary

In recent years, Sustainable Aviation Fuel (SAF) has emerged as a critical component in the global effort to decarbonize the aviation industry. As a drop-in fuel that can be used in existing aircraft engines, SAF offers a promising solution to reduce greenhouse gas emissions associated with air travel. There has been a significant surge in interest and investment in SAF development, particularly within the European Union (EU) and Germany.

The demand for SAF has been steadily increasing, fueled by a growing awareness of the aviation industry's environmental impact and a commitment to achieving net-zero emissions. The EU has played a pivotal role in driving this transition, implementing policies and incentives to encourage SAF production and consumption. The EU's Renewable Energy Directive (RED II) mandates a minimum blend of SAF in aviation fuels, and the Fit for 55 package proposes even more ambitious targets. Germany, as a major aviation hub, has also taken significant steps to promote SAF.

The German government has introduced various support measures, including subsidies and tax incentives, to stimulate domestic SAF production and consumption. These policies, combined with initiatives like ReFuelEU, which aims to establish a sustainable aviation fuel market by setting mandatory blending targets, have created a favorable environment for SAF development and adoption in both the EU and Germany.

Despite the significant progress made in promoting SAF, the EU and Germany face several challenges in scaling up its production and adoption. One major hurdle is the high cost of SAF compared to traditional jet fuel. While the cost gap is expected to narrow over time as production technology improves and economies of scale are realized, it remains a significant barrier to widespread adoption. Additionally, there are concerns about the sustainability of the feedstocks used to produce SAF, particularly in terms of land use and competition with food production. Ensuring that SAF production is truly sustainable and does not contribute to other environmental or social problems is essential.

Furthermore, the development of proper SAF supply chains, including adequate infrastructure, such as SAF storage and distribution facilities, is crucial for integrating SAF into the existing aviation fuel supply chain. Addressing these challenges will require concerted efforts from governments, industry stakeholders, and research institutions.

Airports play a vital role in the transition to SAF by investing in infrastructure and collaborating with airlines and fuel suppliers. In Germany, major airports have taken proactive steps to support SAF adoption. Some of these airports have invested in SAF storage and refueling facilities, enabling airlines to use SAF at their terminals. Additionally, German airports have been working closely with airlines to develop SAF procurement strategies and explore opportunities for joint investments in SAF production projects. By taking these initiatives, German airports are contributing to the creation of a more sustainable aviation ecosystem and demonstrating their commitment to reducing greenhouse gas emissions.

The Stuttgart airport has previously explored strategies to increase SAF usage, including offering incentives to airlines. However, these efforts have met with limited success. A joint feasibility study with the Ministry of Transport concluded that regional PtL production is not viable in the near future. Nevertheless, the airport could still play a different role in driving up the usage of SAF.

This study investigates potential strategies to enhance SAF adoption at Stuttgart airport and examines its role within the SAF supply chain. Findings suggest that while the airport may have a limited capacity to directly drive SAF usage, it can serve as a crucial mediator and facilitator. Its unique position allows it to convene stakeholders, foster open communication, and seek long-term solutions to the SAF challenge. Stakeholders have also highlighted the airport's potential to advocate for SAF and improved policies by representing the diverse perspectives of all involved parties.

1. Introduction

Introduction

Objective of the study

Stuttgart Airport is actively seeking strategies to increase its Sustainable Aviation Fuel (SAF) usage. Given the EU's upcoming blending requirements and Baden-Württemberg's ambitious climate neutrality goals, the airport aims to play a more proactive role in promoting SAF adoption. However, local SAF production and availability are currently limited.

The study will delve into various aspects of SAF integration, including identifying opportunities for regional and national SAF production, exploring ways to increase SAF utilization and sourcing, and determining the airport's optimal role in supporting SAF availability and use. It will also investigate measures to encourage voluntary SAF use beyond EU quotas and assess the airport's infrastructure, identifying any necessary improvements to facilitate SAF handling and distribution.

Despite challenges such as limited local SAF production and lack of availability, the study aims to provide valuable insights into how Stuttgart Airport can contribute to fostering collaboration with stakeholders, supporting the transition to a more sustainable aviation sector, and ultimately achieving its climate neutrality goals.

Scope of the analysis

As part of the future fuels feasibility study for Stuttgart Airport, this report presents an overview of the various aspects considered in the assessment of sustainable aviation fuels (SAF) for Stuttgart Airport.

The report contains an overview of the various stages undertaken to understand the feasibility of increased SAF uptake at Stuttgart Airport. Specifically, the work incorporated the following:

- An analysis and overview of the various production pathways that can be used to produce SAF
- An assessment of potential future demand for SAF at Stuttgart Airport, based on historical fuel throughput data & market forecasts for the region & country
- An overview of the approach to stakeholder engagement performed throughout this study including the key categories of stakeholders identified.
- Mapping of the fuel supply chain specific to Stuttgart Airport
- Analysis of the key trends in stakeholder's positions and views on SAF, both in general and at Stuttgart Airport
- Various recommendations and considerations for the airport based on the results of the stakeholder engagements.

2. Sustainable Aviation Fuels: Production & Distribution

SAF Production Pathways

Context

There are several different conversion pathways/processes to produce Sustainable Aviation Fuels (SAF), as of 2023 ASTM international approved 11 conversion processes, and an additional 11 conversion processes are currently under evaluation (ICAO, 2023). Each pathway is primarily dependent on the feedstock; current technology allows for SAF to be produced not only by biological feedstock (e.g. vegetable oils) but by non-biological/synthetic sources as well. The final product is then blended with conventional kerosene at different blending ratios which need to be tested and certified complying with ASTM international standards. Table 1 shows some of the most used conversion pathways and the maximum blend ratio currently approved.

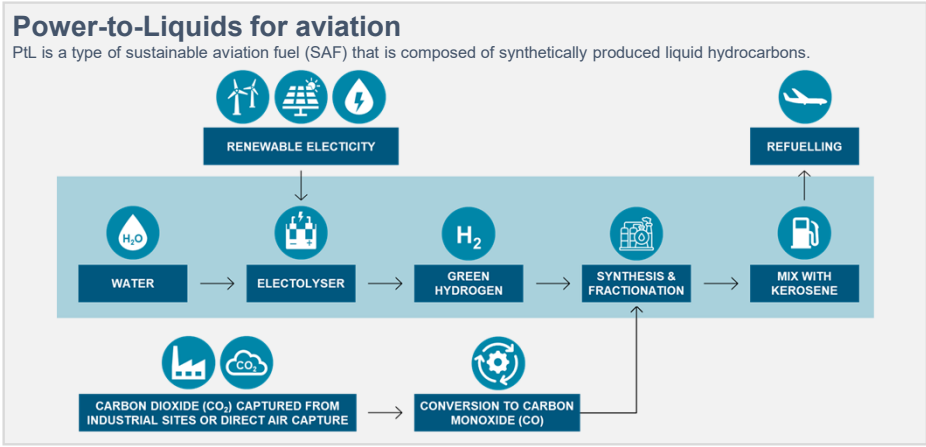
SAF has similar chemical and physical characteristics to those of conventional Jet A1 fuel which allows for the blending to occur. Due to these similarities, SAF as a 'drop-in' fuel can be used in all existing infrastructure and aircrafts without any additional modifications. The maximum allowed blend limit is 50% primarily due to the aromatics needed for seal compatibility in the aircraft, currently research is being done to assess the possibility of 100% SAF in aircraft. However, the impact on both aircraft and airport fuel infrastructure is still to be assessed.

Technology	Maximum Blend in Final Product (%v/v)	Feedstocks
Fischer-Tropsch (FT-SPK & FT-SKA)	50	Waste(e.g Municipal solid waste), sawdust, energy crops and lignocellulosic biomass.
Hydroprocessed Esters and Fatty Acids (HEFA-SPK)	50	Lipid feedstocks like vegetable oils: used cooking oil, palm oil, camelia oil, jatropha oil, tallow, and animal fat.
HEFA from Algae (HH-SIP or HC-HEFA)	10	Oils produced from algae.
Direct Sugars to Hydrocarbons (HFS-SIP)	10	Modified yeast, lignocellulosic sugars, and conventional sugars.
Alcohol to Jet (AT]-SPK)	50	Sugar, starch crops and lignocellulosic biomass
Catalytic Hydrothermolysis Jet fuel (CHJ)	50	Vegetable and animal fat (Triglycerides: soybean oil, jatropha oil.

Power-to-Liquid(PtL)

Power-to-Liquid (PtL) uses renewable electricity, water, and carbon dioxide to produce green hydrogen, and with Fischer-Tropsch (FT) synthesis, the product can be mixed with kerosine. The image below showcases the power-to-liquid supply chain. Despite the high interest and advantage of PtL, it remains costly compared to the other processes for the amount that is produced, still, PtL is expected to be used at a larger scale between 2025 and 2030 (Airbus, 2021). According to Bauhaus Luftfhart, PtL is expected to cost more than 1.50 €/L. However, the production of PtL in Germany is expected to be much higher than at other international locations (Bauhaus Luftfahrt, 2024).

Despite the high costs, in January 2024 the German Federal Ministry of Finance adjusted the 2024 federal budget which will provide additional funding to sustainable fuels (Hussain, 2024). The increase in the budget is set to primarily benefit the power-to-liquid(PtL) fuels technology. Germany is targeting to become a leading producer of PtL in Europe, having set a PtL roadmap in 2021 to use at least 0.5% of e-kerosene in German airports by 2026 (Hussain, 2024). Nevertheless, the roadmap and the targets have been put on hold due to legal compatibility issues with RefuelEU.



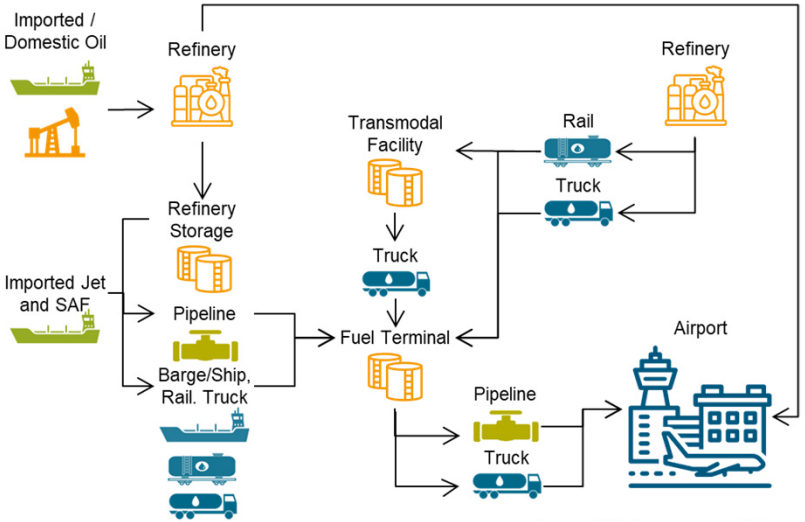
Source: Airbus, 2021

Distribution of SAF

Transport & Supply

The transport and supply of SAF largely depend on the fuel supplier, the existing supply chain, and the entity purchasing the SAF(e.g airline). To ensure compliance and safety standards are met, SAF must be blended with conventional Jet A before is used in an aircraft. Blending on the airport site is not recommended as it is not cost-effective and there are risks in ensuring quality standards of the fuel. Therefore, it is preferred to blend SAF upstream of the airport.

SAF co-processed with conventional Jet A at a refinery can flow through the conventional supply chain in a business-as-usual model via pipeline or by truck to the airport. SAF is usually produced at a biofuel facility, which is then blended with conventional Jet A fuel terminal and then delivered to the airport by pipeline or truck. There is no impact or changes to fuel operations at airports with already blended SAF.



