JUNE

2024

ADVANCING COLLABORATION BETWEEN THE UK AND SPAIN ON SAF PRODUCTION AND REGULATION

British Embassy Madrid

COIAE

ÍNDICE

1. FOREWORD.

The climate emergency drives us to change the way we relate to and exploit nature, seeking a balanced approach to our actions so that their impact is recoverable and endures for the enjoyment of future generations. Every economic sector is promoting actions in pursuit of this common goal, and governments are supporting and directing policies that can help achieve it. Coordination among all is essential.

In the transportation sector, particularly in the case of aviation, efforts are continuously made to reduce consumption and, consequently, emissions. One strategy to achieve this is the reduction or neutralization of the net impact of combustion in aviation engines. This strategy is based on maintaining a neutral balance between emissions and CO2 recovery. A cyclical system that retrieves as much CO2 from the atmosphere as is emitted and produces the fuel used while keeping atmospheric CO2 levels constant.

This closed-loop cycle is the subject of this report, and more specifically, the central element of that cycle which are the Sustainable Aviation Fuels or 'SAF', from raw materials and renewable energies for its production to its combustion and recovery. The environmental certification and accountancy part of the use of sustainable fuels[1] has also been considered to ensure that the system functions.

Spain and the United Kingdom have signed a Memorandum Of Understanding to support collaboration between economic, industrial, and academic stakeholders from both countries, allowing them to address the future demand for SAF and achieve international zero-emission goals by 2050[2] by meeting all the interim deadlines. Specifically, mentioned cooperation areas are:

Participants will decide on the implementation of cooperative activities to promote the use of SAF, which may include:

1. *Establishing an annual meeting among participants. Relevant economic, industrial, and academic stakeholders may be involved in order to promote the SAF development in both countries, especially those SAF produced from waste.*
2. *Jointly promoting the use and production of SAF in Spain and the United Kingdom according to relevant regulatory frameworks applicable to each participant, including relevant SAF adoption goals and sustainability criteria.*
3. *To share knowledge and promoting exchanges between participants and facilitating the development of joint industrial ventures aimed at increasing production capacity and supply of SAF in both markets, as well as supplying other international markets.*
4. *To strength partnerships with the private sector and academic research entities. To promote collaborative initiatives on SAF development whilst facilitating the exchange of actions and best practices between the Jet Zero Strategy vision for SAF established in the UK and related policy documents and Spain's Safe, Sustainable, and Connected Mobility strategy.*
5. *To promote the development of this collaboration with sector companies that share the spirit of cooperation that this statement aims to promote.*

[1] https://www.icao.int/environmental-protection/Pages/CAEP-FTG.aspx

[2] States adopt net-zero 2050 global aspirational goal for international flight operations (icao.int)
La OACI adopta en una conferencia un sólido marco mundial para lograr una transición energética limpia en la aviación internacional (icao.int)
Estrategia Jet Zero: lograr una aviación con cero emisiones netas para 2050 - GOV.UK (www.gov.uk)

6. *Working together to foster the highest standards of economic, social, and environmental sustainability to be applied to SAF production both in the European region and globally.*

This report has been conducted by directly asking companies working in various parts of the cycle about their problems and needs to ensure that policies will be properly aligned with industry needs. Moreover, we have sought their opinions on policies that could assist them in line with the indicated areas of cooperation.

The report clusters research companies' opinions, as well as raw material supply companies, production, logistics, and distribution companies. Attention is also given to consumers and the control and certification of each part.

One of the objectives of this report is to present the agreement between the Kingdom of Spain and the United Kingdom for the promotion of SAF production, taking advantage of the synergies that can arise between both countries. This report is intended to serve as a prelude to the creation of a collaboration network to develop the SAF industry and services. It aims to explore how other agreements, grants, and aids are being leveraged, as well as the industry's opinion on what is still needed to drive these efforts forward. Regarding the state of the industry, the report seeks to provide an overview of the current situation, the main projects, and their medium- and long-term plans, as well as to identify needs and challenges. Ultimately, the goal is to foster joint efforts among the government, companies, and research centres to develop the SAF market and meet environmental objectives. This report includes not only information that various stakeholders have published openly but also comments obtained from interviews and consultations with some of the main companies and research centres related to the SAF cycle.

The report is structured into nine main areas of interest:

1. Policies related to SAF in the UK and Spain
2. Raw materials and life cycle
3. SAF production and production capacity in the UK and Spain
4. Required infrastructure for SAF distribution in the UK, Spain, and their airports
5. Verification and measurement systems
6. Mandates and incentives in the UK and Spain for promoting the use of SAFs
7. Financing of Innovation and Development. Technological interest.
8. Awareness of the agreement between the United Kingdom and Spain and other agreements and sources of funding.
9. Recommendations on how to advance bilateral collaboration

The current global situation provides an opportune time for the report, as this new industry is facing an emerging process with a very significant lack of growth to cover the current aviation fuel market. Its starting point is strong: it relies on a solid foundation in the current refining and aviation fuel industry along with robust areas of research. Nevertheless, it needs to adapt significantly to incorporate new raw materials and refining processes with new forms of non-polluting primary energy.

This discussion paper has been developed by the Colegio Oficial de Ingenieros Aeronáuticos de España (COIAE) and funded by the British Embassy in Madrid.

2. EXECUTIVE SUMMARY.

Spain and the United Kingdom committed to the net zero CO2 emissions target by 2050 (known as the Long Term Aspirational Goal, LTAG) agreed upon at the 41st ICAO Assembly in 2022. Subsequently, in 2023, they agreed on an initial 5% reduction in international aviation emissions by 2030, achieved exclusively through the use of cleaner energy sources such as SAF. Prior to this, both countries had been positioning themselves to develop the SAF industry and had taken significant steps towards committing to the net zero emissions target by 2050. With this common goal in mind, Spain and the United Kingdom signed a Memorandum of Understanding (MoU) in July 2023 to collaborate on the development of the SAF industry.

Engaging major companies in the sector for the drafting of this report has facilitated communication and awareness of the MoU which was not universally known. This underscores a certain distance between administrations and businesses. The SAF industry development project is highly technological and strategic, requiring immediate actions to reach the market in time and meet environmental expectations. The leadership in this industry is at stake.

To achieve these objectives, governments can, among other actions, stimulate collaboration between various industrial sectors (including fuel producers, airlines, aerospace manufacturers, airport operators, and finance) to increase SAF production. This requires governments to create incentives for capital reallocation, as well as for the production and global use of SAF.

There are different regulations between the two countries post-Brexit, although there is still considerable coordination between the United Kingdom and the European Union, as the United Kingdom remains part of the European Civil Aviation Conference[3]. Many aspects of the bilateral agreement remain to be regulated. Specifically, differences are emerging regarding SAF legislation.

Currently, one of the industry's identified problems is the lack of legislation covering the entire SAF pathway until 2030 and 2050. This uncertainty significantly influences investment decisions in various aspects, including available raw materials, access to them, water usage limitations, certification systems at each step, measurement system guarantees, limitations on certain technologies, or the necessary development of adequate infrastructure. Additionally, there is observed complexity in the regulations, prompting calls for seeking as much international uniformity as possible.

Given this future legal uncertainty, many voices are advocating for assistance to reduce investment risks in research, industrialization, demonstrations, processing plants, raw materials, infrastructure, engine tests, flight tests, and certification. Similarly, fostering joint developments between countries requires expanding access to different initiatives and assistance for companies from the other country.

Currently available SAF production technologies involve processes applied to agricultural materials and industrial and domestic waste, using emissions-free energy and large amounts of water. Extensive application alone wouldn't meet the SAF industry's needs, necessitating further development of other technologies. These technologies are still in the research and demonstration phase, requiring significant investments, particularly in the first demonstration and industrial plants (*first-of-a-kind*), which could be pivotal for investors to support these technologies. The regulatory framework concerning eligible feedstocks for SAF production is likely a current focal point.

[3] About ECAC (ecac-ceac.org)

There is particular concern regarding lipid-based raw materials due to their potential for fraud. In this regard, the European Commission is tightening measures to prevent it. Certification bodies play a crucial role in ensuring the sustainability and traceability of the entire value chain.

SAF prices vary among technologies, with no prospects of aligning with traditional fuel prices. There is particular uncertainty surrounding those still in development, depending on the crystallization of their development processes.

The different technological origins of SAF may necessitate different administrative treatment for consumption accounting, traceability, and administration control. There is talk of a centralized database in Europe for monitoring all flights originating from Europe.

Airlines also express concerns about how emissions offsetting balances will be applied with foreign companies. Their functioning is still unclear and causes doubts and uncertainties. Similarly, treatment in other countries may affect air transport competitiveness. Likewise, if SAF from outside the EU or the UK is used, there is a desire for equal offsetting treatment.

There is also a call to advance in the approval of sustainable aviation blends up to 100% and access to different fuels for testing and verifying engine designs.

The entire SAF industrial system relies on each part's credibility and combating fraud. It is supported by sustainability certification schemes ensuring SAF traceability and custody chain, meeting emission reduction criteria and raw material origins defined in current regulations, audited annually by external certification entities. There is a risk of creating overly complex and rigid control structures that hinder operation capacity, affecting competitiveness and deterring investment opportunities. Understanding logistics thoroughly is also necessary, seeking flexibility to avoid unnecessary emissions and optimize the national logistics system.

3. POLICIES RELATED TO SAF IN SPAIN AND THE UK.

Spain and the United Kingdom committed to the net zero CO2 emissions target by 2050 (known as LTAG) agreed upon at the 41st ICAO Assembly in 2022, and subsequently, in 2023, to a 5% reduction in international aviation emissions by 2030, achieved exclusively using cleaner energy sources, such as SAF. Prior to this, both countries had been positioning themselves to develop the SAF industry and had taken significant steps towards committing to the net zero emissions target by 2050. With this common goal, Spain and the United Kingdom signed a Memorandum of Understanding (MoU) in July 2023 to collaborate on the development of the SAF industry.

Drop-in sustainable aviation fuels will play a crucial role in decarbonising the aviation sector, as they can be used in the existing global fleet and fuel supply infrastructure. Currently, certified sustainable aviation fuels are subject to a maximum blending ratio of 50% with fossil-based aviation fuel, depending on the pathway considered, but the industry and fuel standards committees are exploring the future use of 100% sustainable aviation fuels by 2030.

Sustainable aviation fuels are certified by sustainability certification systems according to criteria defined at the EU level in the Renewable Energy Directive and globally under the CORSIA framework. Although sustainable aviation fuels are currently more expensive than fossil-based aviation fuels, cost savings are expected, mainly due to future economies of scale in production. Prices of sustainable aviation fuels may vary depending on the production pathway, associated production costs, and energy market fluctuations. Emissions market pricing mechanisms will also influence the pricing and cost structure to support the profitability of SAF.

We will first provide a brief overview of the situation up to March 2024.

Evolution of Policies in the United Kingdom

In the **United Kingdom**, the strategic foundations for the sustainable aviation sector[4] were set out in the 2022 documents "Jet Zero Strategy: Delivering Net Zero Aviation by 2050[5]" and "Flightpath to the Future: A Strategic Framework for the Aviation Sector[6]," both of which established the same emissions neutrality goal for 2050, as included in the conclusions agreed upon at the ICAO Assembly.

To achieve the 2050 goals, the strategy includes:

- Publication of a Five-Year Development Plan: This plan outlines the needs for the coming years, organised under three principles: international leadership, logistical partnerships, and maximising opportunities.
- Baseline Reference for Emission Comparisons: The starting point for emission comparisons is set at the 2019 peak emissions level, with a roadmap for reductions over the coming years. This reduction is expected to be achieved through the combined efforts of various emission reduction strategies, including SAF.
- More Ambitious Goal for Domestic Flights: The strategy aims for domestic flights to be carbon neutral by 2040. This plan requires airports to review their operations and infrastructure.
- Incorporation of Carbon Markets: Carbon markets play a crucial role in achieving the Jet Zero target, as do greenhouse gas removers (GGRs), which are essential for eliminating residual emissions.
- Environmental Information for Passengers: Providing passengers with environmental information about each flight at the time of booking.
- Accelerated Research on Non-CO2 Pollutants: Increasing research to understand the effects of other pollutants besides CO2 and their potential mitigation.
- Annual Monitoring and Five-Year Strategy Review: Monitoring the entire process with annual measurements, allowing for a major strategy review every five years.

A government consultation was conducted between March and April 2023[7] to gather UK industry views in particular on the obligations of each party, certifications, commercial operations and compliance, responsibilities, and how these function in international interactions. Opinions were sought on whether additional measures should be adopted beyond the mandate and on the need for resources to boost and

[5] Jet Zero strategy: delivering net zero aviation by 2050 - GOV.UK (www.gov.uk)
[6] Flightpath to the future: a strategic framework for the aviation sector - GOV.UK (www.gov.uk)
The IATA has created the SAF Registry to accelerate the adoption of SAF. This registry will provide a robust and rigorous accounting of the carbon footprint of these fuels.
It will allow airlines to purchase SAF regardless of where it is produced. Additionally, it will ensure compliance with regulations such as the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) and the EU Emissions Trading System (EU ETS).
[7] Pathway to net zero aviation: developing the UK sustainable aviation fuel mandate - GOV.UK (www.gov.uk)

expand domestic SAF production. Since its publication, the UK government has provided further support to the SAF industry, such as:

- The £165 million Advanced Fuel Fund to support the development of advanced fuel plants in the UK for the 2022-25 fiscal years;
- £12 million to support fuel testing, including funding to establish a SAF clearing house for the 2022-25 fiscal years, and up to £1 million to support the first net zero emissions transatlantic flight powered by 100% SAF; and
- £400 million investment with Breakthrough Energy Catalyst to drive investment towards the next generation of clean energy technologies, including SAF.

These are vital actions that will stimulate SAF production in the UK to complement the SAF mandate, ensuring that production meets the UK's SAF demand. For this reason, the initial commitment to begin construction of at least five commercial-scale plants in the UK by 2025 was announced[8].

Regarding the initial situation of UK aviation, according to data from the Department for Transport Analysis by the Civil Aviation Authority, UK airports managed 272 million passengers at their terminals in 2023, 238 million of whom were on international flights. Flights departing from UK soil directly reached 370 different destinations in more than 100 countries, and many more through connections. The main destination country was Spain, with 25% of international passengers flying to various destinations in Spain.

Regarding cargo, the total exchange of goods between the UK and Spain in 2023 amounted to €9.6 million from the UK to Spain, and €9.4 million from Spain to the UK.[9]

In Spain, among non-EU destinations, the UK was significantly the country with the highest number of travellers, with 4.9 million in June 2024 (385,000 more than in 2023), almost equivalent to the combined number of travellers who flew to Germany and Italy, the two main destinations in the European Union. [10]

Considering this data, cooperation between Spain and the United Kingdom is a priority in the shared goal of decarbonising aviation and other modes of transport.

The emissions reduction strategy for flights departing from the United Kingdom is illustrated in the Figure 1 Forecast of CO_2 emissions from flights originating in the UK, highlighting the significance of SAF, which will account for 39% of the reduction from the 70 $MtCO_2$ that British aviation is estimated to consume if it continues with the current model.

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[8] https://assets.publishing.service.gov.uk/media/6305fca9e90e0729d7707973/sustainable-aviation-fuels-mandate-summary-of-consultation-responses-and-government-response.pdf

[9]https://www.aena.es/es/estadisticas

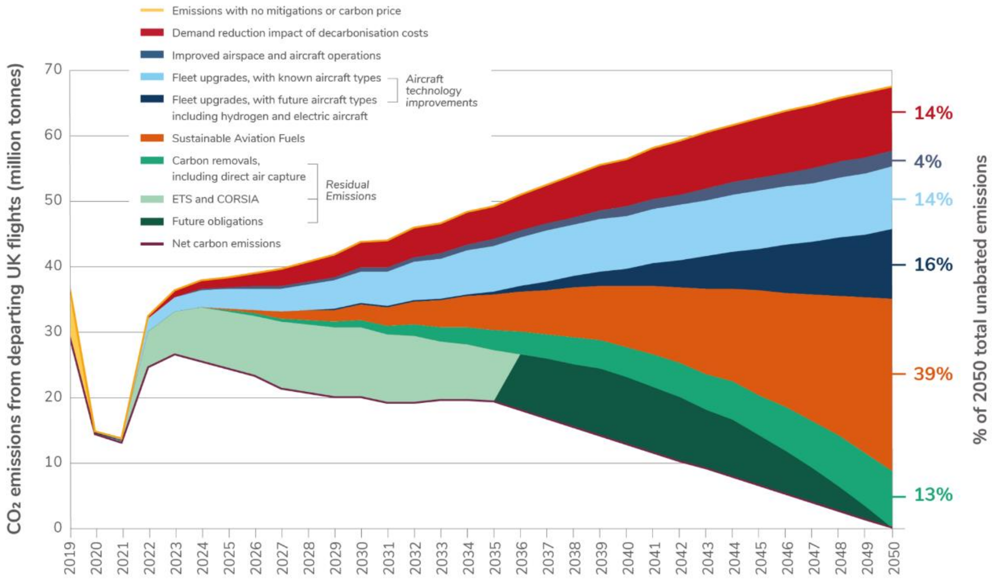

Figure 1 Forecast of CO2 emissions from flights originating in the UK[11]

<u>Proposed Changes to Multiple Incentive Rules for the Renewable Transport Fuel Obligation (RTFO) and SAF in the UK</u>[12]

Now that the UK is no longer a member of the EU, fuels produced and imported from EU states must receive the same treatment as those produced and imported from the rest of the world. Currently, fuels from outside the UK/EU are not restricted from receiving state support in their country of origin and can apply for support under the RTFO. This legislative gap creates an unfair advantage for international suppliers outside the UK/EU.

To address the possibility of multiple incentives being claimed in different countries, several options are being considered to modify the RTFO regulations and replicate this change in the SAF mandate:

Option 1: (the most preferred option) Extend the current UK and EU provisions to fuel supplied from the rest of the world but remove the fiscal support reference from the RTFO support scheme definition. The Trade Remedies Authority (TRA) would continue to investigate international unfair trading practices and provide objective, impartial, and WTO-compatible advice to ministers to implement trade remedies when necessary.

Option 2: Extend the current UK and EU provisions to fuel supplied from the rest of the world, thereby preventing the claim of all forms of multiple incentives.

Option 3: Align the EU treatment with the current treatment for the rest of the world, allowing for the claiming of multiple incentives. The TRA would continue to investigate international unfair trading practices and provide objective, impartial, and WTO-compatible advice to ministers to implement trade solutions when necessary.

[11] https://www.sustainableaviation.co.uk/news/uks-leadership-in-sustainable-aviation-technology-accelerates-industrys-transition-to-net-zero/

[12] https://www.gov.uk/government/consultations/renewable-transport-fuel-obligation-addressing-multiple-incentives/renewable-transport-fuel-obligation-addressing-multiple-incentives

The consultation process on these options ended on March 18, 2024[13], and the UK government is currently considering the responses.

Evolution of Policies in Spain

In **Spain**, as a member of the European Union, much of its modern legislation originates from European policy programmes.

In July 2015, the Spanish Aviation Safety Agency (AESA), the Ministry of Agriculture, Food and Environment (MAGRAMA), the Institute for the Diversification and Saving of Energy (IDAE), and the State Company for Air Navigation Services and Aeronautical Safety (SENASA) signed a collaboration agreement to promote a "Spanish Initiative for the Production and Consumption of Biojet Fuel for Aviation." This collaboration renewed the commitments made in the Framework Agreement signed in 2009, which aimed to achieve greater energy efficiency in the aviation sector, a more rational use of energy, and the utilisation of renewable energy sources in aviation-related facilities and buildings. The goal was to reduce greenhouse gas emissions attributable to this mode of transport, including aircraft operations, airports, and necessary infrastructure, as well as ground support equipment and access means.

The agreement aimed to promote the development of a comprehensive biojet fuel production chain for use by aviation in Spain, considering the entire life cycle, from the production of sustainable raw materials to the commercial use of aircraft. This involves studying the effects of biojet fuel production and use in various areas, such as environmental impact, where a full life cycle analysis of the product is considered. Economically, the analysis focuses on competitiveness, job creation, and economic development in the agricultural, industrial, and aviation sectors.

The main conclusions of that platform have been:

- The start of the ITAKA project, with actual involvement of Spanish stakeholders towards SAF production.
- Initiating the information exchanges with stakeholders, notably btw different administrations (environment, energy, transport) and with the private sector
- Knowledge gathered helped with the White paper of transport and with the participation within international groups (e.g. Spain was co-leading the ICAO AFTF -now called FTG- and later has led the ECAC SAF TG.

The most relevant consequence was the initiation of steps for the opt-in of SAF within RED targets in Spain (which is now a reality) and the Law of Climate Change article that set the basis for a national mandate (now superseded by ReFuelEU).

Notably, Spain has been involved in the ITAKA project, led by SENASA and initiated in 2011. In Spain, Repsol and Iberia conducted pilot tests, and in 2011, the first Spanish flight powered by biofuels took place between Madrid and Barcelona.[14]

Here are some initiatives undertaken in Spain to promote the development of biofuels in transport:

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[13] Renewable transport fuel obligation: addressing multiple incentives - GOV.UK (www.gov.uk)

[14] https://www.senasa.es/index.php?lang=es-ES&idPag=573

- National Centre for Renewable Energies (CENER): Established in 2002, CENER is a foundation with a board consisting of the Ministry of Economy and Competitiveness, CIEMAT, the Ministry of Industry, Energy and Tourism, and the Government of Navarra. Among its main facilities is the second-generation biofuels centre, which includes a semi-industrial scale pilot plant for producing second-generation biofuels from non-food competitive raw materials, using various production pathways (thermochemical, biochemical, and/or enzymatic) and applying biorefinery concepts.

Other International Collaboration Projects:

- CORE-JetFuel Project (2013-2016): The aim of this project was to create a European network of excellence for alternative aviation fuels to consolidate technical knowledge and provide an integrated approach to alternative aviation fuels, including regulatory aspects, research, deployment, and economics. SENASA participated in this project, which was part of the EU's 7th Framework Programme for Research, by analysing raw materials and technologies available for producing alternative fuels for the aviation sector.[15]

- Forum AE Project (2013-2017): This project aimed to create a European network of specialists (academia and industry) focused on key aviation emissions issues. SENASA participated at all levels. The project addressed environmental impacts (air quality and climate change), mitigation solutions (aircraft, engines, operations, alternative fuels), and technical regulatory issues (CAEP, local regulations), including their standardisation, dissemination, and regulatory dialogue.[16]

- Bio4A Project (2018-2023): This Horizon 2020 project aimed to demonstrate the first industrial-scale production and use of SAF in Europe and investigate the potential for recovering marginal lands in the Mediterranean region. The project, which concluded in May 2023, was executed by an international consortium of seven partners, including major industries, research organisations, and SMEs. The consortium comprised Renewable Energy Consortium for Research and Demonstration (Italy), SkyNRG B.V. (Netherlands), CENER - National Centre for Renewable Energies (Spain), ETA-Florence Renewable Energies (Italy), Camelina Company España S.L. (Spain), JRC Joint Research Centre European Commission (Belgium), and ENI spa (Italy).

  The objective of the BIO4A project was to demonstrate pre-commercial scale production of SAF certified to ASTM standards from sustainable raw materials (wastes produced in the EU). The project focused on developing production capacity and investigating long-term opportunities for sustainable non-food lipid supply for conversion into biofuels with low indirect land use change (according to DERII). The project adopted a dual approach, combining industrial demonstration with research and development.[17]

- Contribution to ICAO Technical Working Group: Spain actively contributes to the technical work of the ICAO Fuels Task Group (FTG), which falls under the Committee on Aviation and Environmental Protection (CAEP).[18]

In 2019, the Spanish Government launched two regulatory proposals to promote SAF (Sustainable Aviation Fuel):

[15] https://cordis.europa.eu/project/id/605716/es
https://www.senasa.es/index.php?lang=es-ES&idPag=574
[16] https://www.senasa.es/index.php?lang=es-ES&idPag=25
[17] https://www.cener.com/evaluacion-de-la-sostenibilidad-ambiental-y-social-de-la-produccion-de-combustibles-sostenibles-de-aviacion/
[18] https://www.icao.int/environmental-protection/gfaaf/pages/project.aspx

1) Spanish Climate Change Law[19]: This law explicitly promotes alternative fuels, with a focus on advanced biofuels and other renewable fuels of non-biological origin for aviation. These fuels must comply with sustainability criteria defined by European regulations.

2) Integrated National Energy and Climate Plan (PNIEC) 2021-2030: Submitted by the Ministry for the Ecological Transition and the Demographic Challenge to the European Commission in January 2020, just as the COVID-19 pandemic began.

This plan aims to establish a 2% SAF supply by 2025 under the ReFuelEU Aviation initiative.

While these Spanish regulations have been pivotal for development in Spain, the most relevant framework for SAF development in the country has come from recent European regulations. On December 11, 2019, the European Commission adopted a Communication on the European Green Deal, highlighting that transport accounts for a quarter of the European Union's greenhouse gas emissions and continues to rise. Achieving climate neutrality would require a 90% reduction in transport emissions by 2050, with road, rail, air, and maritime transport all contributing to this reduction. Sustainable transport means prioritising users and providing more affordable, accessible, healthy, and clean alternatives to current mobility habits.[20]

Subsequently, on July 14, 2021, the European Union presented a package of proposals to adapt EU climate, energy, land use, transport, and fiscal policies to reduce greenhouse gas emissions by at least 55% by 2030 compared to 1990 levels. This is known as the Fit for 55 package. The package includes a proposal to ensure a level playing field for sustainable aviation, also known as the ReFuelEU Aviation Initiative.[21]

As an EU member, Spain is subject to the provisions of the ReFuelEU Aviation Regulation, which aims to boost the supply and demand for sustainable aviation fuels in the EU and align the aviation sector with the EU's climate goals for 2030 and 2050. SAF is a key tool for decarbonising aviation in the short and medium term. The regulation seeks to address current obstacles to SAF development, including supply shortages and significantly higher prices compared to fossil fuels.

The new ReFuelEU aviation regulation applied from January 1, 2024, although some articles will apply from January 1, 2025.