Source: U.S. Department of Energy, 2023

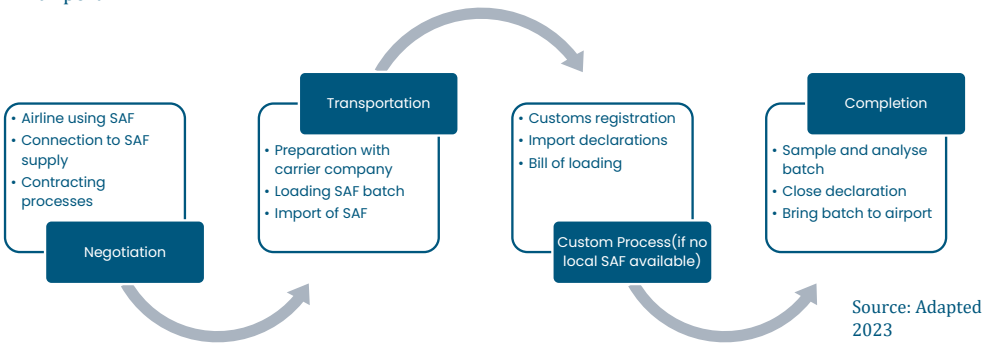
Chain of Custody

Three different supply methodologies can be used depending on the customer buying the SAF and the location of not only the SAF but of the fuel/SAF producer and the airport. In some cases, a certain methodology can provide a higher emission reduction depending on the overall life-cycle and location aspects.

1. Segregation: SAF is physically segregated from traditional jet fuel all the way to the wing. An independent batch of SAF is delivered to the aircraft directly.
2. Mass Balance: SAF is mixed with the rest of the fuel in airport storage or pre-airport pipelines. It is the most used and has a lower carbon footprint than a segregated supply chain.
3. Book & Claim: SAF is delivered to the most efficient supply chain(closest to SAF production/location), the SAF batch is not delivered to the customer location. The customer pays for the batch and can claim the benefits(emissions reductions) via a traceable booking system. SAF will not be physically present at the aircraft.

SAF Purchase & Logistics

The purchase and logistics of SAF are highly dependent on the location of the airport, the relationship with the different stakeholders(fuel providers, SAF producers, and airlines), the availability of SAF, and the willingness to purchase and uplift SAF at the location.
The figure below showcases a general overview of the logistics; however, it may vary per case and per airport.



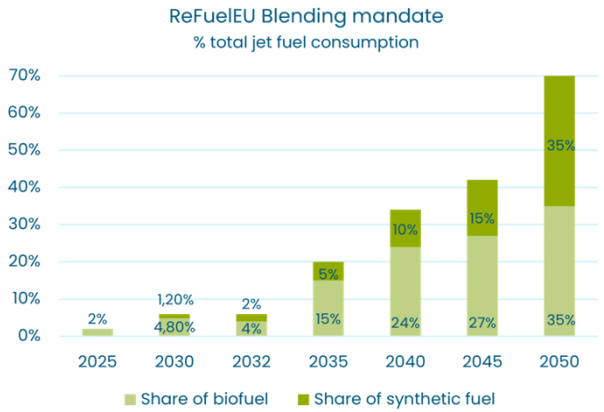
Source: Adapted from ICAO, 2023

Policy & Regulation: ReFuelEU

In July 2021, the European Commission presented a measure to tackle CO2 emissions from aviation as part of the "Fit for 55 package to meet the emission reduction target of 55% by 2030". Within the presented package, the ReFuelEU initiative was proposed to ensure a level playing field for sustainable air transport. The regulation sets obligations for all fuel suppliers to gradually increase the share of biofuel SAF and Synthetic SAF(or e-fuels) in the fuel supplier to aircraft operators at Union Airports. Fuel operators must start providing 2% of blended SAF in 2025 and increase up to 70% SAF by 2050. In 2030 there is a sub-mandate for synthetic SAF, starting with 1.2% in 2030 and reaching 35%(from the 70%) by 2050. The figure below shows the shares of SAF blend to be uplifted starting in 2025 up till 2050.

Under ReFuelEU, SAF must be compliant with sustainability criteria set in the Renewable Energy Directive(RED) and meet the definitions of SAF per the same directive:

- **Synthetic aviation fuels**: from renewable hydrogen and captured carbon (Article 2(36) of RED and limited to liquid drop-in fuels only).
- **Advanced biofuels**: from waste and residues notably(produced from feedstock listed n Part A of Annex IX in Article 2(34) of RED).
- **Biofuels**: produced form oils and fats(from feedstock listen in Part B of Annex IX in Article 2(33) of RED)/
- **Recycled carbon of aviation fuels**: Article 2(33) or RED



The proper implementation of ReFuelEU requires all parties in the supply chain to collaborate, fuel suppliers, EU airports and airlines must work together, and all have certain obligations to fulfil under the mandate. Approximately 95% of air transport departing from EU airports will fall under ReFuelEU. This new regulation is set to contribute to the EU's climate targets, estimations suggest a 60% reduction of CO_2 emissions by 2050 compared to 1990 levels. The uptake of SAF will additionally reduce other air pollutants such as CO, NOx, and PM improving the air quality. Furthermore, with ReFuelEU in place SAF innovations and investments are expected to rise, while also incentivising the development of global SAF value chains. This will likely lead to the creation of new jobs across the EU. As the introduction of ReFuelEU might bring several benefits in the long term, there is still uncertainty on how it will play out. Parties in the supply chain are still awaiting the final details of the regulation to be laid out in 2024. The announced July 1st update was not yet published at the time of preparing this report. The graph shows the current specifications for each of the key parties in the supply chain and the implications it will bring.

Fuel Suppliers	Aircraft Operators	Union Airports
All aviation fuel suppliers supplying to Union Airports	Operating flights from Union airports (regardless of destination): ≥ 500 passenger flights per year ≥ 52 cargo flights per year	Located within the European Union but not in remote regions > 800,000 passengers per year > 100,000 tonnes freight
From 2025: Must progressively blend increasing amounts of SAF with kerosene	From 2025: Uplift at least 90% of "required" fuel from a Union airport	From 2025: Facilitation of access to SAF
Reporting Obligations		
Info. As required by article 10: Annually by 14 Feb, starting in 2025.	Info. As required by article 8: Annually by 31 March, starting in 2025	Info. As required by articles 6 & 7: Annually, no concrete time, starting in 2025
Non-Compliance		
1. Failing to meet shares of SAF 2. Misleading or inaccurate information to aircraft operators or the Union Database	Non-tanked quantities to meet the 90% threshold	Lack of adequate access to aviation fuel blended with SAF
Fines		
At least twice the difference between the price of conventional aviation fuel and SAF/synthetic fuels. In the event of a shortfall, the shortfall must be compensated for in the following year.	At least twice of aviation fuel price for non-tanked fuel in Union airport	Not concrete. It is only stated "liable to a fine"

ReFuelEU: Impact for airports

Requirements

Union Airports will have to comply with certain obligations under ReFuelEU, with the main obligation of "facilitating the access to SAF". Article 6 of the regulation states:

"*Union airport managing bodies shall take all necessary measures to facilitate the access of aircraft operators to aviation fuels containing minimum shares of SAF in accordance with this Regulation.*"

If difficulties in accessing SAF shares at a given Union Airport, aircraft operators may report this to the competent authority or authorities. The competent authority or authorities shall request the Union Airport managing body to show proof of compliance by providing the necessary information. If the Union Airport managing body fails to take the necessary measures, will be liable to a fine.

In addition to this "facilitation" obligation, Union Airport managing bodies must cooperate with the respective Member State on developing national policies for the deployment of alternative fuel infrastructure in airports. More specifically union airports must undertake efforts for aircraft operators to have access to hydrogen or electricity for the propulsion of the aircraft.; providing the infrastructure and necessary services for the delivery, storage, and uplifting of such fuels.

Union airport managing bodies must report to the competent authorities on the advancement of alternative fuel initiatives starting by March 31st, 2025. The report should show information on the projections on the volumes and type of hydrogen and electricity production and supply to aircraft operators at the airport. Deployment plans for recharging and refuelling infrastructure and services must be shown in the report.

The Regulation lays out certain aspects that Union airports must follow, nevertheless, it does not provide detailed information on what those aspects entail. The concept of "facilitation" to the access of SAF is not defined in the context of an airport. Airports generally do not deal with fuel infrastructure and are not actively part of the fuel supply chain. Therefore, what such facilitation entails is not clear under ReFuelEU.

Flexibility Mechanics

The EU Commission intends to implement a flexibility mechanism between the period of January 2025 and December 2034, in which it allows aviation fuel suppliers to supply the mandated minimum shares of SAF as a weighted average over all the aviation fuel it supplies across union airports.

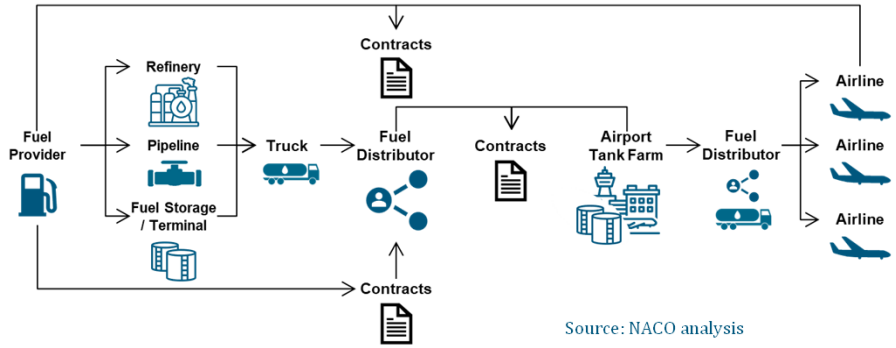
It is challenging for fuel suppliers to be able to deliver the expected SAF to all Union airports under ReFuelEU. Therefore, the flexibility mechanism might allow for the shares to be met as a weighted average. The details on how the flexibility mechanism will play out are expected to be published before the 31st of July 2024.

Fuel Supply Chain at Stuttgart Airport

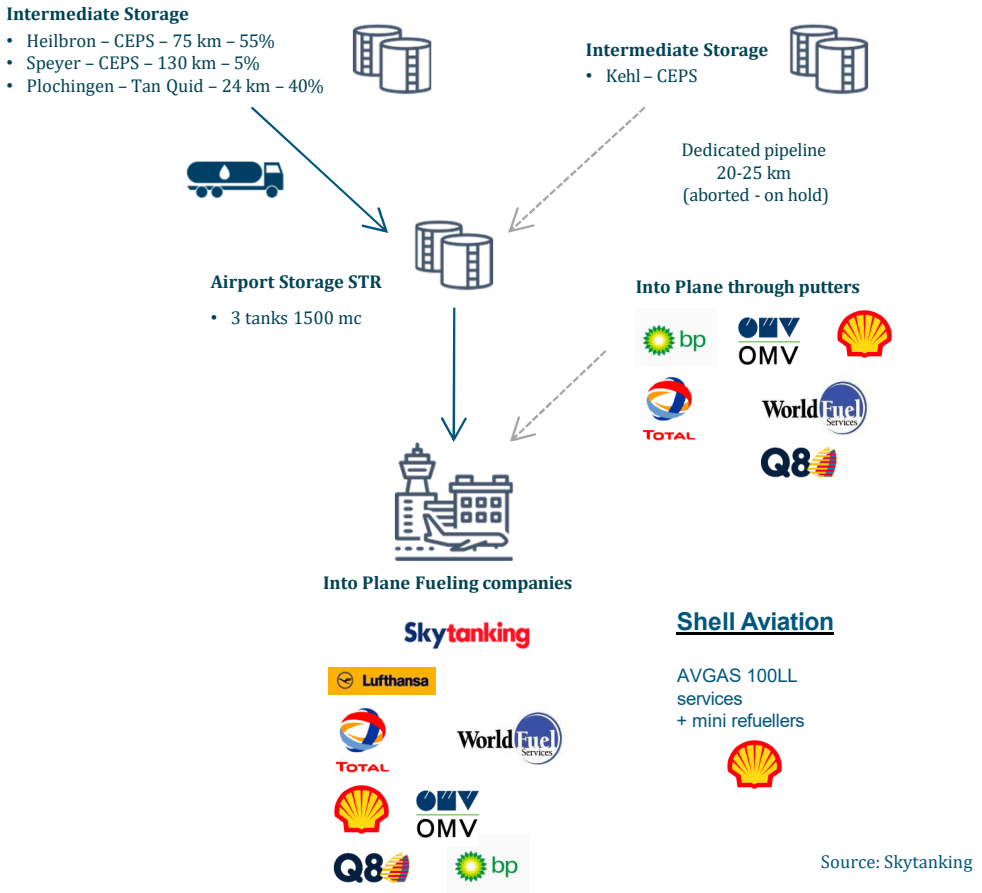
It is important to note that the figure showcasing the fuel supply chain at Stuttgart contains certain assumptions on how the fuel is gathered and delivered to the airport. Certain information on the supply chain and the number of fuel suppliers having uptake agreements with the airlines operating at Stuttgart is unknown. Therefore, the figure should only be used and considered in a general non-representative manner on the fuel supply chain.