In summary, the objectives of ReFuelEU for the use of sustainable aviation fuels are:

- Fuel suppliers are required to distribute increasing levels of sustainable aviation fuel at most EU airports.
- Airlines must source fuel before each flight from an EU airport.
- Emphasis is placed on synthetic fuels (also known as electrofuels).

Figure 2 Objectives for the Use of SAF in Commercial Aviation According to the "ReFuelEU Aviation" Regulation[22]

[19] https://www.lamoncloa.gob.es/consejodeministros/Paginas/enlaces/220219-proyecto.aspx
[20] https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal_es
[21] https://www.europarl.europa.eu/thinktank/es/document/EPRS_BRI(2022)698900
[22] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32023R2405

The "ReFuelEU Aviation" Regulation establishes harmonised EU-wide standards to promote Sustainable Aviation Fuels (SAF), with a progressively increasing minimum percentage of SAF that aviation fuel suppliers must deliver at EU airports. In the next stages, for the implementation of the "Fit for 55" legislation, each Member State will need to integrate this new legislation and demonstrate how climate and energy objectives for 2030 will be met at the national level in their National Energy and Climate Plans (NECPs).[23]

In February 2023, the European Union Aviation Safety Agency (EASA) published the European Aviation Environmental Report 2022. While the report does not include expectations beyond the net-zero commitment for 2050, it provides information on progress in sustainable aviation fuel and mentions relevant actions and data: Currently, the use of sustainable aviation fuel remains low, with less than 0.05% of the total aviation fuel used in the EU.[24]

The European Commission has proposed a mandate for blending sustainable aviation fuels for fuel supplied to EU airports, with minimum percentages of sustainable fuel increasing gradually from 2% in 2025 to 70% by 2050 (see Figure 2 Objectives for the Use of SAF in Commercial Aviation According to the "ReFuelEU Aviation" Regulation), and a sub-mandate for Power-to-Liquid sustainable aviation fuels.

To meet this mandate, approximately 2.3 million tonnes of SAF would be required by 2030, 14.8 million tonnes by 2040, and 28.6 million tonnes by 2050.

To support the increase in supply and use of sustainable aviation fuels, and to explore the feasibility of establishing a consistent long-term support structure to ensure the successful introduction of new sustainable aviation fuel production pathways in Europe with high emission reduction potential, the European Commission has proposed:

- Establishing an **EU SAF Clearing House** to support sustainable aviation fuel producers through the fuel approval process and to explore a EU Fuel Standard to ensure robust certification processes that support environmental protection goals.

- **Encouraging the approval of higher sustainable aviation fuel blends**, up to 100%, based on a diverse mix of feedstocks. Different types of sustainable aviation fuels can support different segments of the aviation market in the medium term.

IThe European Commission also promotes the use of the EU ETS Innovation Fund to support higher-risk investments in SAF production and other mechanisms to incentivise the adoption of sustainable aviation fuels.

Regarding the promotion of green airport operations and infrastructure, it also considers incentivising and allowing the development and implementation of necessary green airport infrastructure and operations (e.g., standards for SAF / hydrogen / electrification).

At the national level in Spain, the Climate Change and Energy Transition Law highlights the importance of advancing bioenergy and SAF Power-to-Liquid (PtL).

In terms of private initiative, in April 2023, the Alliance for Sustainable Air Transport was created to promote sustainable fuels. Spanish airlines are joining forces with oil companies, managers, and institutions to create

[23] Finalización de la legislación clave «Objetivo 55» (europa.eu)
[24] EnvironmentalReport_EASA_summary_ES_08-online.pdf (europa.eu)

a unified approach to the challenge of sustainability. Their first major challenge: to produce more biofuels and reduce their cost.[25]

4. RAW MATERIALS AND LIFE CYCLE.

Pratheepan Karunagaran, CEO of Apical, said: "Global SAF production is expected to triple in 2024 compared to 2023 levels, reaching 1.5 million tonnes. However, the availability of sustainably sourced raw materials remains a challenge for many countries. As we continue to expand Apical's global presence and capabilities, the availability of waste and residues will grow accordingly, enabling us to forge value-added partnerships to ensure that our waste stream drives SAF production and adoption.[26]

The decarbonization potential of each type of SAF is determined by a rigorous and comprehensive study of its environmental impact, from production to final consumption. This is known as the life cycle analysis, which accounts for emissions not only of CO2 but also of other pollutants.[27]

In the case of biofuels, the key aspect is the source of the raw material used in their production. At the European level, in 2022 the European Parliament clearly ruled out biofuels from soy due to their well-known land use impact, labelling them as a driver of deforestation[28]. The Figure 3 Origin of biofuels consumed in Europe (from T&E) shows the origin of the biofuels consumed in Europe over the past decade.

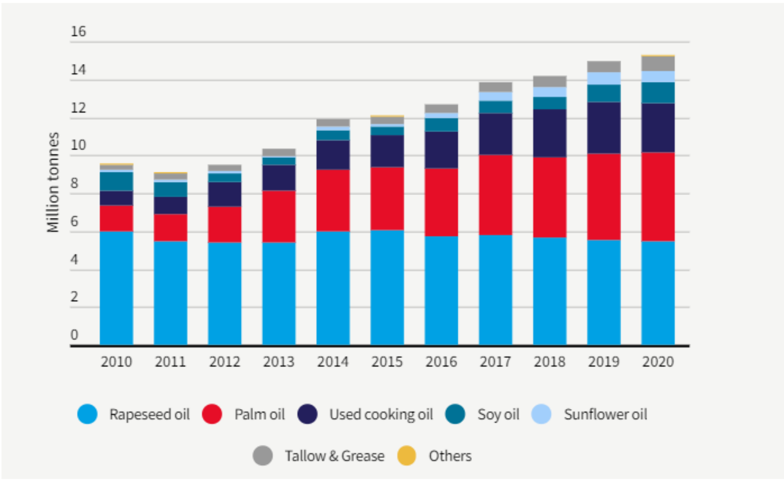

Figure 3 Origin of biofuels consumed in Europe. [29]

Waste of all types, including municipal solid waste, is one of the most promising raw materials, and can be transformed through a process known as gasification/FT. In summary, the field of technologies for SAF production is broad and continues to grow with new innovations such as converting plastic waste into sustainable fuels or designing microbes to biologically process captured CO2 into hydrocarbons[30]. The latter

[25] https://www.lainformacion.com/empresas/sector-aereo-espanol-alianza-futuro-sostenible-saf/2884717/
[26] https://www.cepsa.com/en/press/cepsa-and-bio-oils-build-the-largest-2g-biofuel-plant
[27] National Academies of Sciences. Current Methods for Life Cycle Analyses of Low-Carbon Transportation Fuels in the United States. The National Academies Press, 2022.
[28] https://www.euractiv.com/section/biofuels/news/eu-lawmakers-vote-to-blacklist-soy-biodiesel-over-sustainability-concerns/
[29] https://coiae.es/wp-content/uploads/2023/12/Informe-Aeronautica-Sostenible-2022_Adenda.pdf
[30] https://coiae.es/wp-content/uploads/2023/12/Informe-Aeronautica-Sostenible-2022_Adenda.pdf

example reflects the strategy of some airlines, betting on many decarbonization pathways to secure a competitive position in the future.[31]

But without solutions like PtL, there are not enough residual raw materials to meet aviation demand for biofuels. While today HEFA fuels are largely derived from food production waste, if HEFA fuels were to replace between >5-10% of aviation fuel supply, producers would need land dedicated exclusively to HEFA raw material production. Specific feedstocks with high oil content can have some of the highest land use impacts of any SAF pathway. With dedicated feedstocks, replacing 100 billion gallons with HEFA fuels would require between 0.3 and 3 million square miles, an area of land ranging from larger than Texas to the entire continental U.S.

Corn, sugar beets, or sugarcane used to produce ethanol for aviation alcohol fuels produce between 600 and 1,100 gallons of fuel per acre each year. There are only enough residual feedstocks to cover ~50 billion gallons of demand; by 2050, 100 billion gallons would still need to come from dedicated feedstocks. Expanded to replace the 100 billion gallons of current aviation fuel demand, corn, sugar beets, or sugarcane would cover between 350,000 and 600,000 square miles of land, enough to cover the UK between 4 and 7 times.

Initial gallons of gasification fuels using waste products do not require a significant amount of dedicated land, but more than ~50 billion gallons of dedicated SAF feedstocks would be needed. Assuming the use of gasification fuels from short-rotation forest feedstocks, between 300,000 and 1.1 million square miles would be needed to replace 100 billion gallons, enough to cover the UK with cultivated forests between 3 and 12 times.

Another important environmental aspect is the use and need for water in SAF production processes, and once again, there are many differences between technologies. For PtL fuels, water is required in the production of hydrogen, an intermediate step in the production of e-fuels. However, this process is very efficient and results in approximately 1 gallon of water being converted into 1 gallon of jet fuel, compared to the thousands of gallons of water needed per gallon of jet fuel in the case of other technologies.

Pathway	Max water (gal H2O)	Min water (gal H2O) dedicated feedstock
HEFA The Fats Way	**520 trillion** palm oil	**1,991 trillion** jatropha oil
Alcohol-to-Jet The Corn Way	**142 trillion** sugar beet	**353 trillion** corn
Gasification The Garbage Way	N/A	**353 trillion** short rotation forestry
Power-to-Liquid The Air Way	**138 billion**	**138 billion**

Figure 4 Water Gallons Needed to Replace 100 billion Gallons of Jet Fuel. [32]

[31] https://www.cemvita.com/news/turning-carbon-dioxide-into-sustainable-fuel-united-and-oxy-low-carbon-ventures-announce-collaboration-with-biotech-firm-to-create-new-fuel-sources
[32] https://www.twelve.co/ejet

What Do Companies in Spain Think?

Producers are aware of the long-term scarcity of the primary raw material currently being considered, lipid residues. The availability of these residues is limited. In the short term, there is significant potential in other feedstocks and CO2 for producing renewable fuels, although developing conversion technologies and installing logistical infrastructure will be necessary.

Regarding regulation, it is important to note that ReFuel Aviation is stricter than RED II and U.S. regulations concerning the feedstocks used for SAF. Feedstocks 1G, permitted under RED II and in the U.S., are not allowed for compliance under ReFuel Aviation, which limits the deployment of HEFA and ethanol in jet routes. This could pose environmental issues and competitive problems if SAF from these sources is allowed. The regulatory framework concerning eligible feedstocks for SAF production is a key area of focus at present.

There are significant opportunities for collaboration between the UK and Spain to improve the deployment of logistical networks for both feedstocks and final products, which would enhance the efficiency of the entire value chain. Spain also has considerable potential for generating feedstocks from both waste (in the form of fats/oils) and biomass in various forms, which, after transformation and pretreatment, could feed HEFA units.

One concern with lipid-based feedstocks is the potential for fraud. In this regard, the European Commission is tightening measures to prevent it. The role of certification bodies is crucial to ensure the sustainability and traceability of the entire value chain.

Additionally, technologies for converting feedstocks into SAF require a minimum quality and are highly sensitive to certain contaminants, making proper pretreatment particularly relevant.

Globally, there will be a future deficit of lipid feedstocks for HEFA production (the most mature route). This deficit can be mitigated in the future by: (1) increasing the availability of "Used Cooked Oil" (primarily in Asia, although with a focus on traceability and sustainability assurance), (2) new crops: their impact is limited and still presents technological and regulatory uncertainties.

However, it is necessary to incentivize and support other SAF production routes, where there are no feedstock restrictions (such as eSAF), for commercial deployment at a competitive price to cover the demand gap. In this regard, it is also essential to accelerate the homologation/certification processes of potential alternative SAF production routes, ensuring product quality and safety.

Therefore, producers are open to considering other types of feedstocks based on crops as long as sustainability is guaranteed, indirect land use change (ILUC) is avoided, and there is an increase in greenhouse gas reduction, based on established regulations and standards.

There is also a clear concern about the development of Power-to-Liquid (PTL) technology. Its evolution in recent years has not met expectations, and there is currently no certainty about when it will be available on a significant scale. On the other hand, there is some uncertainty about the correlation between the use of certain feedstocks and their actual contribution to greenhouse gas savings, which is a limiting factor. This applies not only to crop-based feedstocks but also to certain wastes (e.g., forest residues) or carbon sources for Power-to-Liquid (PTL) - SAF, etc.