Stuttgart Airport does not have direct connection to a pipeline which passes through the airport and the fuel supplier, or the fuel distributor can access. Currently an independent fuel distributor (Skytanking) oversees handling the logistics of the fuel and the fuel farm at the airport. They have a contract with the airport to manage the fuel tank farm and ensure airlines obtain the fuel delivered by the fuel suppliers.

The airlines operating from Stuttgart airport have independent uptake contracts/agreements with different fuel providers, each fuel provider must guarantee that the agreed amount will be delivered at the airport. How the fuel is delivered or collected by the fuel providers differs between the fuel companies; the fuel could be provided from a fuel storage farm or terminal close to the location, collected from a pipeline (CEPS) or could be directly brought from the refinery. As there is no pipeline directly connected the airport, fuel suppliers bring the fuel by truck to the airport. The fuel brought into the airport is taken over by the fuel distributor who ensures the fuel is handled properly and stored in the airport fuel farm. The airport distributor then delivers the required fuel by truck to the aircraft.



Source: NACO analysis

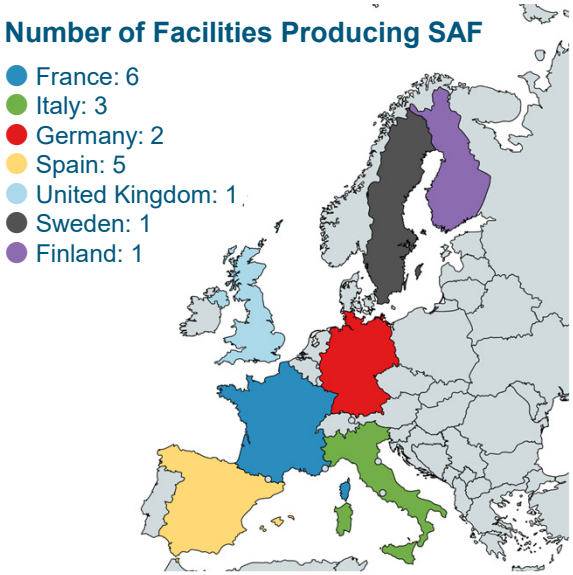


Source: Skytanking

SAF Production Facilities in Europe

The status of SAF production at the EU level is considered to still be in the early stages of development, in 2020 the supply of SAF was less than 0.05% of total jet fuel demand(EASA, 2024). In 2025 jet fuel suppliers must start supplying a 2% SAF blend, this means supplying approximately 1Mt of SAF which is currently double the global market in 2023(SkyNRG, 2024). Europe faces many challenges in scaling up SAF production capacities to meet the ReFuelEU mandate, the current production capacity within the EU is estimated at 0.24 Mt which only represents 10% of the amount needed to meet 2030 SAF mandate targets(European Commission,2024).

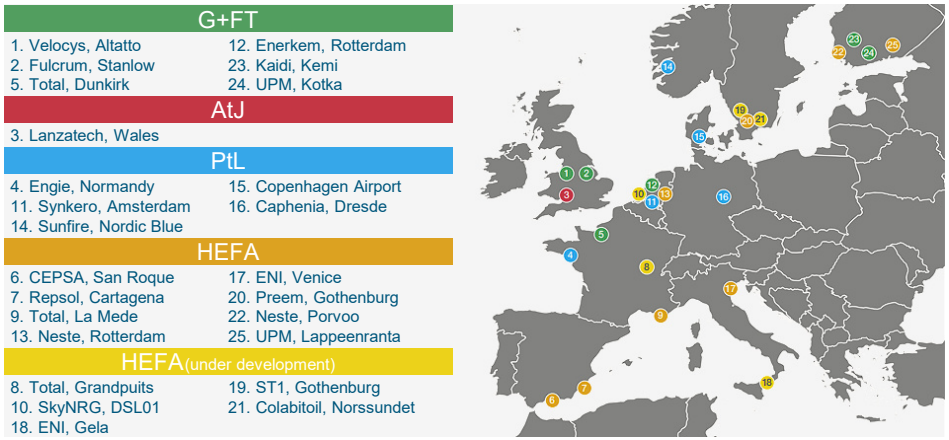
ICAO has set up a tracker of production facilities globally, it provides information on existing and announced facilities that could produce SAF. The Figure below shows the number of facilities that are in service producing SAF as reported on the tracker by ICAO. Nevertheless, the information provided by the tracker is based on publically available announcements, and the situation of announcements made in the past is not actively verified by ICAO (ICAO,2024).



Source: Adapted from ICAO , 2024

According to ICAO's tracker, 7 facilities in Europe currently produce other renewable fuels and have the potential to produce SAF. There are 73 initial announcements of renewable fuel facilities being built, however the capacity destined for SAF is not clear.

It has been estimated that if all existing biofuel facilities in Europe were streamlined to produce SAF, potentially 2.3 million tonnes could be reached(European Commission, 2024). This is enough to meet the 5% SAF target by 2030. To fulfill the PtL target share, a significant portion or EU's renewable electricity will have to be directed to the production of PtL. It is estimated that by 2050, more than 5.5% of the EU's renewable electricity is required for PtL production (European Commission,2024).

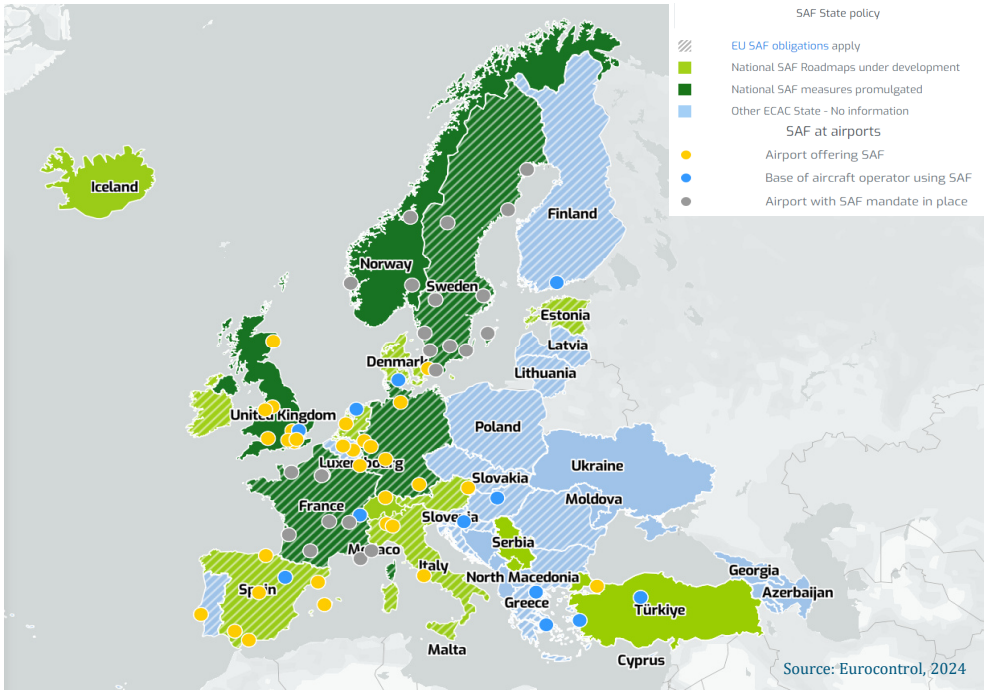


Source: World Economic Forum, 2021

The ambitious targets and goals of the EU require a significant scale-up in the production of SAF, primarily to meet the increasing demand for SAF to meet ReFuelEU obligations. Many fuel producers across Europe have announced different projects(shown in the figure above) to start producing SAF in the next 5 years(2020-2025), however strong policy and financial support are required to idealize all these projects on time. In 2021, a report by the World Economic Forum determined that SAF production could feasibly ramp up to meet 10% of the total EU jet fuel consumption by 2030. Nevertheless, according to SkyNRG's recent SAF market outlook, there is a delay in the sector which suggests that the actual SAF capacity estimated by 2030 will likely be lower than announced(SkyNRG, 2024).

To meet the targets laid out by the EU, 7 additional SAF production facilities are needed by 2030, and by 2050 to meet the increasing demand 104 additional facilities will be required(European Commission,2024). It is expected that most SAF will likely be imported to the EU unless policies outside Europe are placed influencing the demand side. Most SAF is likely to be imported from China, Southeast Asia, the USA, and LATAM. However, certain scenarios might impact imports, such as policies from the EY on imported feedstock, the increased demand from SAF outside the EU, and the ramp of renewable fuels in other sectors(e.g. maritime and road transport sector) (SkyNRG, 2024).

Usage of SAF in European States and Airports



The uptake and availability of SAF at airports widely differ per country and the context they are in. Before ReFuelEU multiple EU states had already developed or were in the process of developing SAF roadmaps, additionally some already had SAF national measures in place which favoured those airports in obtaining SAF to certain extents. The figure above shows which countries have SAF-related policies and/or roadmaps, where ReFuelEU obligations will apply, and which airports are involved with SAF(offering, having a mandate, or base aircraft operator is using SAF).

Looking at which airports have dealt with SAF to a certain extent and observing the Figure on page 12 of this report, the SAF facilities are primarily concentrated in Western Europe and in the same countries in which some airports have offered SAF. There is a clear relationship between where the SAF facilities are, and which airports deal with SAF at different extents.

Multiple factors influence whether an airport can offer SAF to airlines, or if they can be involved with the topic of SAF. Some of the factors involve the following:

- Ownership of the airport: The influence an airport can have over certain targets and ambitions largely depends on who owns the airport and the shareholders involved. Certain shareholders have a green agenda and are willing to invest or provide funding for sustainable project initiatives. In many cases, if the shareholders do not see a business case on such projects no actions will be taken by them.
- Ownership and management of the fuel supply chain: In most cases, airports do not own or operate the fuel infrastructure. The operation of the fuel infrastructure is commonly outsourced to another company or a consortium of companies. The ownership and how the supply chain works, in most cases is not determined by the airport and they are not involved in the supply chain of the fuel. Therefore, in general, airports have limited say in the fuel supply chain and management.
- Local context: Some airports may have an advantage depending on the context they find themselves in, there are cases in which the surroundings help foster certain actions that help ramp up SAF. There are cases in which a SAF production facility is built in the proximity of the airport and the airport may choose to invest in such a project. Airports may assess which factors in their surrounding environment they can take advantage of to get involved with the topic of SAF.
- Partnerships: Airports engage and deal with many stakeholders, additionally they may partner with different actors to enhance certain aspects of the airport. Depending on how they engage with their stakeholders and on which partnerships they decide to enter and foster. Certain partnerships(e.g. SAF fuel suppliers, airlines with SAF ambitions, and research institutions) may help the airport obtain SAF or develop projects involving SAF.

According to Eurocontrol, there are 5 airports in Germany offering SAF to airlines:

- **Hamburg Airport** – The airport offers SAF partnering with different stakeholders(Airbus, Neste, Air bp). Green Fuels Hamburg project (increasing PtL production for Germany. Investment in sustainable aviation projects.
- **Mönchengladbach Airport** – Partnered with TotalEnergies for regular SAF deliveries, they offer a continuous supply of SAF at the airport.
- **Cologne Bonn Airport** – SAF is offered to all airlines, primarily targeted at freight and corporate customers. Partnered with Neste, offering MY Sustainable Aviation Fuel.
- **Frankfurt Airport** – SAF is commercially available at the airport.
- **Munich** – SAF is commercially available at the airport.

3. Future demand mapping

Existing Route Analysis

In 2023, Stuttgart was connected to 126 destinations, through a mix of direct and non-stop flights

Stuttgart Airport (STR) serves as the gateway to the city of Stuttgart and recorded over 71,000 flights in 2023. Most of the destinations served from Stuttgart Airport are in Europe, with these flights representing 97% of all commercial passenger movements - arrivals and departures.

In 2019, it was estimated that the throughput of jet fuel at STR was 320,000 cubic metres (m^3), a total that is yet to be surpassed following the COVID-19 pandemic. While recovery in the western European market has been strong, Stuttgart is yet to reach pre-pandemic levels of traffic, and subsequently fuel throughput.

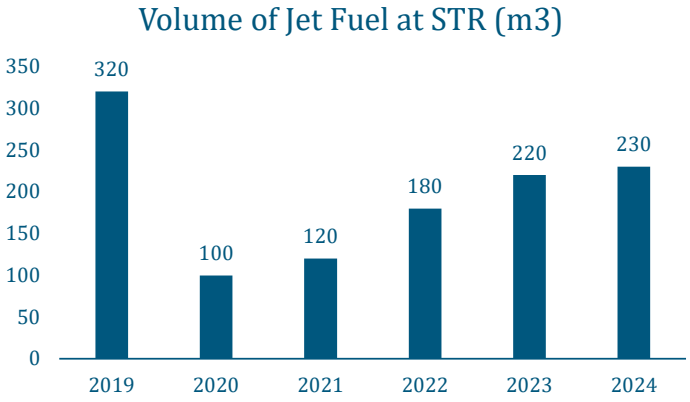


Figure – Estimated annual throughput of jet fuel at STR
Source: *Data collected during stakeholder interviews*

Figure – Route map of destinations served from STR in 2023
Source: *Diio Mii & Data provided by client*

Future growth outlook

Various market forecasts estimate aircraft movements will grow upto 7.3% annually in the coming two decades

Various market forecasts, including those developed by Airports Council International (ACI), and Airbus as part of their global market forecast estimate that the coming decades will bring significant growth in the Western European air transport market.

While exact growth rates are subject to much variation and are challenging to predict without an airport specific air traffic forecast, the upper limit of 7.3% established by ACI allows for several scenarios to be developed. Considering annual growth rates in fuel throughput between 1 and 7.3%, the resulting fuel throughput in the coming decades can be calculated. Clearly significant

Year	1% Annual Growth	7.3% Annual Growth Rate
2019 (actual)	320,000 m^3	
2023 (actual)	230,000 m^3	
2030	244,000 m^3	351,000 m^3
2040	269,700 m^3	710.1 m^3
2050	297,900 m^3	1,436,000 m^3

Figure – Estimated annual throughput of jet fuel at STR in low and high growth scenarios
Source: *Data collected during stakeholder interviews, ACI Air Traffic Forecasts*

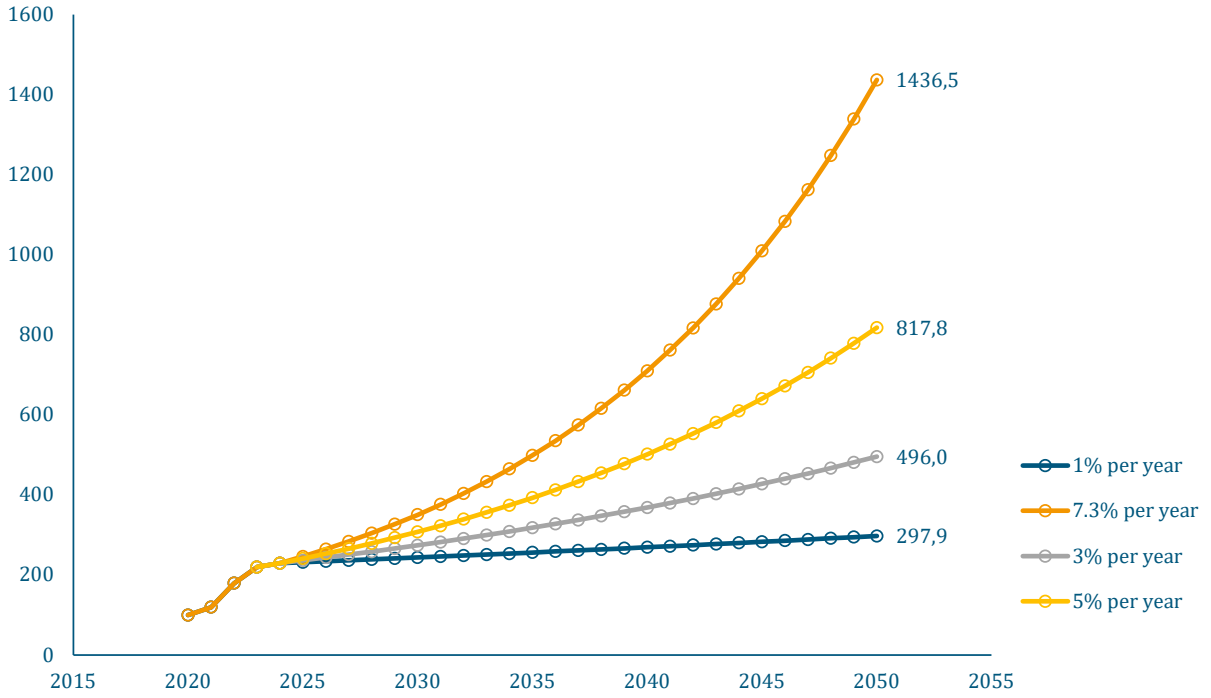


Figure – Estimated annual throughput of jet fuel at STR in low and high growth scenarios (2023-2050) in 1000's of m^3
Source: *Data collected during stakeholder interviews, ACI Air Traffic Forecasts*

Potential Future SAF Demand

Based on estimated fuel throughput, the SAF demand at STR can be estimated based on mandatory blend percentages stipulated in ReFuel-EU

Adding the ReFuel-EU blend percentages to the forecast total jet fuel throughput gives an estimate of the order of magnitude of SAF required at Stuttgart Airport. Clearly the main driver of this is traffic.

By 2050, even the slowest growth scenario (1% per year) results in needing 208,500 m^3 of SAF on an annual basis. Considering current throughput is 230,000 m^3, the airport must be prepared to facilitate an equal amount of SAF within the next 25 years.

In addition, sub-percentages of the SAF must be synthetic. Taking the most conservative growth scenario once again, this requires 104,300 m^3 of synthetic SAF by 2050.

Estimated volumes by growth scenarios can be found in the table on the following page

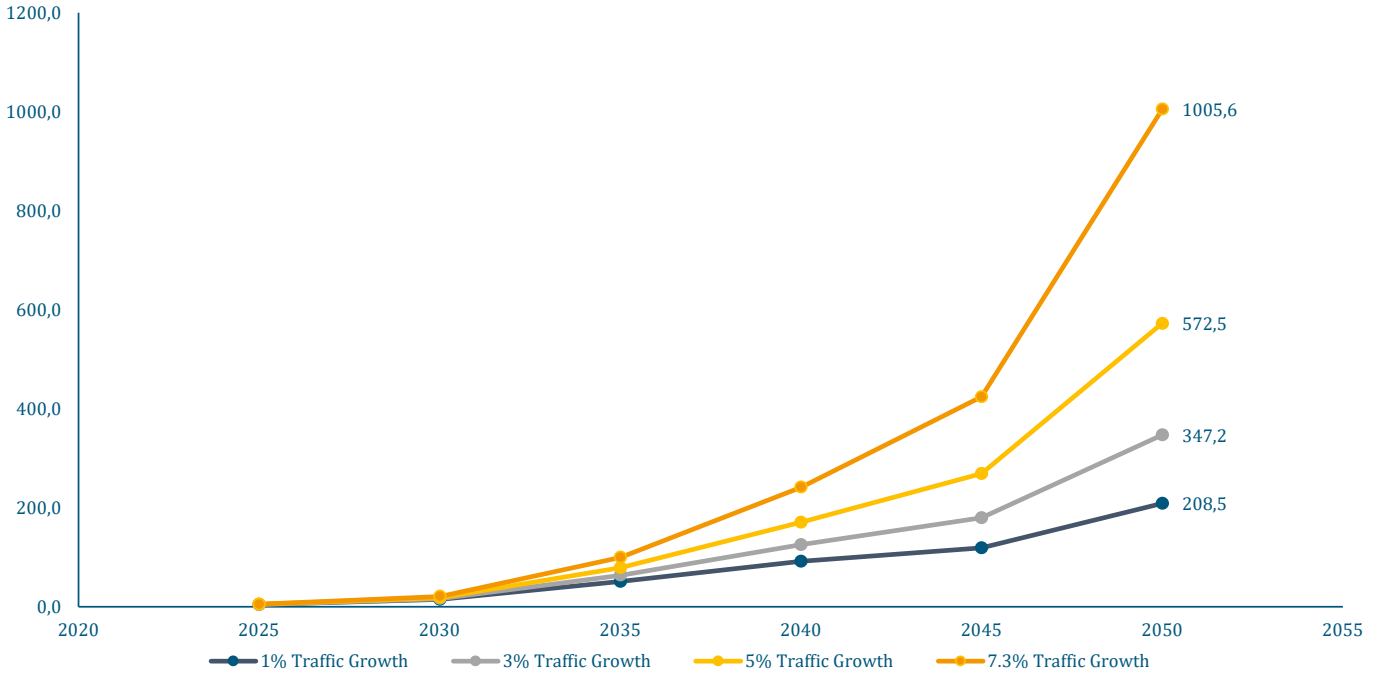


Figure – Estimated annual requirement of SAF at STR based on traffic growth between 1 and 7% annually (2023-2050) in 1000's of m^3
Source: *Data collected during stakeholder interviews, ACI Air Traffic Forecasts*

Potential Future SAF Demand

Summary table of estimated SAF demand including synthetic SAF at Stuttgart Airport in 1000's of m^3

Year	1% Traffic Growth			3% Traffic Growth			5% Traffic Growth			7.3% Traffic Growth		
	SAF	Synthetic SAF	Total	SAF	Synthetic SAF	Total	SAF	Synthetic SAF	Total	SAF	Synthetic SAF	Total
2025	4.6	0.0	**4.6**	4.7	0.0	**4.7**	4.8	0.0	**4.8**	4.9	0.0	**4.9**
2030	11.7	2.9	**14.6**	13.2	3.3	**16.5**	14.8	3.7	**18.5**	16.8	4.2	**21.1**
2035	38.5	12.8	**51.3**	47.8	15.9	**63.7**	59.0	19.7	**78.7**	74.9	25.0	**99.9**
2040	64.7	27.0	**91.7**	88.6	36.9	**125.5**	120.5	50.2	**170.7**	170.4	71.0	**241.4**
2045	76.5	42.5	**119.0**	115.5	64.2	**179.7**	173.0	96.1	**269.1**	272.7	151.5	**424.2**
2050	104.3	104.3	**208.5**	173.6	173.6	**347.2**	286.2	286.2	**572.5**	502.8	502.8	**1005.6**

4. Stakeholder Engagement Analysis

Stakeholder Engagement Approach

Three key categories of stakeholders were identified and interviewed, representing the airline-, fuel supply side- and airport perspectives

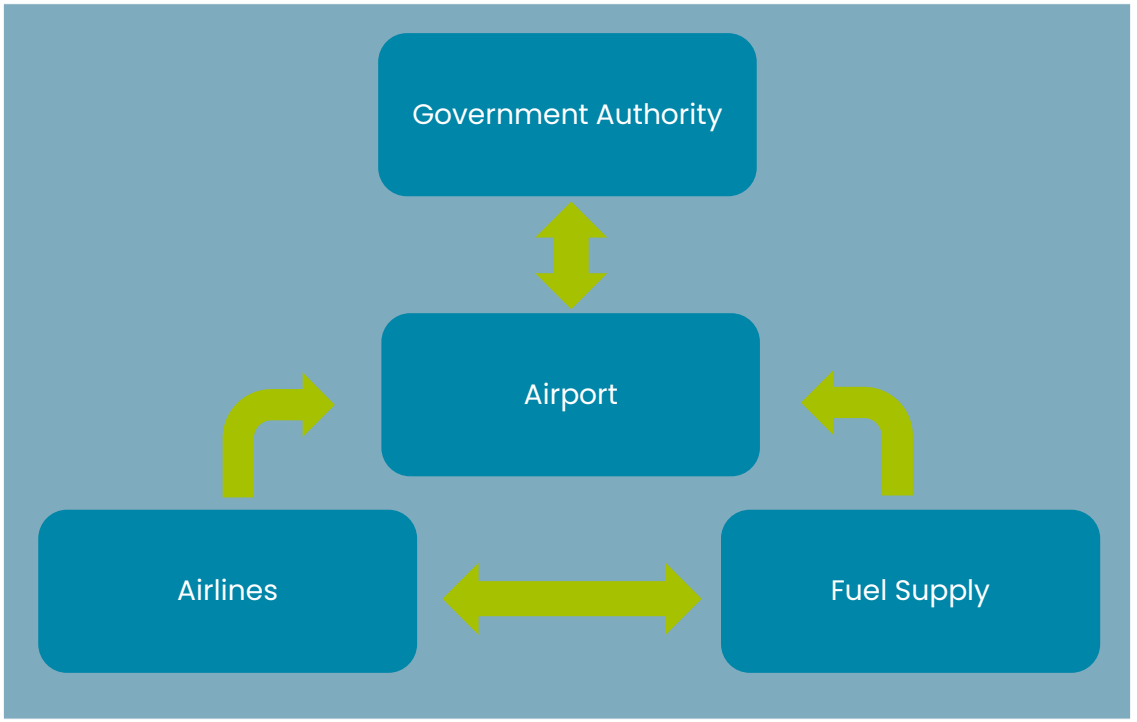
With the aim of understanding the drivers, opportunities and challenges associated with developing the use of SAF at STR, 3 key categories of stakeholders were identified.