5. PRODUCTION AND PRODUCTION CAPACITY IN SPAIN AND THE UK.

5.1. Processes and technologies.

Approved processes for SAF production have expanded in recent years, with technologies aiming to access new feedstocks and resources to increase production capacity. A classification can be made with the characteristics of the main types of biofuels and PtL, as shown in the Figure 5 Main SAF Production Methods [Clean Skies for Tomorrow] :

	HEFA	Alcohol-to-jet[i]		Gasification/FT		Power-to-liquid
Opportunity description	Safe, proven, and scalable technology	———	Potential in the mid-term, however significant techno-economical uncertainty		———	Proof of concept 2025+, primarily where cheap high-volume electricity is available
Technology maturity	Mature	———	Commercial pilot		———	In development
Feedstock	Waste and residue lipids, purposely grown oil energy plants[ii] Transportable and with existing supply chains Potential to cover 5%-10% of total jet fuel demand	———	Agricultural and forestry residues, municipal solid waste[iv], purposely grown cellulosic energy crops[v] High availability of cheap feedstock, but fragmented collection		———	CO_2 and green electricity Unlimited potential via direct air capture Point source capture as bridging technology
% LCA GHG reduction vs. fossil jet	73%–84%[iii]	———	85%-94%[vi]		———	99%[vii]

i. Ethanol route; ii. Oilseed bearing trees on low-ILUC degraded land or as rotational oil cover crops; iii. Excluding all edible oil crops; iv. Mainly used for gas./FT; v. As rotational cover crops; vi. Excluding all edible sugars; vii. Up to 100% with a fully decarbonized supply chain

Source: CORSIA; RED II; De Jong et al. 2017; GLOBIUM 2015; ICCT 2017; ICCT 2019; E4tech 2020; Hayward et al. 2014; ENERGINET renewables catalogue; Van Dyk et al., 2019; NRL 2010; Umweltbundesamt 2016

Figure 5 Main SAF Production Methods [Clean Skies for Tomorrow] [33]

The extractive impact of CO2 can be better seen in the Figure 6 Life Cycle Emissions, LCA, for Each Type of SAF:

[33] Informe-Aeronautica-Sostenible-2022_Adenda.pdf (coiae.es) [Clean Skies for Tomorrow]
Clean Skies for Tomorrow

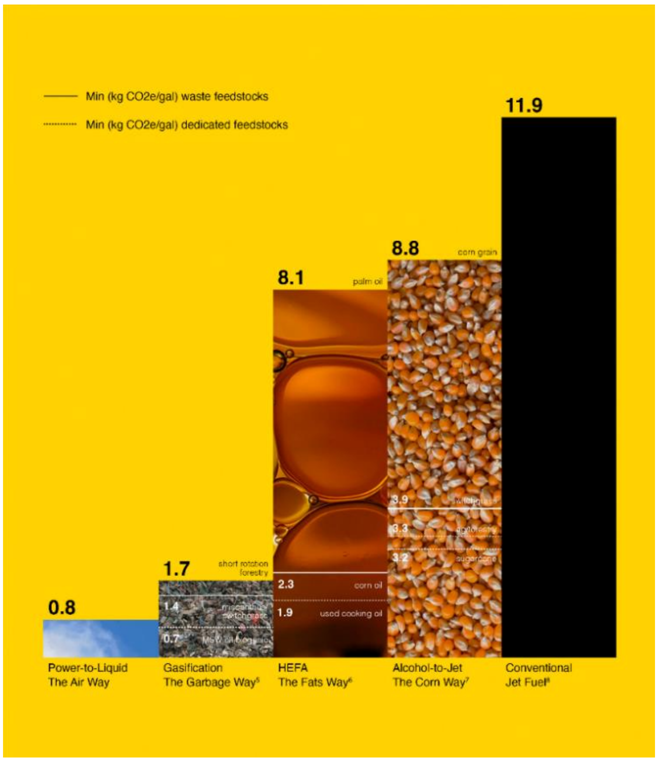

Figure 6 Life Cycle Emissions, LCA, for Each Type of SAF[34]

Nevertheless, currently and in the short term, it is expected that biofuel produced through the HEFA process will continue to clearly dominate, as shown in the Figure 7 Production Expectations for Different Types of Biofuels Until 2025 [Clean Skies for Tomorrow].

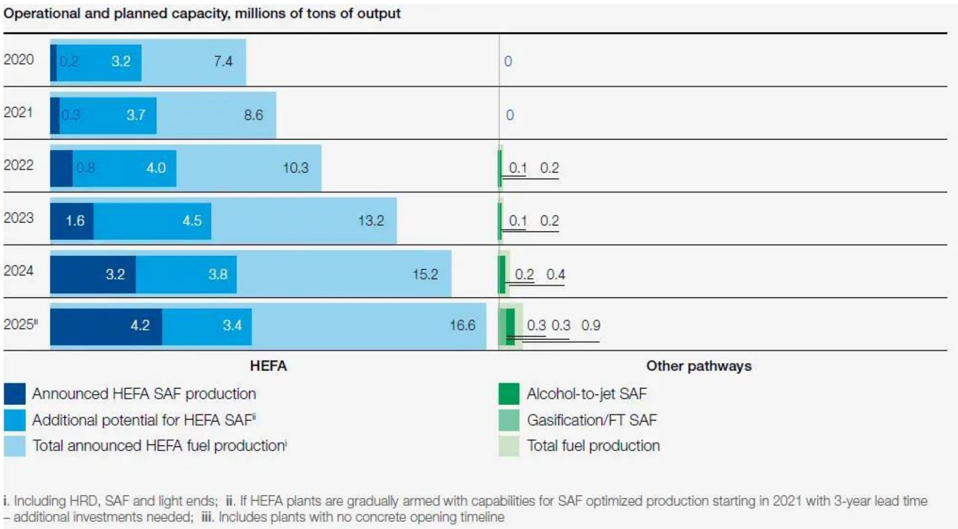

Figure 7 Production Expectations for Different Types of Biofuels Until 2025 [Clean Skies for Tomorrow]

34 https://www.twelve.co/ejet

One of the processes generating the most expectations is alcohol-to-jet (ATJ), with industrial plants coming into production from 2023, which will be able to use a broader range of sustainably sourced raw materials. Additionally, this technology also allows for the inclusion of carbon capture from carbon-intensive industries for SAF production.[35]

On the other hand, it is noteworthy to mention other industrial initiatives focusing on producing fossil fuels with a lower environmental impact. Examples include co-processing, which allows for the partial decarbonisation of aviation fuels by jointly refining petroleum and organic materials, such as used oils[36]. Similarly, hydroprocessing (using hydrogen) reduces aromatic compounds and sulfur in conventional kerosene, which results in fewer condensation trails. The minimum required percentage of aromatics in aviation kerosene is 8%, and experimental studies place the usual percentage between 16 and 20%, indicating potential environmental improvement, which has already been proposed to be expanded in European legislation RefuelEU[37]. Moreover, all these processes enable the use of existing infrastructure while advancing the reduction of the net impact of produced aviation fuels.

The global SAF needs can be seen in this IATA forecast (Figure 8 Sustainable Aviation Fuel Required to Reach Net-Zero Emissions by 2050. Source: IATA.), as SAF is a fundamental pillar in achieving zero CO2 impact by 2050.

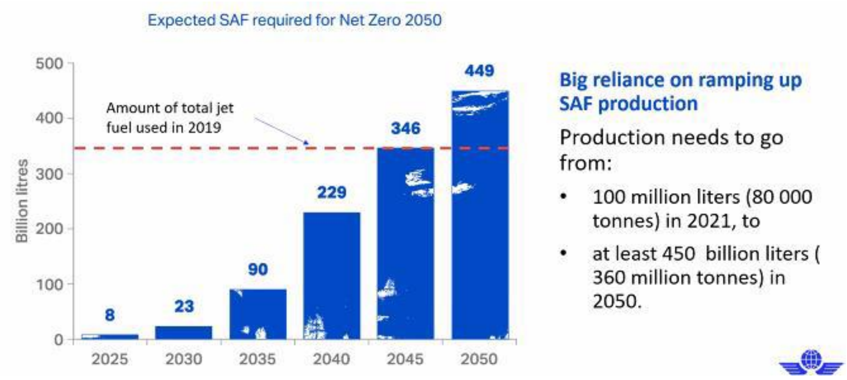

Figure 8 Sustainable Aviation Fuel Required to Reach Net-Zero Emissions by 2050. Source: IATA. [38]

The challenge of scaling up SAF is immense, even aside from the additional demand for this solution for decarbonisation from other transportation modes.

In 2022, SAF production increased to a total between 300 and 450 million litres, compared to 100 million litres in 2021. This remarkable increase must be contextualised with the total consumption of commercial aviation in the past year, estimated by IATA at 276 billion litres. The SAF produced this year, therefore, represents less than 0.2% of the fuel consumed, highlighting the difficulty and effort required to achieve, initially, the short-term goal of 2% by 2025.

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[35] https://www.greenairnews.com/?p=2501
[36] https://www.bp.com/en/global/air-bp/news-and-views/press-releases/bp-refinery-in-lingen-starts-production-of-saf.html
[37] CE Delft. Potential for reducing aviation non-CO2 emissions through cleaner jet fuel. Febrero, 2022.
[38] https://www.iata.org/en/pressroom/2022-releases/2022-12-07-01/

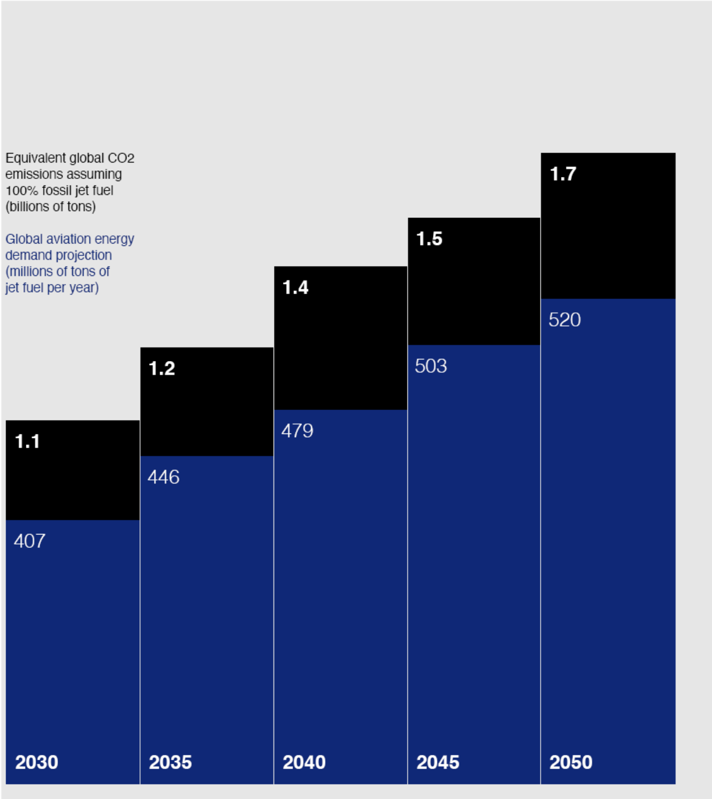

Figure 9 Projected Aviation Fuel Demand and Resulting CO2 Emissions[39]

5.2. Production cost.

A key aspect in the success of each of these SAF production pathways is the production cost. Compared to the current clear advantage of HEFA, progress is expected in other technologies, particularly in electrofuels, which are currently the most expensive to produce[40]. Of course, the production cost of fossil-based kerosene will improve its production cost ranges compared to fossil-based kerosene. The estimated evolution for the different pathways, as seen in Figure 10 Production cost ranges of SAF compared to fossil-origin kerosene. Estimated evolution for different pathways ,depends entirely on oil prices but serves as a reference.

[39] Informe de Twelve "Know your SAF" https://www.twelve.co/ejet
[40] https://coiae.es/wp-content/uploads/2023/12/Informe-Aeronautica-Sostenible-2022_Adenda.pdf

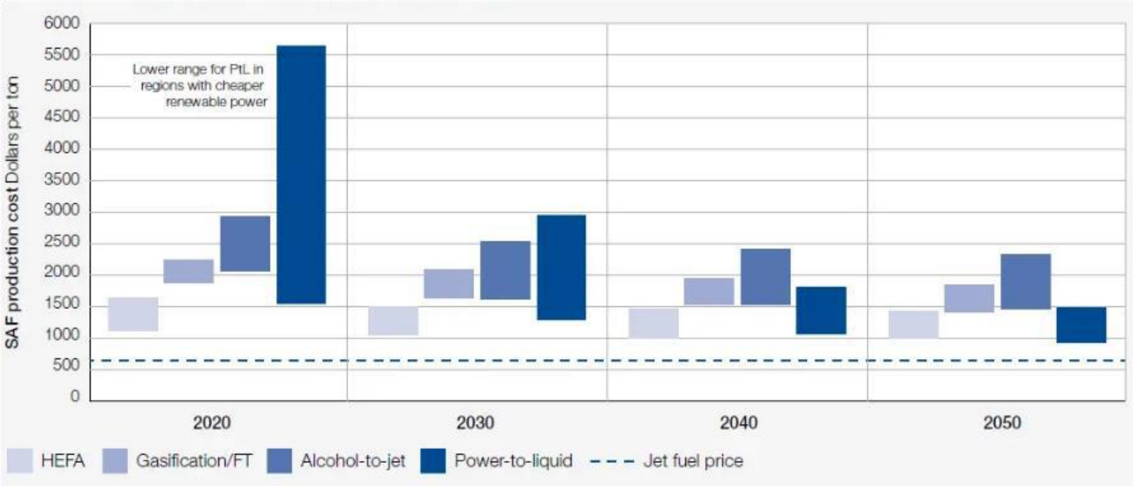

Figure 10 Production cost ranges of SAF compared to fossil-origin kerosene. Estimated evolution for different pathways [Clean Skies for Tomorrow].

Currently, the use of blends up to 50% is fully certified (ASTM) [41], and the percentages of available SAF in the coming years mean this is not a limitation in the medium term. Nevertheless, the aviation industry continues to make efforts to demonstrate that both in-service designs and especially new models of engines and aircraft under development are compatible with 100% sustainable fuels.

The SAF strategy has been developing for many years. Indeed, a study was published on fuels and the development of a competitive market in 2017[42].

5.3. Some projects in the United Kingdom.

The UK's first commercial-scale waste-to-jet fuel project stems from a collaboration between the renewable fuels business Velocys, British Airways, and Shell, who are developing the UK's first commercial-scale waste-to-renewable fuels conversion plant. The plant would convert hundreds of thousands of tonnes of waste per year into clean-burning, sustainable aviation fuel. In 2021, Shell withdrew from the project, but Velocys and British Airways continued with it.

It is expected that the aviation fuel produced will reduce greenhouse gas emissions by over 70% and reduce 90% of particles compared to conventional aviation fuel. In June 2018, nearly £5 million in funding was committed to building the first plant in the UK, which included over £0.4 million in government funding. Production at the plant is due to start in 2025[43] and should be the first of many in the UK. Moreover, it could attract private capital investment and create hundreds of skilled jobs in the long term and during construction[44].

[41] The certification of the quality of biofuels for aviation is coordinated by ASTM International, which has developed the ASTM D 7566 standard, thus establishing the quality parameters for aviation turbine fuels containing synthetic hydrocarbons.
[42] Future Fuels for Flight and Freight Competition feasibility study - GOV.UK (www.gov.uk)
[43] British Airways | BRITISH AIRWAYS FUELS ITS FUTURE WITH SECOND SUSTAINABLE AVIATION FUEL PARTNERSHIP
[44] Aviation 2050 (publishing.service.gov.uk)

Nova Pangaea Technologies (NPT) is another company in the UK gearing up to contribute to the national production of SAF, which would help the industry decarbonize. The commercial-scale production plant NOVAONE in Teesside will be one of the first facilities in the UK to produce fuel from waste. NPT's innovative technology converts agricultural residues and wood waste into second-generation bioethanol, which can then be processed into Sustainable Aviation Fuel[45].

LanzaTech has launched the first stage of the Dragon Project to create an Alcohol-to-Jet facility in Port Talbot. This facility would transform sustainably sourced ethanol into sustainable aviation fuel. Next, a separate facility will be developed, which will take the waste gases from one or more industrial processes and convert them into ethanol using LanzaTech's innovative gas fermentation technology. LanzaTech has patented this technology, which utilizes microorganisms (bacteria) to create ethanol that can be used to supply the Alcohol-to-Jet facility.

Sustainable ethanol will be used to supply the Alcohol-to-Jet facility until the gas fermentation facility is operational.

Once the Alcohol-to-Jet and gas fermentation facilities have been developed, LanzaTech will produce SAF from the waste gases from local industrial sites. Some industries, such as steelmaking, will always need to use some carbon, as it is embedded in the steel. LanzaTech can continue to capture and reuse this carbon, reducing the need for fossil fuels.

In the future, as industries progressively decarbonize, LanzaTech plans to use other sources of carbon in its processes, such as agricultural residues. Over time, it is anticipated that carbon will even be extracted directly from the air to manufacture aviation fuels, plastics, and chemicals in a perfectly circular carbon economy[46].

5.4. Some projects in Spain.

In **Spain**, in October 2011, the first initiative for energy diversification against traditional kerosene was carried out. The Ministries of Transport, Environment, and Industry agreed to collaborate with public institutions and the private sector to develop a project to produce aviation biofuels in collaboration with 13 airlines and energy companies. The project was carried out comprehensively in Spain with the collaboration of the Ministry of Environment and Rural and Marine Affairs (MARM), through the of Quality and Environmental Assessment General Directorate, the Ministry of Transport through the State Air Safety Agency (AESA), the Institute for Energy Diversification and Saving (IDAE) together with the organization Services and Studies for Air Navigation and Aeronautical Safety (SENASA).

The private companies collaborating in the Agreement signed a "Voluntary Agreement for the participation of entities associated with the Spanish initiative for the production and consumption of bio-kerosene in aviation”. These companies are: Airbus, Camelina Company España, Cepsa, Ciemat, Clh, Rsb (Epfl), Iberia, Residuos y Refinados Iberia S.L., Pullmantur Air, Repsol Comercial de Productos Petrolíferos S.A., Tecnología y Biomasa Sostenible S.L. (Tecbio), Tecnalia, and Uop LLC.

The purpose of the Agreement and the Voluntary Agreement was to promote the production of bio-kerosene for aviation use in Spain, from the production of sustainable raw materials to the commercial use of aircraft.

[45] iag-announces-investment-into-nova-pangaea-technologies.pdf (iairgroup.com)
[46] LanzaTech - Project Dragon (lanzadragon.wales)

The aim is to analyse and exploit the potential for wealth and job creation in this production and consumption chain, strengthening and positioning both the Spanish aviation sector and the industries involved in the entire production cycle. The implementation of this chain would help to meet the objectives of energy diversification in a country that is a net importer of oil.

The data from studies conducted so far indicate that there is potential in Spain for the cultivation of plants such as camelina, which is currently being grown in Spain in pilot trials. Its main characteristic is its adaptation to low-yield or unused soils, making it suitable for agricultural areas in Spain that are currently in decline.[47]

In August 2020, Repsol successfully completed the manufacturing of the first batch of aviation biofuel in the Spanish market. The production of this biojet took place at Repsol's Industrial Complex in Puertollano (Ciudad Real) and will continue with the production of more batches of aviation biofuel at other industrial complexes of the group in Spain, and subsequently with initiatives using biofuels from waste. The first batch, made from biomass, consists of 7,000 tonnes of aviation fuel —equivalent to the consumption of 100 Madrid-Los Angeles flights— and has passed the demanding tests required for these products. It has a bio content of less than 5% to meet the quality requirements established by international specifications, and its use will avoid the emission of 440 tonnes of CO2 into the atmosphere, equivalent to 40 Madrid-Barcelona flights.

The promotion of biofuels, along with renewable generation, synthetic fuels, green hydrogen, self-consumption, and the circular economy, is one of Repsol's working axes to achieve carbon neutrality by 2050.

In the case of this biojet, tests have been carried out to determine the most suitable raw material, aiming to meet the stringent requirements of Jet-A1 regarding low-temperature behaviour and additional quality controls. Likewise, numerous tests were conducted to determine the most suitable concentration of biofuel.[48]

In the case of Spain, the 2% target for 2025 equates to 200,000 tonnes of the current eight million tonnes of kerosene that fuels aviation, as estimated by Repsol. An amount that the company will be able to produce entirely at the plant under construction in the Cartagena refinery, which was opened at the end of 2023, with an investment of around 200 million euros.[49]

Once this plant is fully operational, the company will focus all SAF production there. This plant, which uses agricultural waste such as vegetable oils and animal fats, will be complemented by another one at the company's refinery in Bilbao, where from 2025 the synthetic variant will begin to be generated, through the capture of CO2 using green hydrogen.[50]

The Bilbao plant will not reach the production levels of Cartagena, but it will be necessary because the EU imposes (through ReFuelEU aviation) that a portion of the supply at the Union airports must be synthetic-origin SAF.

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47 Fomento, Medio Ambiente e Industria impulsarán los biocombustibles en aviación en colaboración con 13 empresas aéreas y de energía (miteco.gob.es)

48 https://www.repsol.com/es/sala-prensa/notas-prensa/2020/repsol-produce-por-primera-vez-en-espana-biocombustible-para-aviones/index.cshtml

49 Repsol ha comenzado la producción a gran escala de combustibles renovables en Cartagena, la primera planta de la Península Ibérica

50 https://elperiodicodelaenergia.com/petroleras-y-aerolineas-quieren-convertir-a-espana-en-lider-de-la-aviacion-sostenible/

Repsol has started supplying SAF to Atlas Air for the cargo flights that this company operates for Inditex from Zaragoza airport. Since early November, Atlas Air has been using 5% SAF on all its flights.[51]

On other side, Cepsa has started construction of a new facility, whose start-up is planned for 2026, in Palos de la Frontera (Huelva), next to La Rábida Energy Park. Its development involves a 1.2-billion-euro investment and the creation of 2,000 direct and indirect jobs during the construction and operation phases.[52]

This new plant will produce both renewable diesel and SAF. Meanwhile, 2G biofuels will be manufactured from organic waste, such as used cooking oils or agricultural waste, among others, promoting the circular economy.

The construction of this new plant responds to the company's objective of becoming a reference point for energy transition in this decade and leading biofuel manufacturing in Spain and Portugal, with an annual production of 2.5 million tonnes, of which 800,000 tonnes will be SAF.[53]

5.5. Needs of SAF production for Spain.

In 2022, the total production of SAF worldwide was 240,000 tonnes, according to the International Air Transport Association (IATA). By 2025, around 120,000 tonnes will be needed in Spain to cover the 2% obligation of RefuelEU Aviation. Therefore, with the production of the new Repsol plant in Cartagena, it will be possible to cover all SAF demand in the Iberian Peninsula, meeting the obligation until the European mandate increases to 3%.

<u>New Projects and Challenges Mentioned by stakeholders</u>

Repsol currently has SAF production capacity of 56,000 tonnes per year of HEFA and is commissioning a new unit to produce 100% renewable fuels from lipid residues, which can operate in HEFA or HVO production mode and will have a production capacity of approximately 200,000 tonnes per years of HEFA.

In the short term, some production units are being adapted to increase SAF production through co-processing in hydrotreatment units to reach approximately 90,000 tonnes per year. They expect to continue increasing co-processing capacity to a total of 187,000 tonnes per year by 2030 with the aim of achieving net-zero emissions by 2050, maintaining their facilities among the most advanced in the world and developing low-carbon initiatives that will be contingent on the evolution of the regulatory and fiscal framework.

bp has SAF production by co-processing at the Castellon Refinery and is expanding co-processing capacities. It has launched the HyVal project as an industrial cluster for the production of Green Hydrogen

[51] https://www.europapress.es/economia/energia-00341/noticia-repsol-apunta-saf-principal-palanca-aviacion-lograr-objetivo-cero-emisiones-2050-20231205125901.html
[52] https://www.cepsa.com/en/press/cepsa-and-bio-oils-build-the-largest-2g-biofuel-plant
[53] https://www.lainformacion.com/clima/cepsa-invertira-1000-millones-planta-biocombustibles-huelva/2882607/
https://www.cepsa.com/es/prensa/cepsa-y-bio-oils-construyen-la-mayor-planta-de-biocombustibles-2g

and SAF around the Castellon Refinery, with a total investment of 2 billion euros before 2030. It expects to have a new HEFA plant at its Castellon refinery with a SAF production capacity of 500,000 tonnes per year.

The challenges to increase SAF production are diverse, ranging from technological development, operating costs, and raw material availability to regulatory obstacles and market adoption.

Regulation regarding renewable fuels is complex and there is not yet a clear and stable regulatory framework, making investment decisions difficult. Likewise, the lack of assistance and incentives also fails to minimise the risks associated with investments, especially in the case of innovative technologies and first-of-a-kind plants. The lack of legislation in the UK was also mentioned.

Addressing these challenges will require collaborative efforts from industry stakeholders, policymakers, and investors to ensure successful integration of SAF into the aviation sector.

Engine manufacturers are partnering with companies providing SAF for testing purposes, as well as with new disruptors exploring new technologies for SAF production pathways.The 100% SAF-powered Virgin Atlantic's flight performed on November 28, 2023, became an outstanding example of this.[54]

6. INFRASTRUCTURE FOR SAF DISTRIBUTION IN SPAIN AND THE UK TO AIRPORTS.

Context: Publicly available information.

The number of airports where SAF can be refuelled continues to increase, along with political actions to promote it and pre-purchase agreements of SAF between airlines and suppliers, as shown in the figure. By the end of 2023, commitments for future delivery amounted to approximately 52 billion litres[55], of which half were signed during 2022.

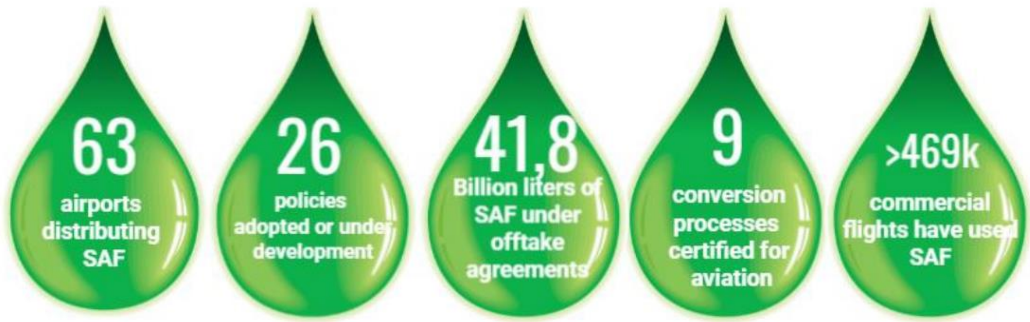

Figure 11 Data on Sustainable Aviation Fuel (SAF) deployment as of late 2022 [ICAO]

In the case of AENA's climate action plan extending until 2030 and in line with ReFuel EU requirements Spanish airports will have the capacity to cover 4.6% of fuel with SAF by 2030.