As shown in the supply chain overview earlier, there are numerous actors involved in ensuring the current supply of fuel reaches STR. The grouping into categories is done to simplify future analysis of the various stakeholder views on SAF.

To maximize the effectiveness of the stakeholder interactions, interviews were conducted with two key segments. The first segment focused on more general questions, targeted at understanding the stakeholder organisation's general relationship with SAF. These general, introductory questions, were formulated to assess the boundary conditions stakeholders associate with the use of SAF.

Building on from these introductory questions, interview questions became more specific to the stakeholder's interactions at STR. By understanding the stakeholder's general view of SAF, as well as their view specifically related to STR, a more complete picture of the challenges and opportunities can be formed.

The interview questions formulated for each category of stakeholder can be found in the annex of this report.



Stakeholder Analysis – Airline perspective (1/2)

5 airlines were interviewed, with significant variation in current approach to SAF

Targets and Ambitions

Based on the interviews conducted with key airlines operating at Stuttgart, it was found that there is significant variation in the set targets and long-term ambitions pertaining to SAF. Most notably, one of the interviewed airlines is seen globally as a market leader in SAF uptake, using it for over a decade to date, while others are currently establishing internal teams and strategies to incorporate the use of SAF into their operations. This disparity is significant internally within the organisations but is also visible in the set targets and market offering to the client.

The more advanced airlines with respect to SAF use classify uptake into a mandatory and voluntary segment, with a focus on stimulating and realising demand for both. Airlines with less experience using SAF are currently focused on establishing the necessary procurement, commercial and operational resources required to meet the targets set by RefuelEU legislation. A mid-way scenario involves airlines setting additional targets, such as the Science Based Target Initiatives, whereby mid-term goals are set for 2030.

A significant point that was observed through the stakeholder engagement was that all airlines are in the process of setting up internal processes to deal with SAF, both upstream towards the production and downstream towards the customer. The internal structure is typically in the form of a Task Force or absorbed within the larger ESG strategy. On the customer facing end, all airlines are currently in the process of allowing customers, private and corporate, to purchase SAF as an add-on to their base ticket. The product offering is diverse and often tiered in price to maximize customer engagement, although airlines indicated further product offerings will aim to incentivize SAF purchases through added benefits in the airport process such as security lanes or lounges for clients.

Perceived role of Airports

The interviewed airline stakeholders generally indicated that they perceived a limited role for the airport in the physical supply chain of SAF, due to the nature of contractual agreements between airlines and their fuel supplier(s). However, the role of facilitating third parties and advocating for further industry collaboration was perceived by airlines as a promising avenue for airport involvement in the SAF deployment. Therefore, for airlines it was seen that some key activities the airport could undertake include:

- Advocacy with policy makers for the flexibility mechanism
- Facilitation of SAF supply by third parties
- Facilitators of collaboration between airlines, airports and fuel suppliers
- Introduction of passenger incentives to stimulate SAF purchases supplementing tickets

Another point raised by airlines regarding airports was the influence of the airline business model on the chosen locations for SAF uplift. The airlines with strong hub & spoke models, indicated a strong preference to maintain uplift operations solely at large hubs, using the proposed flexibility mechanism to meet RefuelEU targets. In line with this, most airlines indicated that they do not currently uplift SAF at STR, and that the incentive is not currently commercially attractive enough to change the hub-focus approach to SAF. Furthermore, airlines noted that individual airport incentives may disproportionately impact full-service carriers over low-cost carriers who may be able to move faster to destinations with more attractive incentives, thereby reducing the level playing field.

Stakeholder Analysis – Airline perspective (2/2)

5 airlines were interviewed, with significant variation in current approach to SAF

Challenges

A significant number of potential challenges were identified by the airline stakeholders, centered around several key themes including:

- Availability of SAF / Supply Chain
- Commercial attractiveness of SAF
- EU flexibility mechanism
- Airline operations and SAF strategy

Firstly, significant concerns were raised about the availability of SAF across airports, primarily due to the lack of large-scale projects following on from small scale pilots, as well as the challenge of sufficient feedstock & technical capital. Furthermore, the costs associated with the initial capital investment for SAF production were seen as a potential threat to stable supply.

As a result of supply scarcity, SAF is currently priced at a premium, often being significantly more expensive than existing jet-fuel. The result of this is that the business case to support SAF offtake agreements by airlines have become even tougher. The result thereof is that airlines are critical of where they sign offtake agreements and uplift SAF. At STR, the perceived challenges of fuel-supply by truck contribute to the commercial challenges associated with offtake agreement. A further challenge is that airlines are expecting to be able to make use of the flexibility mechanism to hedge SAF offtake at a select number of high-frequency hub airports, to benefit from economies of scale in their costs.

The flexibility mechanism designed by the EU has not yet been revealed and is a source of potential challenge for airlines, as most intend to use it to avoid having to uplift SAF at all the EU airports they operate at. This ties in further with the airline operations, which would be significantly impacted if the flexibility mechanism does not meet expectations.

The driving conclusion of the airline engagement with respect to the challenges were that the business case must support the availability of SAF, and that there is a limit to the price elasticity of demand for SAF.

Opportunities

Having highlighted challenges, airline stakeholders also indicated several potential opportunities for airports. These include:

- Airports being able to get involved as stakeholder unifiers
- Airports taking a role to incentivize travellers to purchase SAF
- Airports playing the role to level the playing field for airlines

Furthermore, it was highlighted that the development of a fully green airport concept, is required to lower scope 3 emissions of the airport, with SAF as a block to decarbonization. This requires collaboration with existing and new SAF producers alongside jet fuel producers, opening the potential for new, novel partnerships.

Finally, significant opportunities were identified by airlines for airports to educate and communicate to passengers, differentiate the supply chain and develop centralized incentives.

Stakeholder Analysis – Fuel Supplier & distributor perspective

A fuel distributor and a fuel supplier were interviewed to understand the supply side landscape for SAF at STR

As part of the stakeholder engagement study, a fuel supplier and a fuel distributor that operate the fuel infrastructure at STR were interviewed. The fuel supplier at present produces and supplies both jet-fuel and SAF, through their refineries in Europe. The fuel distributor is the operator of the fuel infrastructure and has limited involvement in the SAF supply chain beyond accounting for the throughput.

Targets/Ambitions

The fuel supplier indicated that at present they do not have any fixed targets for SAF delivery at STR, primarily due to the uncertainty in the potential market size. However, they have indicated that they expect to be able to meet the demand established as a result of the ReFuelEU targets at STR. Furthermore, they are able to currently deliver SAF locally at STR to airlines that voluntarily uptake it, achieving a previously set ambition.

Complementarily to this, the fuel distributor indicated no specific targets due to their limited role in the supply chain. However, they stressed the need for proper accounting and governance in tracking quantities as well as certification of SAF. The distributor indicated that limited infrastructural impact is expected and as such there is no perceived need on their end to set targets. This is seen as the role of the airlines and fuel suppliers.

Role of Airport

Both stakeholders saw limited role for the airport in the SAF supply chain due to the limited infrastructural impact. When considering the possibility of blending 'neat SAF' with jet fuel on the airport site, both stakeholders made it clear that while could be feasible for small pilot projects, they would not rely on such facilities to meet eventual demand. Reasons cited for this include the technical complexity, the regulatory environment and the costs associated with on-site blending. However, it was noted that the fuel supplier was more open to concepts trialling on-site blending than the fuel distributor, possibly due to the supplier being further removed from the day-to-day infrastructural operations at STR.

Challenges

A number of challenges are currently foreseen, with the main one being identified as the road transport dependency in the current fuel supply chain. Furthermore, the lack of proven demand at STR was considered a challenge.

Operationally the distributor indicated that the accounting process for SAF would need to be set-up carefully to ensure regulatory compliance. This was seen as a challenge due to the novelty of such regulation.

Furthermore, the dominance of established fuel suppliers and the influence on smaller, new-to-market players was seen as a threat to a diverse supply side. Finally, the threat of regulation was highlighted as it was perceived to limit the space the airport has for future innovation.

Opportunities

However, three key opportunities were also identified by the supply chain stakeholders:

1. The business case around the market size for SAF at STR could prove to have a significant upside that could benefit all players involved.
2. The push for SAF could result in upgraded infrastructure in the fuel supply chain in and around STR
3. The book and claim system could open up innovative business models and make STR an attractive uplift destination subject to pricing conditions.

Stakeholder Analysis – Airport perspective

Stuttgart airport provided its current targets and ambitions on sustainability and SAF. The airport current role is limited, however there are several opportunities for them.

Stuttgart Airport's Sustainability Communications lead was interviewed as part of the stakeholder analysis. The insights were crucial to understanding the status of the airport when it comes to SAF, how it is viewed, and what challenges they are facing.

Targets/Ambitions

The airport has ambitious targets for achieving net zero by 2040, they have a holistic view towards sustainability in which all departments within the airport focus on different aspects of sustainability. The airport has put its focus on primarily reducing scopes 1 and 2, additionally, they have set certain scope 3 targets. The airport is aiming to invest in lower-emission technologies, electrifying its GSE fleet, carbon pricing for project decisions, and improving its buildings.

Currently, there are no specific milestones set for having SAF at the airport. The airport has a SAF incentive setup, but it has not been used by any airline. They are however looking into hydrogen as a fuel for aircraft, partnering with a start-up to conduct certain projects and tests for it.

Role of Airport

The airport only provides the infrastructure for the operations to take place, they are not involved in the supply chain and handling of the fuel for aircraft. They are in contract with a fuel distributor(Skytanking), in which they have a lease type of agreement for them to operate the infrastructure and ensure the fuel is delivered to the aircraft.

Their current role besides providing the infrastructure, remains around the communication aspects to the passengers. The airports' Destination STRzero strategy involves raising awareness for climate-conscious travel among passengers(currently an airport magazine informs passengers on SAF usage), implementing airport charge incentives for SAF, and helping realize the vision of emission-free flying. As mentioned, the airport is also aiming to take a role in investing in alternative/renewable technologies.

The airport also foresees a role in collaborating with stakeholders and with the Managing body(concerning ReFuelEU) to assess how SAF monitoring can be set up or in which aspects the airport may aid in the monitoring/controlling SAF at the airport aspect.

Challenges

The airport is facing challenges in finding its role within the uptake of SAF and the upcoming mandate ReFuelEU. Local political and civilian groups have been strongly focusing on emission reductions, pushing the airport to deliver and demonstrate their climate strategy. This has impacted the airport positively and it has been well-received as it has pushed the airport to set tangible targets and include sustainability aspects in their operations.