[54] Rolls-Royce Trent 1000 engines power Virgin Atlantic's world first 100% Sustainable Aviation Fuel flight from London Heathrow to New York JFK | Rolls-Royce
[55] https://coiae.es/wp-content/uploads/2023/12/Informe-Aeronautica-Sostenible-2022_Adenda.pdf
https://www.icao.int/environmental-protection/GFAAF/Pages/Offtake-Agreements.aspx

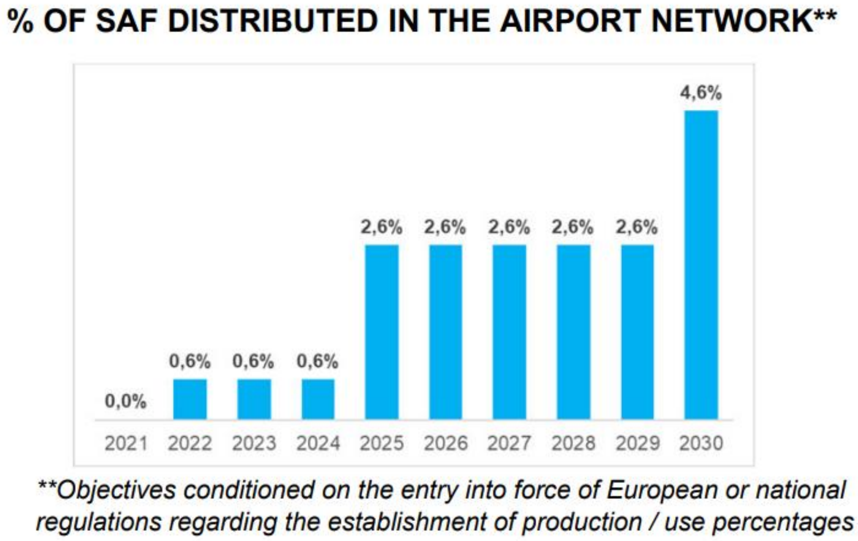

Figure 12 Percentage of SAF distributed in the AENA Airport network.

Similarly, it includes three points in its plan:

- It will promote participation in SAF production projects to encourage its use by airlines.
- It will facilitate SAF distribution at airports.
- Creation of an incentive system for airlines to prioritise sustainable fuel consumption.

For monitoring their progress, they will include the percentage of SAF usage on flights departing from their airports as a Key Performance Indicator (KPI).[56]

Exolum operates in the UK with a pipeline system spanning 2,000 kilometres and 24 storage facilities with a capacity of nearly 2.5 million cubic metres. They provide fuel storage and transportation services to various military installations and airports along the country, including Heathrow, Gatwick, Stansted, and Manchester. Exolum's infrastructure is equipped to receive, blend, and store SAF, and transport it via pipeline to the connected airports. On a broader scale (not just in the UK), Exolum aims to transport 400,000 tonnes of sustainable aviation fuel by 2030 and reach six million tonnes by 2050.

In Spain, Exolum has an extensive infrastructure that includes a pipeline network spanning over 4,000 kilometres, 39 storage facilities with a total capacity of nearly 8 million cubic metres, 37 airport facilities, and the management of 6 hydrant networks at major airports such as Madrid, Barcelona, Palma, Málaga, Alicante, and Tenerife Sur. The company also operates 13 port facilities connected to ports for the export and import of petroleum products.

How Different Stakeholders Have Had to Adapt Their Infrastructures

One of the great advantages of SAF is that it can be used as a direct replacement fuel in aircraft, and much of the logistical networks for production and distribution of the product can be reused with only minor adaptations, or so it seems. We do not have information on the plans designed for airports and subsidiary facilities, but modifications have been necessary in the logistics and storage of industrial centres to store

[56] AENA'S CLIMATE ACTION PLAN 2021-2030 Towards zero emissions

and feed the new feedstocks (wastes and vegetable oils) into existing plants, according to RepsolSOL. Likewise, new projects include this new working philosophy from the engineering stages, with different raw materials requiring different permits and pretreatments. Work is being done on existing infrastructure to provide greater flexibility to plant operations.

There is a plan for accompanying and adapting infrastructures for greater efficiency of production facilities. Likewise, there is a roadmap for various projects to meet long-term objectives. However, the final investment decision on future projects will depend on the existence of a favourable framework and the actual demand at the regulatory/commercial level. The aviation sector currently has long-term decarbonization objectives, but there is no clearly defined roadmap on how to achieve them, which conditions and delays the final decision-making on projects.

Regarding raw material procurement and product sales, the main difficulties lie in the different requirements of each client and/or country and the complexity of being present in different registers and certification systems.

Rolls-Royce leads the sector's activity towards the development of a 100% non-drop-in SAF specification (JetX). SAF without direct access would require a separate infrastructure (for direct fuel supply) to be implemented, which would require significant investment. Currently, this is subject to intense debate, and the industry needs to reach a convergence on how direct and non-direct SAFs are being considered and applied.

7. VERIFICATION AND MEASUREMENT SYSTEMS.

The complete lifecycle must ensure the CO2 neutrality of SAF use in the industry, and the risk of fraud or malpractice can affect the objectives or harm those who do things correctly.

7.1. Emission Compensation.

Aviation was introduced in 2008 in Directive 2003/87/EC as one of the activities of the European Union Emissions Trading Scheme. This regulation covered emissions produced by any flight originating or departing from states in the European Economic Area. Since then, this initial scope (also known as "full scope") has been modified several times by EU regulations. In general, the EU ETS covers emissions from intra-European flights, i.e., flights originating and departing from aerodromes located in states of the European Economic Area (EEA). The purpose of this reduction has been to facilitate negotiations within the ICAO to establish a global market instrument. This is the "Carbon Offsetting and Reduction Scheme for International Aviation" known as CORSIA, adopted by ICAO at its 39th Assembly held between September 27 and October 7, 2016.

In 2022, the scope of the EU ETS for aviation includes, in addition to intra-European emissions (produced by flights originating and departing from aerodromes located in states of the European Economic Area), emissions produced by the following flights:

- Flights originating from aerodromes located in states of the European Economic Area and destined for Switzerland, as a result of the Agreement between the European Union and the Swiss Confederation on linking their greenhouse gas emissions trading systems.

- Flights originating from aerodromes located in states of the European Economic Area and destined for the United Kingdom (except aerodromes located in Gibraltar).

Directive (EU) 2023/958 aims to contribute to the goal of reducing emissions by 55% by 2030 as envisaged in the European Green Deal and to adapt the scope of the EU ETS for aviation to CORSIA. A monitoring, reporting, and verification system regarding aviation's impacts on the climate other than CO2 emissions is established starting in 2025, and a future legislative proposal with mitigation measures is mentioned from 2028 onwards.

To achieve emissions reduction, the Directive establishes the gradual elimination of free allocation of emission allowances to aircraft operators (applying an annual linear reduction factor of 4.2% in 2023 and additional discounts of 25% in 2024 and 50% in 2025), thereby increasing the quantity of emission allowances to be auctioned. A reserve of 20 million free allowances is created, to be allocated during the period 2024-2030, to cover part or all the price difference between the use of fossil kerosene and the use of SAF, taking into account incentives based on carbon pricing and harmonised minimum levels of taxation on fossil fuels.[57]

However, there are no references to the operation of official control and verification systems for the origin of SAF and how to certify the entire supply chain, production, and distribution.

In summary, in air transport, there are three regulatory mechanisms: Refuel EU Aviation / ETS Aviation / CORSIA.

All three have obligations for aircraft operators (demand), and exceptionally, Refuel EU Aviation also includes obligations for fuel suppliers (supply). CORSIA and ETS aim to limit CO2 emissions, while ReFuel Aviation drives the production of renewable fuels. In the case of ETS, the focus on reducing CO2 emissions is through the use of SAF.

To avoid overlaps between CORSIA and EU ETS, the Commission has proposed in the ETS Directive that intra-European flights operated by European airlines be exempt from CORSIA requirements, although this is still subject to ICAO ratification. As a result, international flights will generally have to comply with CORSIA, and flights within the EU with ETS and ReFuel Aviation.

The requirements for renewable fuels in CORSIA and ReFuel Aviation/ETS are different; in general, European regulations are much more demanding in terms of minimum greenhouse gas emissions reductions (6 times more, 65% compared to CORSIA's 10% reduction in GHGs).

In July 2023, the European Commission presented a package of three proposals for greening freight transport. Among them is a proposal for a unified methodology to calculate greenhouse gas (GHG) emissions from transport services, known as CountEmissionsEU. The initiative covers both freight and passenger transport. Its goal is to ensure that GHG emissions data provided in relation to transport services are reliable and accurate, allowing for fair comparisons between transport services. It establishes a methodological framework but does not regulate where it should be used. The committees adopted their joint report on 4 March 2024. The Parliament is expected to vote on its position in the first reading during an upcoming plenary session.[58]

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[57] https://www.miteco.gob.es/content/dam/miteco/es/cambio-climatico/temas/comercio-de-derechos-de-emision/Balance%20Sectorial%20Aviaci%C3%B3n%202022.pdf

[58] Count Emissions EU: Medición de las emisiones de los servicios de transporte | Think Tank | Parlamento Europeo (europa.eu)

In March 2023, the International Organization for Standardization (ISO) issued a standard for calculating emissions from transport services. Since then, the European Committee for Standardization (CEN) has transposed it as the equivalent European standard ENISO14083:2023. ISO14083 provides a common methodology for quantifying and reporting GHG emissions from passenger and freight transport chains, while setting requirements and guidelines for the quantification, allocation, and reporting of such GHG emissions. The standard covers all modes of land, water, and air transport, as well as operational emissions from transport hubs, and is applicable across the entire transport chain.

The ISO14083 standard is based on and consistent with the GLEC framework. The Global Logistics Emissions Centre (GLEC), led by the Smart Freight Centre (SFC), established in 2014, is a collaborative effort of over 150 companies, associations, and expert-supported programmes. GLEC has developed a universal methodology for calculating emissions in logistics across various modes of transport.

For the aviation industry, the International Civil Aviation Organization (ICAO) provides environmental tools, available to States and the public, to reduce aviation's carbon footprint, such as a CO2 emissions calculator for passengers and cargo. In 2014, the IATA Cargo Services Conference adopted Recommended Practice 1678 (RP1678), which established a methodology for measuring CO2 emissions. RP1678 is recognised by GLEC as the reference methodology for air cargo. Additionally, IATA has introduced another related recommended practice for calculating CO2 emissions per passenger.[59]

7.2. Certification Systems in Use.

International Organization for Standardization (ISO) 22095:2020 Chain of Custody[60]

This standard defines a framework for chain of custody by providing:

- A consistent generic approach for the design, implementation, and management of chains of custody.
- Harmonised terminology.
- General requirements for different chain of custody models.
- General guidance on the application of defined chain of custody models, including initial guidance on the circumstances in which each chain of custody model might be appropriate.

This standard is applicable to all materials and products. It does not apply to services as final products.

This standard can be used by any organisation operating at any step of a supply chain, as well as by organisations setting standards as a benchmark for specific chain of custody standards.

This standard can enhance the transparency of specific claims about materials or products and thus support the reliability of these claims. It is not intended to be used alone to make or verify such claims.

This standard, by itself, cannot support claims about an organisation's materials or products. This is misleading, especially for consumers and other end customers, as the existence of a chain of custody system alone does not specify the characteristics or conditions under which materials or products are produced. This standard includes requirements and guidance on this subject.

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59 CountEmissionsEU (europa.eu)
60 https://www.iso.org/es/contents/data/standard/07/25/72532.html

The Roundtable on Sustainable Biomaterials (RSB) Book & Claim System[61]

It is a certification system based on its own standard by which sustainable fuels can also guarantee that their production does not negatively affect ecosystems or food security.

The RSB Book & Claim System is a reservation and claiming mechanism that includes the RSB Book & Claim Manual (normative procedure), the RSB Registry (digital data storage system), and the RSB Book & Claim Recognition Framework (normative procedure for a registry ecosystem).

As materials and products progress along the supply chain, their attributes (including sustainability benefits) are tracked, documented, and verified through the "chain of custody."

"Book and claim" is a chain of custody model, "where the flow of administrative records is not necessarily connected with the physical flow of material or product along the supply chain" (Source: ISO 22095:2020). It allows the customer to dissociate specific product attributes (such as sustainability benefits) from the physical product and transfer them separately through a dedicated record. This approach, which has been successfully implemented in the renewable electricity sector, is particularly valuable for sectors such as aviation and maritime transportation, which require versatile chain of custody models to link supply with the growing global demand.

Book and claim do not require the buyer and seller to be connected with a physical supply chain, as is the case with other chain of custody models such as mass balance. Although technically a customer cannot fly or ship their goods with sustainable fuels, their purchase demonstrates market demand and supports the development of supply globally. In turn, they can claim sustainability benefits, such as greenhouse gas emission reduction, in relation to their voluntary goals.

RepsolPSOL has received certification from the Roundtable on Sustainable Biomaterials (RSB), granting it access to sell its sustainable aviation fuel (SAF) within the RSB Book & Claim System.

The certification allows Repsol to deliver sustainable aviation fuel (SAF) to specific airports and enrol it in the RSB Registry, thereby enabling customers at other airports worldwide to claim carbon reductions from the registered SAF when purchasing traditional aviation fuel.

Part of what makes SAF sustainable is ensuring sustainability in its supply chain. Transporting SAF to specific airports or flights is not always feasible and could result in higher greenhouse gas emissions.

The Book and Claim system offer a solution for these situations. This is a common practice where a sustainability statement made by a company is separated from the physical flow of these goods.