Despite the positive outcomes of such an agenda, the airport still struggling with certain challenges such as identifying and quantifying scope 3 targets. Additionally, the airport lacks funding to be able to meet its 2040 net-zero targets. Local legislation does not allow the airport to use offsetting or neutralizing CO2 actions to meet their targets, making it more challenging for them. Furthermore, a pipeline for the fuel tried to be installed but it was not possible as there were environmental impacts and local communities were heavily opposed to this.

The airport is also trying to address the challenge of why the SAF incentive has not been used, as there is currently no local production of SAF. According to the previous feasibility study, despite airlines' requests to uplift SAF at STR, fuel suppliers have not been able to meet such requests.

Furthermore, the airport has mentioned that critical stakeholders are not encouraging the usage of SAF or new technologies. The stakeholders are rather pushing for bans and regulations such as private jet bans and banning short-distance flights. The airport must also be careful about how sustainability is being communicated to avoid any backlash and greenwashing claims by the public and stakeholders.

Opportunities

The airport has strong partnerships and connections with the stakeholders, which provides opportunities to create future engagement workshops and round table discussions on common topics such as SAF and alternative fuels. The airport can collaborate with them and start involving the federal ministry to which they must answer once ReFuelEU is set in motion.

There are other opportunities the airport has looked at to reduce emissions such as developing infrastructure for hydrogen.

Stakeholder Analysis – Ministry of Transport perspective

The Ministry of Transport considers synthetic fuels and SAF are urgently needed to decarbonize the aviation industry.

The Ministry of Transport of Baden-Württemberg has ambitious targets for the aviation industry and has developed a roadmap for SAF and synthetic fuels. The responsible for synthetic fuels at the ministry has been interviewed as part of the stakeholder analysis, their input is crucial as they are not only funding the study but are aiming to further support the airport in its decarbonization pathway.

Targets/Ambitions

The Ministry has ambitious targets of reaching net zero by 2040 in the region and is looking and all the different transport sectors. They are looking into what is needed to be able to reach set targets and the various solutions to get there.

The Ministry has previously supported a feasibility study on the production and use of synthetic aviation fuel from renewable energy in the area. They have been looking at different options to be able to produce SAF in the area, as they consider SAF necessary to decarbonize the aviation sector.

The roadmap created by the Ministry has a stronger focus on SAF from PtL and expects it to play a bigger role in fulfilling the ReFuelEU mandate. Hydrogen and the development of hydrogen infrastructure are seen as crucial and more relevant than SAF in the region.

Role of Airport

The Ministry has viewed the airport as ambitious in its sustainability goals and targets, however, they still consider more actions can be taken by them. The Ministry considers the airport could purchase SAF itself as other airports in Germany and Europe have done, nevertheless, the Ministry is aware that at STR this is currently not feasible as the supply chain is quite complex.

The airport should continue collaborating with the Ministry and other airports to find solutions and develop projects for the uplift of SAF and alternative fuels. The role they are currently playing is mainly collaborative and moderating, which could be further enhanced.

Challenges

The demand for SAF is set to grow as the ReFuelEU mandate kicks in, Germany and all of Europe's biggest challenge is the necessity to rapidly upscale SAF production and ensure the availability of feedstock. The Ministry, as mentioned has conducted a feasibility study to produce SAF from PtL and AtJ which concluded that AtJ pathway is not feasible in the region and for PtL several other conditions must be tested. Additionally, due to regulations, the capturing of CO2 from cement production to generate SAF is not permitted, which has brought additional challenges to establishing economic SAF production in Baden-Württemberg.

Other regulations that pose a challenge to fulfilling the ReFuelEU mandate, involve certain import blocks in PtL fuel, methanol, and other feedstocks. European feedstock and SAF production will not be enough to meet the growing demand for SAF. Furthermore, the regional Ministry has little impact and influence on national and European-level policy, this brings further challenges as multiple regional policies might clash with European-wide ones. There is a certain level of concern if targets and goals to meet 2040 net zero in the area will be met together with EU-level mandates such as ReFuelEU.

The Ministry has mentioned its interest in funding additional infrastructure and tanks for SAF which could bring some opportunities, however, this would pose additional supply chain challenges as isolating portions of SAF is complex and not economically feasible in the long term.

Opportunities

The Ministry has supported the airport for them to meet their climate targets and is willing to continue supporting them by funding more studies and projects that contribute to their goals. Further collaborations with other regions and German airports for the support on the uplift of SAF.

The STR airport can observe what other airports have done to uplift SAF and assess which actions and items could be applied or developed at STR. This can open the door to new collaborations and projects with other airports and partners. The Ministry considers the airport can further improve its moderating role by developing other concepts such as marketing campaigns or involving corporate/business customers to purchase SAF.

5. Airport Roadmap for Sustainable Aviation Fuels

Roadmap Structure

Development of a roadmap for SAF Development at Stuttgart requires five key activities to be carried out

Roadmap Development Process for SAF at STR

The preceding stages of this report have presented the various building blocks required for the development of a SAF roadmap for Stuttgart Airport (STR). Synthesizing these building blocks into an actionable roadmap for STR requires 5 key activities. These are explained shortly on these slide and reported in the following chapter.

1. Spheres of Influence

The first activity that must be performed is mapping the spheres of influence of the airport. The key input for this process is the stakeholder interviews and resulting analysis. All the stakeholders required to realize SAF uplift at STR can be classified into three spheres: core, strategic and external. With each of these spheres the influence the direct influence of the airport diminishes. Mapping these stakeholders forms the foundations in understanding the capability of the airport to influence SAF uplift.

2. Goals & Objectives

Following this, a number of high-level goals and objectives can be formulated. Based on a pre-defined time horizon, the influence of legislation such as ReFuel EU will dictate the aims of the airport to facilitate SAF uptake. However, in addition to the mandated SAF uptake, goals can be set related to stakeholder interaction, capacity development, capability variation and financial performance.

3. Strategy Formulation

Realizing the goals set in the previous stage of the roadmap process requires a clear strategy. This must be formulated based on stakeholder insights, capability mapping within the airport and evaluation of current activities. The strategy will identify key priorities the airport can set to attain the set goals and objectives.

4. Implementation Plan

The implementation plan refines the strategy into time-bound, actionable tasks. Each of these tasks can be linked to key stakeholders, desired outcomes and necessary preparation. Based on these tasks, the implementation plan forms the path to attainment of goals and objectives.

5. Monitoring & Evaluating

While engaging in the activities outlined in the implementation plan, it is important to develop a framework for monitoring progress and evaluating the implementation process. This will allow for real-time course corrections based in-situ developments.

Based on the five steps outlined above, and reported hereafter, a comprehensive and actionable roadmap for the development of SAF at STR will take form.

Airport Sphere of Influence

Stuttgart Airport can influence certain spheres differently, and the outcome of the stakeholder analysis indicates they currently have limited influence on their Core Sphere. Nevertheless, the airport has the potential to influence their strategic and external sphere.

Core Sphere

The assessment has shown the airport has a limited direct influence when it comes to obtaining physical SAF as they are not part of the SAF supply chain and have no purchasing power. In their direct influence, the airport has already collaborated on feasibility studies, and due to their limited participation in the supply chain as a consequence of their context, they should assess alternative options within their direct influence that will not involve physical SAF in the near future.

Nevertheless, within their direct influence, they can focus on influencing passengers positively and looking at solutions internally in terms of marketing campaigns, educational campaigns, and SAF for their business flights(book and claim), among other solutions that will be laid out in the roadmap.

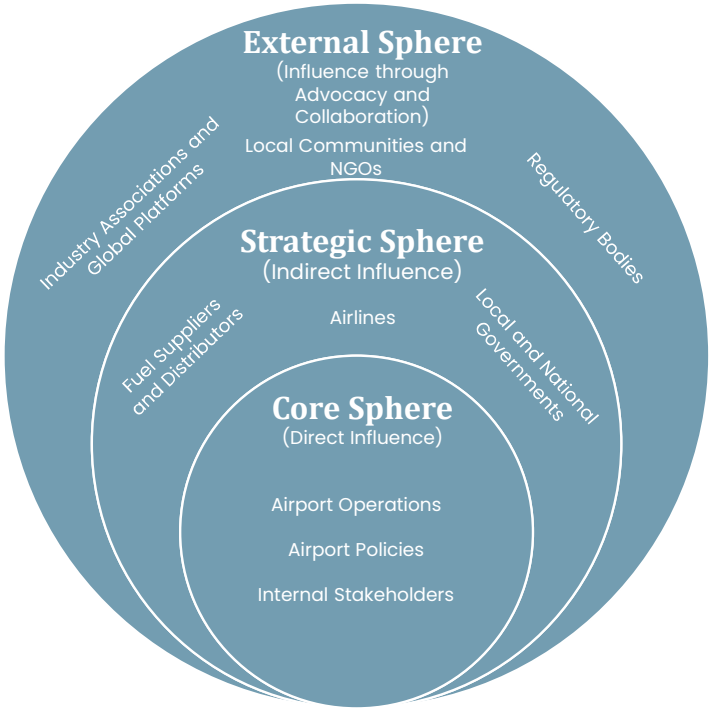
Strategic Sphere

The airport has the potential to further improve its indirect influence, primarily by collaborating and setting up engagement channels with the fuel supply chain stakeholders. Currently, they do not actively collaborate with the supply chain but have active collaboration with the local government. Therefore, the airport could start setting up engagement workshops and round-table discussions in which fuel supply chain stakeholders and the government are brought together enabling brainstorming and finding gaps and solutions for the uptake of SAF.

External Sphere

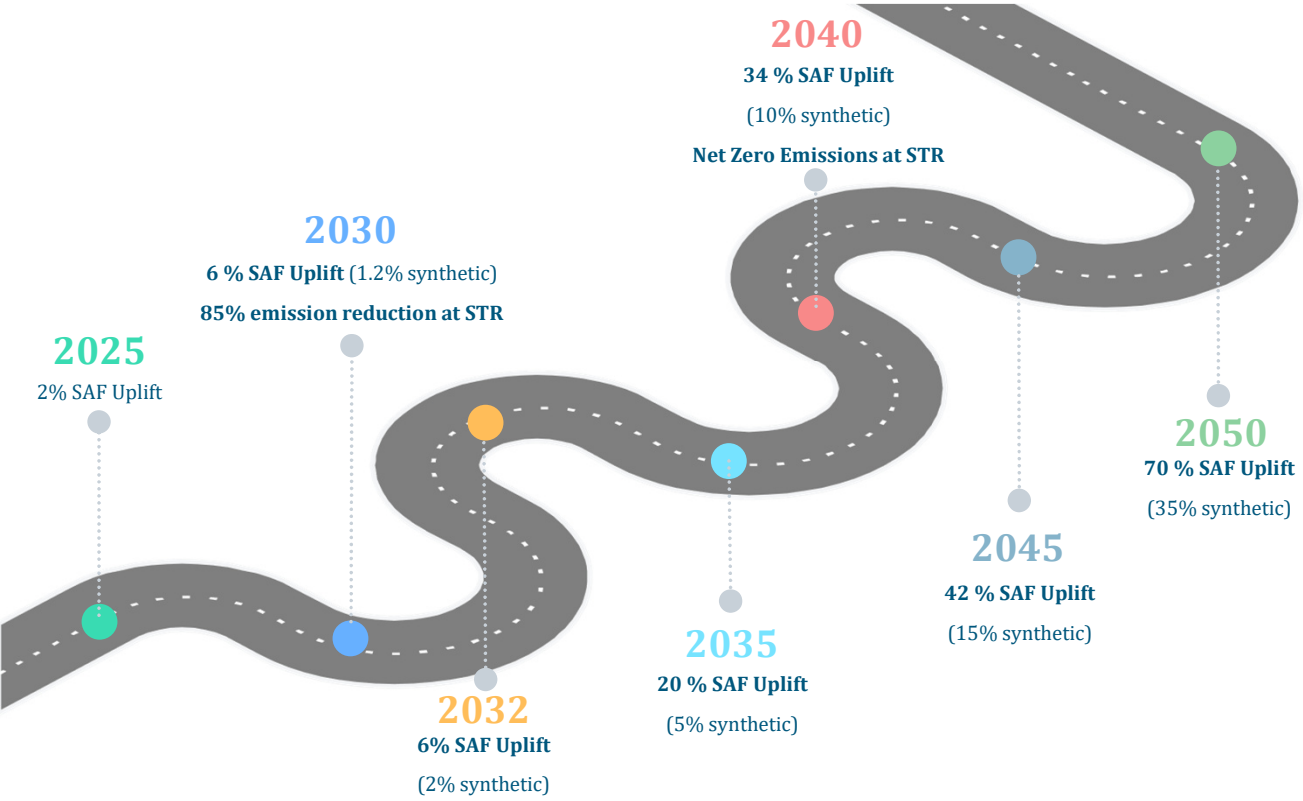
At present, the airport has had limited influence on its external sphere when it comes to SAF, they are active in collaborating with other companies and organizations on other aspects such as hydrogen for aircraft propulsion. Our research has shown that industry stakeholders consider advocacy and engagement with policy an underdeveloped opportunity and role for airports to take up. Many have expressed the need for airports to become more active in the advocacy aspect and engage in policy within the industry, as their positioning can be considered neutral in the fuel supply chain. Their advocacy may benefit the improvement of policies toward the uplift of SAF and alternative fuels, by also considering passengers and the communities.