Through this system, the carbon reductions associated with SAF will be recorded as a "book and claim unit" and transferred to any willing buyer worldwide. Currently, Book and Claim only addresses voluntary markets, thereby contributing to carbon emission reductions that supplement mandates and regulations[62].

Comments from major companies regarding control and certification systems:

Initially, all renewable fuels that meet the requirements of RED II are counted as zero emissions in the EU ETS. In the case of ReFuel EU Aviation, not all renewable fuels that comply with the RED II regulations are eligible, as there are additional limitations based on the feedstock.

[61] https://rsb.org/programmes/book-and-claim/
[62] https://generandi.com/es/repsol-obtiene-nueva-certificacion-para-comercializar-saf/

Currently, the sustainability of SAF can be certified under various certification schemes:

- A voluntary scheme recognised by the European Commission for compliance with RED II, such as ISCC EU. This scheme is also useful for compliance with ReFuel EU Aviation and EU ETS.
- Schemes that serve to verify compliance with ICAO CORSIA regulations: ISCC CORSIA or similar schemes.
- Other schemes for voluntary markets such as ISCC PLUS or RSB Book and Claim.

These sustainability certification schemes are based on ensuring traceability and chain of custody of SAF, ensuring criteria for emissions reduction and feedstock origin as defined in current regulations, and being audited annually by external certification entities. There is a risk of creating overly complex and rigid control structures that may hinder operations' efficiency, affecting competitiveness and deterring investment opportunities.

It is also essential to have a comprehensive understanding of logistics and flexibility to avoid unnecessary emissions and optimise the national logistic system.

8. MANDATES AND INCENTIVES.

There are two main approaches to promoting the introduction of SAF in commercial aviation, including the development of production capacity, which generally apply in contrasting ways on both sides of the Atlantic. While Europe opts for mandatory mandates for use by airlines (RefuelEU), aiming to create demand that generates supply, in the U.S., the strategy consists of economically incentivising the involved companies.

When viewed on the Figure 13 SAF mandates around the world map), the most involved areas and their approaches can be observed.

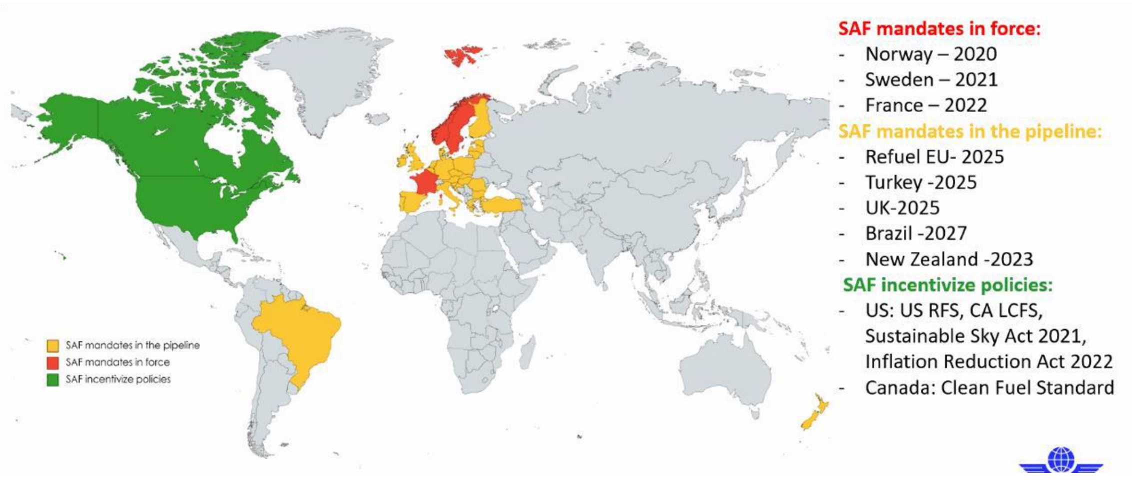

Figure 13 SAF mandates around the world

In Europe, in addition to the forthcoming EU regulations, by mid-2022, France and Sweden already had mandates of 1% in their commercial flights, with 0.5% in Norway. Although this strategy is generally assumed to be effective, it is crucial to control and analyse the origin of the raw materials used to generate biofuels, thus avoiding collateral environmental damage.

Meanwhile, in the U.S., a roadmap was launched to meet the objectives of the US SAF Grand Challenge, which aims to produce around 11 billion litres by 2030, multiplying this figure by a factor of 10 for 2050. Other countries have also set targets for the introduction of SAF, such as Japan, which aims to reach 10% by 2030.[63]

The UK mandate for SAF requires that at least **10% of aviation fuel be produced from sustainable sources by 2030**. This represents **1.2 million tonnes of fuel (1.5 billion litres)**. Since the total global SAF production in 2022 was estimated to be at most **450 million litres**, more than tripling the global supply would be necessary to meet the UK mandate.

The design of the **UK** policy employs a system of **tradable certificates**. Fuel providers must acquire enough SAF certificates from producers to meet the blending target. These tradeable certificates represent an amount of SAF measured in energy content. Certificate calculations consider a carbon intensity factor. Fuels that reduce emissions by more than 70% compared to a baseline of 89 gCO2/MJ (representing fossil fuels) receive additional certificates. The policy sets an emissions reduction threshold of 50% for eligible fuels, which is considerably stricter than CORSIA's 10% threshold (DfT, 2023). Additionally, the policy excludes food and feed crops as feedstock sources and proposes a cap for HEFA in aviation to protect existing HEFA uses in the road sector from potential supply bottlenecks and price increases. [64] [65]

The policy proposal includes a buyback mechanism to relieve blending obligations and prevent price wars in case of supply shortages. The proposed buyback price is £2 per litre for bioenergy SAF and £2.75 per litre for PtL SAF. These prices reflect pessimistic expectations of production costs for the most expensive production pathway in the respective fuel families (bioenergy and PtL), minus the expected cost of fossil fuel[66]. Once adopted, this policy will be standalone and promote SAF adoption with more targeted support than that offered by the current Renewable Transport Fuel Obligation (RTFO), which currently includes aviation fuel.

In a recent interview with Jonathon Counsell, Sustainability Director of the IAG Group, he was asked about how to address the limited supply of SAF, to which he responded:

"We need governments to play their part. At the EU level, a mandate has been agreed upon. Mandates only serve to increase demand, and what we urgently need are incentives for SAF to drive production at the scale and pace we need. We welcome the provision of 20 million SAF allocations to help airlines close the cost gap between SAF and fossil fuels, but we need more allocations to help meet the 6% SAF mandate target for 2030.

In the UK, we need the mandate to be legislated. We welcome the commitment to consult on an income certainty plan, but we need it to be implemented as soon as possible. In the UK, the Government has set the goal of having five SAF plants under construction by 2025. At this rate, it seems there will be none."[66]

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[63] https://coiae.es/wp-content/uploads/2023/12/Informe-Aeronautica-Sostenible-2022_Adenda.pdf
O. Castro Álvarez y E. Martín Santana. La sostenibilidad medioambiental en el sector aeronáutico. COIAE, 2022
https://www.europarl.europa.eu/thinktank/en/document/EPRS_BRI(2022)698900
https://www.transportenvironment.org/discover/the-good-bad-and-the-ugly-of-saf-mandates/
https://www.greenairnews.com/?p=2908
Gobierno de EEUU. SAF Grand Challenge Roadmap. Flight Plan for Sustainable Aviation Fuel. Septiembre de 2022.
[64] https://www.gov.uk/government/consultations/mandating-the-use-of-sustainable-aviation-fuels-in-the-uk
[65] https://questions-statements.parliament.uk/written-statements/detail/2023-09-04/hlws986
[66] https://www.gov.uk/government/consultations/mandating-the-use-of-sustainable-aviation-fuels-in-the-uk

Comments from major companies regarding each country's policies:[67]

Airlines are open to combining mandates to facilitate basic development of the SAF market, especially to facilitate the development of certain pathways through "sub-mandates" (such as the Power-to-Liquid (PtL) mandate in the EU). This ensures that once SAF production and usage advance massively, it receives more effective support through market-based incentives like the EU-ETS or EU-ETS SAF.

However, combined mandates should only guarantee reference volumes, and additional incentives should support airlines willing to use SAF beyond mandatory levels, partially offsetting the price increase. Combining mandates can be particularly significant in driving the development of certain SAF pathways (such as Power-to-Liquid (PtL)).

There is concern about the custody chain of SAF, partly due to regulatory incentives and mandates, as greenhouse gas savings accounting by airlines or even airline customers is generally not considered. Therefore, a robust registry is necessary to ensure transparency and reliability in the accounting of SAF's environmental benefits throughout the value chain. The EU database could be updated to meet this demand, or alternatively, the EU and/or European member states could recognise privately operated registries (such as ISCC or RSB) and use them to prove SAF usage and claim incentives.

Currently, there is a lack of approved incentives for airlines using SAF, indirectly obligating them to purchase it since it will be included in the supply chain from 2025 onwards. There is no clarity in the allowance allocation system for SAF use. There should be unified Allowances allocation and the same SAF usage criteria and obligations in all countries, with standardised criteria and obligations.

The impact on price remains the most relevant aspect and where measures should be taken by administrations. In the current situation, at the beginning of market development, costs are high, and uncertainty is also high. Therefore, access to financing is required, incentives to produce, and incentives for airlines to consume at national airports. Many incentive systems are already in operation (such as the US IRA tax credits model, Heathrow incentive, Schiphol...). Certainty in benefit generation is needed now, not in 2026, for investment to take place.

Governments should support and encourage collaboration between industries (e.g., fuel producers, airlines, aerospace manufacturers, airports, and finance) to increase SAF production. This will require governments to create incentives for capital reallocation and SAF production and usage worldwide.

SAF can be produced through a variety of feedstocks and processes, all of which will be necessary for the maturity and development of the SAF industry using increasingly sustainable sources, e.g., PtL fuels. This process must be sustainable, and governments should prioritise pathways with minimal environmental impact.

To ensure that SAF production has minimal environmental impact, we encourage governments to incentivise the production of PtL fuels, which, besides not requiring organic material-based fuels, are a better way to convert variable energy (wind and solar) into stored energy.

[67] Fly Net Zero Media Update January-February 2024
https://go.updates.iata.org/webmail/123902/1637712177/39ddf2795cb5e91be68cf06669126df3142f2a0381fc24b73dd4687e4f164cba

9. FINANCING FOR R&D AND TECHNOLOGICAL DEVELOPMENT.

The entire SAF market is under development, and there are many production and supply pathways that need to be supported by institutions. In the **UK**, actions have been taken towards this goal; the government has allocated £180 million in funding to promote the development of the SAF industry in the country and unlock private financing to develop its own SAF plants, aiming to have at least five SAF plants under construction by 2025 and to cover at least 10% of fuel needs with SAF by 2030 (about 1.5 billion litres of SAF).

In September 2023, to support different countries "at the start of their journey towards sustainable aviation fuels (SAF)," the UK announced it would contribute CAD 750,000 to the ICAO Environment Fund to conduct SAF feasibility studies.[68]

On 14 November 2023, the UK government announced that the Aerospace Technology Institute's (ATI) Small and Medium Enterprises (SME) Programme would offer UK companies the opportunity to bid for a portion of £10 million in total funding per year for their innovative research projects. The new programme opened for applications in February 2024 and aims to provide SMEs with the best possible opportunities to apply for funds and develop innovative technologies that support the Government's Jet Zero commitment. The programme will allow UK aerospace SMEs to bid for grants of up to £1.5 million each, which will help drive highly skilled jobs in the industry across the UK. Furthermore, this programme builds on the Government's commitment to support UK aerospace R&D, as demonstrated by the ATI Programme, for which the government provided £685 million in 2022. The ATI Programme is a joint investment between the government and industry. Its purpose is to offer competitive funding for research and technological development in the UK, with the aim of maintaining and strengthening the UK's competitive position in the civil aerospace industry and accelerating the transition to net-zero aviation.

On 17 November 2023, the UK government announced that nine projects would receive £53 million from the second round of the Advanced Fuels Fund to help scale up SAF production in the UK. The winning projects in this round include a demonstration plant converting sawmill and forestry waste, and a commercial plant using power-to-liquid (PtL) technology to convert CO_2 and green hydrogen into aviation fuel. Together, these two projects could produce over 70,000 tonnes of SAF per year. As a result, the UK could soon have the capacity to produce up to 810,000 tonnes of SAF.

Additionally, a SAF Compensation Centre has been launched at the University of Sheffield, a SAF research and development facility, the first of its kind in the UK, where new fuels can be developed, tested, and certified in one place. These are transformative steps for the sector, helping to create jobs and foster economic growth. With £700,000 in government funding and an additional £5.35 million allocated to support the costs associated with fuel testing, this central body will coordinate testing and approval of new SAFs, removing barriers to foreign investment and supporting the growth of SAF expertise in the UK. The goal is not only to make the UK an attractive place to invest but also to deliver SAF to internationally recognised safety and technical standards, helping to meet crucial SAF mandate objectives.