Stuttgart Airport is in a position in which it could influence both the strategic and external spheres. The influence they can have an all spheres should be looked at in a holistic manner in which all spheres can positively impact each other. By collaborating and improving their influence on the external and strategic spheres, the airport might be able to further improve or enhance its direct influence in the future



Goals and Objectives

STR's climate strategy, Destination STRzero, is complemented by SAF offtake mandates, supporting the airport's journey to net-zero by 2040.



Stuttgart Airport currently has several pillars on which its climate strategy (Destination STRzero) is based. One of these is accelerating zero-emission flights, focused on:

- Advancing technological progress
- Realize the vision of emission-free flying
- Airport charges that incentivise sustainable aviation fuel and electric aircraft
- Raise passenger awareness for climate-conscious travel

In addition, hard targets currently exist to reduce greenhouse gas emissions 85% by 2030, relative to 1990 levels. In addition, the airport holds the aim to achieve net zero emissions by 2040.

The targets for SAF uplift set by ReFuel EU form a complementary set of objectives, driving the zero-emission pillar of Destination STRzero.

Besides the overall SAF uplift mandates, the sub-mandate relating to synthetic SAF is also significant, with these percentages are shown in brackets on the roadmap.

Key years for goals include **2030** and **2040.** Firstly, 2030 is the first year in which a synthetic fuel sub-mandate is effective, requiring 1.2% of all fuel to be synthetic SAF. In addition, 2030 is the year in which overall emissions at STR must be 85% less than in 1990, with a fully zero emissions GSE Fleet as outlined in Destination STRzero.

2040 is the year by which the airport has set the target to be net-zero. In this year, in addition 34% SAF uplift is mandated (with 10% being synthetic SAF) contributing to reduction of scope 3 (airline) emissions.

Strategy Formulation

The future SAF development strategy at STR should aim to position the airport as a key stakeholder engagement & representation hub – a joint SAF Task Force could unlock stakeholder potential

The present actions of STR in the development of SAF uptake are largely focused on involvement of the airport in the operational and financial activities in the supply chain. The incentive offered by STR has been repeatedly highlighted through stakeholder interviews as having limited impact on airline decisions to uplift SAF. Furthermore, the role of the airport in development of SAF supply chain and infrastructure was indicated to be limited.

A common theme of the stakeholder interviews are the repeated calls for the airport to become a platform for cross-stakeholder engagement and representation. Several stakeholders highlighted the need for the airport to be the voice of the industry to government institutions, making use of the airport's strategic position as a hub for connectivity.

Realizing the significant targets that exist for SAF usage and uplift therefore requires a pivot in the airport's strategic approach to SAF development. A renewed emphasis should be placed on the role of the airport as a hub for stakeholder engagement & representation.

Facilitating this pivot requires development of capabilities, engagement with influential stakeholders and evaluation of the current activities related to SAF by the airport.

Based on the required pivot in strategy, 4 key pillars have been identified. These four pillars form the basis of the new SAF uptake development strategy and are related to actionable items, as shown in the figure on the right. The four pillars are related to the physical supply chain for SAF, development of the business case, leveraging the airport position with authorities and finally the facilitation of cross-stakeholder engagement. However, in line with the findings of all the stakeholder engagement study, not all actions are of equal priority.

As indicated in the earlier discussion, the key focus of the pivot in strategy is for STR to focus its SAF efforts on the external sphere of influence. Existing subject matter expertise in the core and strategic spheres mean that the role of the airport is most suited as a collective hub for all these stakeholders in their engagement with the external sphere.

Therefore, a key cornerstone of the strategy for the coming time-horizon should be the consolidation of stakeholder viewpoints through a common forum. A potential form for this is a task-force or coordination committee.

The development of a SAF task force at STR could serve to inform all stakeholders equally and in time to align on key objectives to meet the set targets. A particular focus area would be the development of technical, logistical and policy capacity for synthetic SAF's in view of the sub-mandate from 2030.

Not Applicable (at this moment)	
Done/Covered	
Possible Development	

SAF Uptake Development Strategy Pillars & Instruments		
Physical Supply Chain	Provide SAF blending capacity	
	Assess feedstock availability	Feasibility study 2022
Business Case Development	SAF incentive (fund)	
	Sign or secure SAF supply contracts	
	Invest in SAF production	Feasibility study 2022
	Third-party SAF funding	
	SAF for business travel	
Regulatory Spearheading	SAF uptake regulations	
	Influence/lobby/advocate policy making	
Collaboration, facilitation & leadership	Passenger campaigns and education	
	Engage (more) with supply chain actors	
	Internal policies	
	Initiate and/or publish research	
	Build partnerships	

Implementation Plan (1)

The airport has several instruments at its disposal that are expected to positively influence the uptake and availability of SAF in the long run

The following plan provides instruments based on the research conducted, each instrument should be assessed internally to ensure the feasibility of it. They serve as a guide for the airport to follow and mainly encourage the airport to become an active advocate throughout all spheres of influence. The uptake of SAF must be viewed as something from which the entire industry will benefit, not as a competition among individual airlines, fuel suppliers, and airports.

Category	Instrument	Stakeholders Involved	Sphere of Influence	Timeframe	(Expected) Outcome
Physical Supply Chain	Assess / monitor feedstock availability: Follow up on previous studies conducted or asses if new possibilities have arisen in the area.	Airport (enabler/facilitator), Airlines and SAF/fuel producers	External and Strategic	Revisit every 5 years, starting in 2025.	As the demand for SAF increases, technology improves and policy changes other possibilities on producing SAF might be available in the area. Airport can aid in keeping up to date on such developments locally.
Business Case Development	SAF incentive (fund): Assess the success of the current incentive, if it is seen as a disruption to the market consider modifying the type of incentive or pivot to other funding types.	Airport (enabler/facilitator), Airlines and SAF/fuel producers	Strategic and Core	2025-2027	Implement an incentive or fund that is guaranteed to be beneficial to all parties. The incentive/fund is being used properly.
	Invest in SAF production: In 2022, a feasibility study was done to assess whether it would be possible to produce SAF in the Baden-Württemberg region. The conclusion was negative. However, STR can periodically *revisit* with internal stakeholders and supply chain the feasibility of investing in SAF production facilities (nationally or internationally) or research for production initiatives. It must be noted though that given the flexibility mechanism in the near future SAF production will be concentrated around major hubs in the EU. The proposition of local or regional production therefore must be very competitive for airlines to be attractive and source SAF at non-base airports.	Airport (enabler/facilitator) and SAF/fuel producers	External and Strategic	Start investigation opportunities in 2025/2026	The airport can financially support the R&D of SAF, investments as such speed up the upscale of SAF production.
	Third-party SAF funding: Investigate third-party funding opportunities and assess effectivity	Airport (enabler/facilitator), Airlines, Passengers and Service Providers	External and Strategic	Start investigation opportunities in 2025	Third-party funding is obtained, and funding is used for SAF related initiatives
	SAF for business travel: Set-up SAF for own business travel via legitimate book & claim systems	Airport (enabler/facilitator), Airlines and SAF/fuel producers	Strategic and Core	Start in 2025 and follow ReFuelEU ramp-up	The airport uses a legitimate book and claim system that allows to purchase SAF for their business travel and encourages stakeholders to follow the same steps.

Implementation Plan (2)

Category	Instrument	Stakeholders Involved	Sphere of Influence	Timeframe	(Expected) Outcome
Regulatory Spearheading	Influence/lobby/ advocate policymaking: The airport sets up a SAF advocate group that actively engages with policy and the government. The airport participates and attends related events/meetings.	Airport (enabler/facilitator), and Government	External	2025-2050	The airport can communicate the needs and challenges of the fuel supply chain to policymakers and vice-versa. The airport actively advocates for SAF and can create a bridge between the government and the fuel supply chain.
Collaboration, facilitation & leadership	Passenger campaigns and education: Initiate and set up SAF campaigns and investigate related initiatives/programs targeted at passengers.	Airport (enabler/facilitator), Airlines, Passengers, and Government	External, Strategic, and Core	2025-2027	The airport creates a successful marketing campaign in which passengers are educated and are more aware of the topic of SAF. Assess every 2 years of passenger's awareness on SAF. Assess the possibility/feasibility of a green lounge or incentives to encourage passengers to purchase SAF.
	Engage with supply chain actors: Create a SAF focus engagement group. Have round-table discussions and workshops to understand and connect all actors. ReFuelEU is considered and the respective authorities are involved or contacted.	Airport (enabler/facilitator), Airlines, SAF/fuel producers, and Government	External and Strategic	2025	The engagement group brings insightful information and stakeholders can communicate and understand each other. Opportunities and challenges are assessed and tackled, looking at potential collaborations and initiatives for the uplift of SAF.
	Internal policies: The Airport assesses and updates internal policies. Outlining clear targets and actions when it comes to SAF.	Airport	Core	Revisit every 5 years, starting in 2025 till 2050	The airport can modify and update internal policies as the ReFuelEU mandate advances. The policy is kept up to date with technological advancements and initiatives/projects as proposed accordingly.
	Initiate and/or publish research: The airport continues to engage in research for the development of SAF locally and internally.	Airport (enabler/facilitator), Airlines, SAF/fuel producers, Passengers, Government, and Service Providers	External and Strategic	Has already been initiated: revisit and keep-up with past and current initiatives.	The airport follows up on studies and research done, the outcomes are further investigated and considered for their internal policies.
	Create partnerships: Investigate companies, institutions, and organizations involved in the uptake of SAF. Include them in engagement groups and assess opportunities for projects.	Airport (enabler/facilitator), Airlines, SAF/fuel producers, Passengers, Government, and Service Providers	External and Strategic	Revisit every 5 years, starting in 2025 till 2050	The airport identifies key organizations, companies, and /or institutions to enter partnerships with. Collaboration is set up and projects are initiated.

Appendices

Annex 1 – Stakeholder Summaries

Stakeholder	SAF Targets/Ambitions	Role of Airports	Challenges	Opportunities	Notes
Airline #1	• SAF has been a cornerstone of sustainability strategy for 10+ years • 4 SAF contracts at present and clear ambition to use SAF to become more sustainable • SAF uptake as two parts: mandatory and voluntary – airline is focused on stimulating and realising both	• Strong hub and spoke model focus • Airports to facilitate sufficient supply from third parties • Limited interest in considering blending/production on airport site • Not currently using SAF incentive at STR	• Business case must support the availability of SAF • Availability of SAF across all airports remains a challenge	• Significant opportunities for airports to get involved as stakeholder uniters • Airport role to incentivize travellers to purchase SAF • Airport can play the role to level the playing field	• Flexibility mechanism will dictate approach to purchase and uptake of SAF • Support for book and claim • High costs prohibitive for PtL (synthetic) SAF • Availability of SAF in large quantities still forming a challenge
Airline #2	• SAF usage based on SBTI targets to form a roadmap between present and 2030 • Estimation of required SAF volume to meet SBTI targets (2030) already underway	• No foreseen role airport in fuel supply • Individual airport mandates unlikely to benefit uptake, not level playing field • Airport can be facilitator for improved availability of SAF	• Individual airport mandates likely to impact conventional airlines disproportionately compared to LCC's due to the latter's perceived agility in adjusting destinations • Cost effectiveness remains a challenge • The variation in suppliers across airports in an airline's network can challenge offtake agreement feasibility • SBTI targets require a full airline perspective, thereby challenging the business case to uplift SAF at certain airports • Buying decisions are not based on individual incentives today	• Use of a mass balance approach based on flexibility mechanism • Fully green airport concept required to lower scope 3 emissions of the airport – SAF as a block to decarbonization • Collaboration with existing and new SAF producers alongside jet fuel producers	• Commercial case drives procurement choices – volume and economies of scale to justify SAF investment by airline • ReFuel EU also spurring on electrification of ground handling and waste segregation

Annex 1 – Stakeholder Summaries

Stakeholder	SAF Targets/Ambitions	Role of Airports	Challenges	Opportunities	Notes
Airline #3	• Sustainability not part of strategy • SAF task force: Formed by all departments dealing with the fuel and SAF supply chain. Includes corporate customers engaging with them. • Customers can soon purchase additional SAF • SAF targets and ambitions are focused on hub airports	• Support on flexibility mechanism • Airport incentives create competition and prevent scale-up. • Airports, airlines and fuel suppliers must work together • Certain incentives or nudging for passengers in short-term(green lounge) • Airports advocating for SAF and getting involved with government/policy.	• How ReFuelEU is interpreted by fuel suppliers and airlines. • How to support the ramp up • Small pilot initiatives do not ramp up SAF in the long-term • Regional/National sub-mandate interacts with ReFuelEU • Awaiting on flexibility mechanism details • SAF price, high costs for ramp-up. • Proper communication to passengers • Scarcity of SAF • Having SAF available at all airports	• Centralised investments for SAF ramp up • Clear regulatory frameworks • Customer/passenger education and communication	• Holistic and centralized approach needed • Support of Book & claim mechanism • Airlines uplift SAF where it is cheapest and where it is available. • Airlines will do what is the most cost effective for them • Stakeholders looking at ReFuelEU individually. It is an industry-wide joint effort
Airline #4	• ESG strategy: alternative fuels are part of strategy to reduce CO2 emissions. • Passengers can purchase SAF during bookings(12 months selling SAF already) • Different shares of SAF can be purchased(3 different products): SAF contributions from customers	• Airports generally do not have to change anything. • Airport can play role on the political side • Airports and airlines need to engage with each other more frequently. • Educating/informing passengers • Creation of supply networks • Alignment of initiatives	• Scaling up SAF and high costs • Production of SAF to meet demand • Location of where SAF can be refuel is limited • Educating and raising awareness with customers/passengers • Voluntary and mandated SAF reporting and uptake. • Availability of tech to produce SAF(PtL) • Complexity of supply chain and logistics • Convincing shareholders on environmental benefits	• Reducing SAF costs: incentives • Educating customers • Location/context advantages • Looking into tangible benefits for passengers • Strategies to differentiate the supply chain(voluntary and mandated)	• Part of airline group, uses airline group hub to uplift SAF • Business/corporates more willing to pay additional price for SAF • SAF offered to charter flights • Fuel managed by airline group: centrally managed and mass balancing approach at hub. • SAF should be supplied through the traditional supply chain

Annex 1 – Stakeholder Summaries

Stakeholder	Current Role	SAF Targets/Ambitions	Role of Airports	Challenges	Opportunities
Fuel Supplier	• Currently fuel supplier for both SAF and Jet Fuel • Owners of refineries in Europe • Existing SAF producer	• No explicit targets due to uncertainty of market size at STR for SAF • Supply sufficiently SAF to meet ReFuelEU targets • Currently able to deliver SAF locally for airlines at STR if uptake is voluntary	• Due to limited infrastructural impact of SAF – role of airport will be limited • Airport could work towards a concept for blending facility • Fuel suppliers unlikely to rely on airport blending facility but could ease supply side pressure	• Current main challenge is transportation of fuel to airport – done by road due to lack of pipeline • No indication for strong demand at STR for SAF	• Business case depending on market size • Infrastructure update to get fuel to STR
Fuel Distributor	• Not part of purchasing or selling fuel, primarily logistical warehouse on airport. Operating fuel infrastructure. • They don't have a role in SAF, only in terms of accounting on how much SAF is brought up.	• SAF Supply depends on the fuel supplier and if there is a contract with airline.. • Project with European consortium project on bringing SAF to airport as a test run. • They must get certified SAF	• Airports pressure from shareholders to get SAF. • Existing infrastructure can be used. • Blending on site should not be done or considered	• SAF Accounting • Limited space at airports for innovating • Dominating fuel suppliers on the fuel being used. • Fuel suppliers struggling to get fuel to airport • Physical SAF molecules on airlines paying for SAF	• Book and Claim

Annex 1 – Stakeholder Summaries

Stakeholder	Current Role	Sustainability & SAF Targets/Ambitions	Role of Airports	Challenges	Opportunities
Airport	• Holistic view on sustainability, integrated view. • Department of Aviation: pushing SAG • Supporting hydrogen projects for aircraft fuel.	Destination STRzero: • 85% GHG reduction by 2030 • Net zero emissions by 2040 • GSE fleet zero emissions by 2030 • Investing in lower-emission technologies • Carbon pricing for project decisions • Digital twin with other airports	• Infrastructure providers • Communication to passengers Destination STRzero: • Raise passenger awareness for climate-conscious travel • Airport charges incentivise sustainable aviation fuel and electric aircraft • Advance tech, progress, and help realise the vision of emission-free flying	• Local group activity (noise, carbon reduction, climate change awareness) • Scope 3 reductions: quantifying them • Offsetting airport emissions not allowed. • Company has no necessary funds to meet the target on net zero. • Communications on sustainability • SAF incentive is not being used, there is no local production of SAF. • Pipeline access: environmental impacts and to local communities • SAF monitoring and book and claim.	• Stakeholder engagement • Politics and political agenda: climate strategy • Carbon storage(not practical yet) • Infrastructure for hydrogen • Collaboration with federal ministry(ReFuelEU)

Stakeholder	Ambitions & Targets	Vision on SAF	Role of Airports	Challenges	Opportunities
Ministry of Transport	• Region climate neutral by 2040 • Funding studies for the airport • Ministry of Transport: use 100% SAF by 2040 (not possible to achieve) • Aim to improve and modify policy to favour renewables • Cooperation on PtL plants at federal level	• EU incentive strategy has to change and consider the ramp-up and taxation. • Limited feedstock available in the area and the possibilities of developing alternatives are limited due to policy. • Biobased SAF cannot be the sole focus • Roadmap for PtL	• Airport is seen as ambitious • Moderating role: assess what other airports are doing • Collaboration with other regions	• The ministry only has impact on policy at regional level, there is limited influence on national and EU level. • Targets are more ambitious than EU level, there are concerns if it can be reached. • Possibility of pipeline was stopped due town close to airport. • Ministries do not agree with each other and therefore cannot advise at EU level • Policy is not supporting the business case of fuel suppliers for SAF • SAF cannot be produced in the region(limited sources available • Import on feedstock for PtL limited due to policy	• Possibility of funding SAF tanks and infrastructure if needed • Collaboration with other German airports. • Airport might be able to purchase SAF themselves • Funding other studies for the airport to assess additional options • Changing landing fees(airlines using SAF could pay less fees)

Annex 2 – Stakeholder Interview Questions Airlines

Introductory questions - Airlines

1. Can you provide an overview of your airline's current initiatives and strategies related to sustainable aviation fuel (SAF) implementation?
2. Do you think airports should have a role in the implementation and uptake of SAF? If yes, what role do you think they should have?
3. What are the main challenges faced by your airline in implementing SAF initiatives at airports?
4. What type of incentives or mechanisms could airports further implement to help airlines in the uptake of SAF? (Financial and non-financial)
5. How do you collaborate with the airports and fuel suppliers to ensure a reliable supply of SAF? Do you envision a collaboration between airlines and airports evolving in the future to further accelerate the uptake of SAF?

Detailed questions - Airlines

1. Who is your fuel provider at STR? What does the supply chain look like? (Fuel uptake and usage info, for SAF projections)
2. Do you currently use SAF at STR? If not, why not, and when do you expect this to change? Why haven't you used the incentive provided by the airport?
3. Do you expect that at STR there will be sufficient supply of SAF? What course of action are you taking to ensure this? (At STR subject to ReFuelEU blending mandate)
4. Concerning the uptake of SAF at STR, are there any specific challenges or favourable conditions that you would like to bring to our attention?

Annex 2 – Stakeholder Interview Questions Fuel Suppliers & Distributor

Introductory questions - Fuel Suppliers & Distributors

1. Could you please briefly introduce yourself & your (role within) the organization?
2. Are there any SAF strategies or initiatives in place already? Can you provide general overview on how SAF is currently being viewed?
3. Would you be willing and able to share an estimate of the total volume of fuel provided by your organization at Stuttgart Airport in 2023 or previous years?
4. Could you indicate how many airlines you are currently the fuel supplier for at Stuttgart Airport? Could you provide a general overview of how the fuel supply chain works at Stuttgart?
5. Does your organization currently offer SAF at Stuttgart Airport?
6. How does SkyTanking view the role of airports in the uptake of SAF?

Detailed questions – Fuel Suppliers & Distributors

1. What role do you think airports should play in the uptake and diffusion of SAF in the aviation market?
2. How do you think airports can influence the availability of SAF?
3. Airports are not involved in the fuel purchase process, however, they provide the infrastructure do you think airports could hold more power over what fuel airlines buy?
4. How can airports aid in the uptake of SAF without losing competition?
5. How can airports avoid airline dissatisfaction and avoid them diverting to other airports?
6. What infrastructure requirements do you think are needed in the long term for the uptake of SAF to meet the EU goals?
7. Do you believe that airport-specific SAF mandates will clash with EU mandates, and if so, what would you consider a potential solution for this?(e.g Stuttgart incentive)
8. Which incentives or strategies would you concede viable only for short-term? Medium-term and long-term?
9. What are your views on the trend in price for SAF, both on an EU and more local level?
10. Do you believe that SAF will be cost competitive in the medium to long term?

Annex 2 – Airport Interview Questions

1. **What are the sustainability ambitions** of the airport and where does SAF play a role?
    a. Is the airport setting up strategies for alt. fuel implementation/ development? *under ReFuelEU airports must demonstrate efforts in developing such strategies for alternative fuels
    b. Vision or strategy for SAF/(hydrogen) in aviation, role of SAF in strategy?
    c. Does the airport have specific targets on SAF uplift? Vision for SAF or alt fuels?
    d. How are you planning on measuring/monitor the impact and uplift of SAF at the airport? (e.g ground emissions, the share of SAF)
2. **What have been initiatives so far in the uptake of SAF? *STR airport affected by ReFuelEU reporting period 2024. SAF supply should start in 2025**
    a. How do you collaborate with airlines, fuel suppliers, and other stakeholders to promote and facilitate the use of SAF at the airport?
    b. Has there been collaboration set up with the Union Airport managing body? *under ReFuelEU airport managing bodies will enforce regulation
    c. Are there any specific actions the airport has taken(aside from feasibility study) for SAF uptake?
    d. Has the airport engaged with passengers with regards to SAF and alternative fuels?
3. **What does the current fuel supply chain look like?**
    a. Ownership and management of fuel infrastructure (leased/rented to fuel supplier?)
    b. Airports participation in the supply chain: extent of influence on fuel supply chain/infrastructure.
    c. Have the impacts on the infrastructure of SAF been assessed?

1. **What is current status of SAF uptake?**
    a. Has the airport uplifted SAF in the past? (test flights, partnerships, or collaborations?)*
    b. Why did no airline or fuel supplier apply for the incentive on SAF? (demand or supply side issue?)
    c. How does the airport currently deal with tankering practices?
    d. What are the main challenges and opportunities you encounter when implementing SAF initiatives at airports?(info missing or lacking?, concerns?, monitoring, control over supply chain)
    e. Has the supply chain for hydrogen been set up(ground vehicles and aircraft)?
    f. Have promotion strategies on hydrogen and electricity supply been set up? *
2. **What role is the airport currently playing in the development of SAF? Has it been mainly driven by the local political agenda?**

NACO

a company of **Haskoning**