Given the cost of fuel, real-world testing has also been funded. The first 100% SAF flight took place on 28 November 2023 between London and New York. This was made possible by £1 million in funding from the UK government to the Flight100 project, led by Virgin Atlantic and partly funded by the Department for Transport. This project involves a consortium including Imperial College London, the University of Sheffield, Boeing, Rolls-Royce, bp, and others, to demonstrate SAF as an alternative to regular aviation fuel. Researchers from Imperial and Sheffield conducted the scientific work to assess the climate impacts of

[68] https://www.gov.uk/government/consultations/mandating-the-use-of-sustainable-aviation-fuels-in-the-uk

Flight100. They measured the amount of particles emitted by a scaled-down aircraft engine to confirm that SAF reduces CO_2 emissions by up to 70% compared to conventional aviation fuel. This achievement not only represents a significant step towards decarbonising aviation but also a successful collaboration between academia, industry, and government to drive SAF adoption and advance towards a more sustainable aviation sector.[69]

On 24 July 2023, International Airlines Group (IAG), the parent company of Aer Lingus, British Airways, Iberia, Vueling, and LEVEL, announced an investment in Nova Pangaea Technologies (NPT). This investment will support the development of the commercial-scale NOVAONE production plant in Teesside, which is expected to commence biofuel production in 2025, creating significant employment opportunities in the North East of the UK.[70]

IAG also plans to use NPT's technology to support the decarbonisation of its other group airlines. This project forms part of IAG's SAF investment programme, which, by the end of 2022, amounted to USD 865 million in future SAF purchases and investments (based on assumed energy prices), with agreements for 250,000 tonnes of SAF, representing 25% of its one-million-tonne target for 2030. IAG aims to secure additional SAF supply in the UK before the introduction of the UK government's SAF mandate, which is expected to commence in 2025. IAG was the first European airline group to commit to using 10% SAF by 2030 and intends to achieve carbon neutrality by 2050.[71]

On 28 February 2024, IAG announced the largest SAF purchase agreement to date, for 785,000 tonnes of e-SAF.[72]

Luis Gallego, CEO of IAG, stated: "Sustainable Aviation Fuel is the only realistic option for long-haul airlines to decarbonise, so investment in this area is critical. We are not only purchasing to invest in the industry's development, but we also need the UK and European governments to act now to encourage further investment."[73]

LanzaTech has secured £25 million in funding from the Department for Transport's Advanced Fuels Fund for its Dragon project, which will be located in Port Talbot, Wales. The proposed plant will generate over 150 jobs and significantly contribute to the UK's net-zero emissions goal, with Port Talbot playing a leading role in creating new carbon reduction industries. The engineering designs for the facility were based on technical requirements in coordination with local administrations, including Neath Port Talbot Council, Natural Resources Wales, the Welsh Government, and Associated British Ports (ABP). LanzaTech submitted its planning application to Neath Port Talbot Council in November 2023.[74]

In **Spain**, actions are associated with the "**European Green Deal**," which emerged as a response to the COVID-19 pandemic but directs a third of the €1.8 trillion investments from the NextGenerationEU recovery plan and the EU's seven-year budget to finance the European Green Deal.

[69] https://www.sheffield.ac.uk/news/world-first-transatlantic-flight-using-sustainable-aviation-fuel-takes
[70] iag-announces-investment-into-nova-pangaea-technologies.pdf (iairgroup.com)
[71] iag-announces-investment-into-nova-pangaea-technologies.pdf (iairgroup.com)
[72] IAG-eSAF
[73] https://www.iairgroup.com/press-releases/2023/iag-announces-investment-into-nova-pangaea-technologies-to-drive-uk-sourced-saf/
[74] LanzaTech - Project Dragon (lanzadragon.wales)

The European Commission has adopted a set of proposals to adapt EU policies on climate, energy, transport, and taxation to the goal of reducing net greenhouse gas emissions by at least 55% by 2030, compared to 1990 levels.[75]

Comments from major companies

For SAF producers, the goals target all technologies that can coexist to meet SAF needs, although currently, the development of lipid waste hydrotreatment (HEFA) capabilities and the expansion of potential feedstocks are receiving the most push. Demonstration projects have already been carried out in collaboration with clients (airlines), on commercial flights, with blends of HEFA and conventional kerosene. It is a product in a very advanced state of maturity.

Research lines are focused on the entire value chain of this production route, including:

- Identifying, evaluating, and validating new lipid wastes.
- Developing pre-treatment technologies and contaminant removal from these wastes to enable hydrotreatment.
- Developing new catalysts that maximise waste conversion and selectivity to kerosene.
- Retrofitting existing industrial units for adaptation to this process.
- Developing simulation models and process optimisation.
- Evaluating and developing additives to improve SAF properties.

In each case, and for each sustainable aviation fuel, the challenges in implementing production processes will be very different, and the same path that HEFA follows will need to be followed by others. The main limitation of other SAF production technologies concerns the technical complexity of the processes and the lack of technological maturity.

SAF production routes using other technologies different from lipid hydrotreatment (gasification + Fischer-Tropsch, Alcohol to Jet, synthetic SAF production, etc.) require more complex process schemes (e.g., more process stages), which entail higher investment and operational costs. Additionally, these processes need to complete their technological development and demonstration at an industrial scale, minimising the technological risks associated with adopting these new technologies.

Administrations in both countries can play a crucial role both in developing supply chains (with initiatives promoting the selective collection of lipid wastes, such as cooking oils and animal fats) and in adopting a favourable legislative framework that includes a broader range of new lipid wastes for SAF production, both in terms of waste types and the maximum limits to which certain types of waste are currently subjected.

For SAF production using less mature technologies, which involve higher investment and operational costs, it is recommended to establish a system of subsidies or incentives that make profitability viable and minimise the risks associated with investments, particularly in the first demonstration and industrial plants (First of a Kind). This could be key for investors to commit to these technologies, which will be necessary in the medium

[75] El Pacto Verde Europeo - Comisión Europea (europa.eu)

and long term, once the hydrotreatment route reaches its maximum implementation and is constrained by raw material availability.

In particular, there is interest in new pathways to achieve immediate 100% SAF solutions, including those based on sustainable aromatic fractions, as they would not require a separate SAF infrastructure like non-direct SAF types.

In this regard, it is essential to mature and bring to market key enabling technologies for Power-to-Liquid (PtL) solutions, such as carbon capture and electrolyser technologies.

An important and fundamental phase for the industry involves engine manufacturers, who will need to use the new SAF fuels to see how they affect their designs and determine if new adaptations are needed. Flight tests have been conducted, and both Rolls-Royce and ITP Aero are working with producers and their innovation programmes. Additionally, Rolls-Royce is a key collaborator in the ASTM SAF approval processes.

Rolls-Royce has conducted an industry-leading ground and flight engine testing campaign confirming the use of SAF in its engines. They collaborate with UK partner universities and with Air bp at its Castellón refinery, a leader in introducing coprocessing technology for SAF. They have also had discussions with Repsol regarding their PtL technology, although there are no joint projects at this stage. It is one of the few cases of collaborations between the two countries.

ITP Aero began in 2023 to consistently use coprocessed SAF at its engine test facilities in Albacete, where they have a development strand for combustion system technology that includes numerical modelling of injection and combustion processes to develop design tools and criteria. These methods and tools cover the use of different types of fuel. Simultaneously, test facilities and validation strategies are being developed that cover different levels of technological maturity.

At times, there is a certain delay in the legislative development of the SAF production and consumption framework, as well as a degree of complexity in the regulations. There can also be some disparity in criteria across geographic areas or substantial differences in support policies. This is particularly relevant when qualifying SAF (valid feedstocks, certification of carbon reduction levels, etc.). Achieving the greatest possible international homogeneity is desirable.

In all this research and engine testing environment, the availability of SAF in sufficient quantities and economically viable terms is one of the greatest challenges.

10. AWARENESS OF THE AGREEMENT BETWEEN THE UNITED KINGDOM AND SPAIN AND OTHER AGREEMENTS AND FUNDING SOURCES.

In July 2023, the United Kingdom and Spain signed a Memorandum of Understanding (MoU) on Sustainable Aviation Fuel (SAF) and related matters to promote and support the transition to SAF in both countries.

<u>Similar Agreements Signed by the United Kingdom:</u>

A comparable agreement was signed between the United Kingdom and France. On 15 December 2023, an event was held at the French Embassy in London with 60 stakeholders on SAF. Attendees and industry presenters included airlines, Rolls-Royce, Airbus, the UK SAF Compensation Centre, experts in alternative fuels, and investors.[76]

Similar Agreements Signed by Spain:

Bilateral Agreement: Spain – Italy: On 24 June 2011, Spanish and Italian national authorities, the Spanish Aviation Safety Agency (AESA) and the Italian Civil Aviation Authority (ENAC), along with the Spanish Air Navigation and Aeronautical Safety Services Agency (SENASA), signed a memorandum of understanding to develop joint initiatives supporting the use and sustainable production of new aviation fuels.

Bilateral Agreement: Spain – United States (US): On 11 February 2013, Spain and the United States signed a cooperation agreement on the development of aviation biofuels. This agreement, signed by the Spanish Aviation Safety Agency (AESA) and the US Federal Aviation Administration (FAA), strengthens the programmes undertaken by both countries with industries and institutions to develop alternative fuels to Jet-A1 kerosene.[77]

Bilateral Agreement: Spain – France: A declaration of intent regarding cooperation and promotion of sustainable aviation fuels was signed in March 2021 between the Spanish Ministry of Transport, Mobility and Urban Agenda and the Ministry for the Ecological Transition and Demographic Challenge of Spain, and the Ministry of Ecological Transition of France. Various companies from both French and Spanish sectors also signed the declaration.

Bilateral Agreement: Spain – ICAO: On 28 September 2022, Spain joined the ACT-SAF programme.

Awareness of the Agreement and Comments on Future Development:

Among consultations with some of the most representative companies in the sector in both countries, we found that half of them were not aware of the agreement. With future agreements, it would be worth proactively contacting key stakeholders with an interest in the bilateral relationship on SAF to ensure they are aware and encouraged to engage.

To achieve a coordinated approach, there is a call for greater awareness of each country's activities and key initiatives to foster closer engagement and develop collaboration opportunities. There is a need for a tailored financing framework that recognises efforts made by the other nation. This would facilitate the recognition of centres of excellence in each country.

Current interactions are driven by the international nature of the companies, with operations and facilities in both countries. Given the global market, there is an emphasis on the importance of international agreements that establish common criteria and standards. There is a demand for shared experiences and advancements.

Comments gathered express some concern about the final development of the UK/EU agreement and the continuity of long-term projects such as Clean Aviation, which require stability assurances. There are barriers or restrictions on the participation of foreign companies in projects like those promoted by the

[76] https://www.gov.uk/government/news/new-measures-to-support-sustainable-aviation-fuel-industry
[77] https://www.seguridadaerea.gob.es/es/ambitos/comercio-de-emisiones/sostenibilidad-del-sector-aereo.-medidas-de-mitigacion-frente-al-cambio-climatico-y-preservacion-de-la-calidad-del-aire-local/combustibles-sostenibles-de-aviacion

Aerospace Technology Institute (ATI) that need to be removed. The Brexit experience posed additional challenges in international operations, including those related to research, but participation in the European Horizon programme can help to maintain collaboration.

Collaboration has happened between Rolls-Royce and the bp Castellón refinery, and there have been numerous consultations with Repsol regarding PtL technology.

11. CONCLUSIONS AND RECOMMENDATIONS.

This report presents information on key aspects, tools, policies, and investments related to the development and promotion of SAFs in the UK and Spain, as well as the reactions of sector companies to these aspects, based on interviews with some of these stakeholders. The report does not aim to reflect the views of all these agents but rather to highlight the most relevant aspects and reactions received through the study.

Based on this analysis, we can conclude that the MoU could support this development and production in both countries. To facilitate collaboration, it is important to:

1. Maintain Close Collaboration Between Governments and the Market:

    - Improve understanding of the contents of the MoU signed between Spain and the United Kingdom. More proactive and frequent actions are needed to unite efforts and understand each of the main stakeholders. Establish a joint work plan and specialised working groups (fuel producers, airlines, aerospace manufacturers, airport operators, finance and universities).

    - Encourage business alliances that contribute their expertise in each part of the SAF lifecycle.

2. Provide greater legal certainty: Legislation is still in development, which creates uncertainty:

    - There is significant concern among companies about the legal void that remains to be filled, the uncertainty it generates, and which all investment decisions depend on. This includes decisions on which feedstocks to use or which country to invest in, as well as the development of research and innovation plans.

    - Similarly, differences in legislation between countries may favour access to certain feedstocks that are prohibited elsewhere, resulting in a competitive advantage in international competition and a misfocus on the environmental issue in some areas.

    - Reduce the complexity of current legislation.

    - Seek as much consistency as possible between international legislation.

3. Support for Investment:

    - Although the United Kingdom has already launched a powerful aid package, due to legislative uncertainty, investment aid is being requested to minimise risk.

4. Promotion of PtL SAF:

    - The great hope for meeting the future demand for 100% SAF lies in PtL technology, and its slow development is causing concern. Incentives are needed at all stages of its development, from research.

5. Certification Systems and Combatting Fraud:

- The credibility of the entire industry relies on the credibility of this system, which must be highly active and robustly combat fraud.
- Common criteria are needed within the industry and between countries, supported by the integrative collaboration of IATA, ICAO, and governments. Joint actions by countries, such as Spain and the United Kingdom, that promote common frameworks are essential.