IN-DEPTH

Global Feedstock Assessment for SAF Production

Outlook to 2050

September 2025

In this global assessment of feedstock availability and SAF production potential, around 400 Mt of SAF is forecast to be possible to produce in 2050. Although this would be a major achievement, it is 100 Mt of SAF short of what will be needed in 2050. Sustainable biomass feedstocks are largely available, though access can be limited, underlining the need for e-SAF. Still, the major barrier to reaching the 500 Mt needed in 2050 is the pace of technology rollout.

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List of acronyms

- **ASEAN**: Association of South-East Asian Nations
- **BECCS**: Bioenergy with carbon capture and storage
- **CAGR**: Compound annual growth rate
- **CAPEX**: Capital expenditure
- **CO_2**: Carbon dioxide
- **CORSIA**: Carbon Offsetting and Reduction Scheme for International Aviation
- **DAC**: Direct air capture
- **EtJ**: Ethanol-to-Jet
- **EUDR**: EU Deforestation-Free Regulation
- **FOAK**: First-of-a-kind
- **FT**: Fischer-Tropsch
- **HEFA**: Hydroprocessed Esters and Fatty Acids
- **IATA**: International Air Transport Association
- **ICAO**: International Civil Aviation Organization
- **IRA**: Inflation Reduction Act
- **LCFS**: California Low Carbon Fuel Standard
- **LTAG**: Long-term aspirational goal
- **MENA**: Middle East and North Africa
- **Mha**: Million hectares
- **MSW**: Municipal solid waste
- **Mt**: Million tonnes
- **MtJ**: Methanol-to-Jet
- **OBBBA**: One Big Beautiful Bill Act
- **OEM**: Original equipment manufacturer
- **OPEX**: Operational expenditure
- **POME**: Palm oil mill effluent
- **PPPs**: Public-private partnerships
- **PtL**: Power-to-Liquid
- **R&D**: Research and development
- **RFS**: Renewable Fuel Standard
- **RINs**: Renewable Identification Numbers
- **RWGS**: Reverse water gas shift
- **SAF**: Sustainable aviation fuel
- **TRL**: Technology readiness level
- **UCO**: Used cooking oil
- **WtE**: Waste-to-Energy

Executive summary

The air transport industry will require approximately 500 million tonnes (Mt) of sustainable aviation fuel (SAF) in 2050 to achieve net zero CO_2 emissions. In 2025, global SAF production is estimated at just 2 Mt. Having conducted assessments on global feedstock availability, technology readiness, and regional suitability, the core forecast of this study estimates that global SAF production could potentially reach 400 Mt by 2050. Reaching this level is a daunting task and would represent a major scale-up in SAF capacity. However, it also reveals a significant shortfall of around 100 Mt. Bridging this gap is possible but would require both securing greater access to sustainable biomass feedstocks and an urgent and accelerated scaling up of novel SAF technologies.

Although the global biomass feedstock potential is estimated to reach over 12,000 Mt by 2050 due to population growth and increased access to wastes, less than 35% of that amount is realistically available for bioenergy and biofuels because of competing uses. After accounting for such uses in other sectors, around 1,580 Mt may be available for SAF production, enough to support just over 300 Mt of bio-SAF in 2050. Unlocking the full biomass feedstock potential will require prioritized access for sectors that have few alternative solutions for their decarbonization, such as air transport, and the scaling up of additional sustainable feedstocks, including energy crops and cover crops, which have been excluded from this forecast.

Bio-SAF is expected to make up a large share of the future SAF mix, but it will need to be complemented by significant volumes of e-SAF produced via power-to-liquid (PtL) technologies. These routes require both large-scale expansion and reliable access to low-cost renewable electricity, hydrogen, and carbon capture infrastructure. Globally, an estimated 1,000 Mt of biogenic CO_2 could support nearly 200 Mt of e-SAF production by 2050. Competition for biogenic CO_2 exists, but this constraint may be eased if non-biogenic point source CO_2 is accepted as an eligible input. However, achieving this level of e-SAF production would require a doubling of current global renewable energy capacity.

The main constraint to reaching 500 Mt of SAF by 2050 is the pace of technology rollout, which curtails the feasible production of both bio-SAF and e-SAF. Large-scale SAF deployment will require an acceleration toward full technology readiness and the scaling up of commercial facilities across all regions. With the exception of Hydroprocessed Esters and Fatty Acids (HEFA), most SAF pathways are not yet approaching commercialization, and would need to reach maturity earlier to fully exploit the amounts of feedstock available for SAF production by 2050.

Achieving 500 Mt of SAF by 2050 will require coordinated action across the full SAF value chain, including the development of strong policy frameworks that give certainty, a coherent regulatory environment, industrial partnerships, global feedstock access, infrastructure investment, and effective technology deployment. The roles played by different regions will make a great impact on the outcome and will require strong regional leadership. While a global contribution to SAF production is needed, a handful of areas, including North America, Brazil, India, the People's Republic of China (PR China), and parts of Europe, will need to drive the majority of global output.

About

IATA

The International Air Transport Association (IATA) is the trade association for the world's airlines, representing 360 airlines covering 85% of global air traffic. IATA supports many areas of aviation activity, including working to accelerate SAF production to achieve net zero CO_2 emissions by 2050, as per the resolution adopted by the IATA General Assembly in 2021.

Worley Consulting

Worley Consulting is the global advisory and consulting business of Worley, a global professional services company of energy, chemicals, and resources experts headquartered in Australia. Worley partners with customers to deliver projects and create value over the entire project lifecycle, providing strategic advice, market insights, and technical/economic analysis.

1 Introduction

1.1 The aim and scope of the study

IATA member airlines are committed to achieving net zero carbon emissions from their operations by 2050. Meeting this ambitious target necessitates leveraging all available strategies to reduce emissions, of which sustainable aviation fuel (SAF) is expected to deliver the vast majority of the required decarbonization.

The SAF estimated output of 2 million tonnes (Mt) in 2025 represents a mere 0.7% of total jet fuel consumption and illustrates that the market is still in its early stages of development.[1] The annual production must increase exponentially to reach 500 Mt in 2050 to enable net zero CO_2 emissions by that year, as outlined in IATA's net zero CO_2 emissions roadmaps.[2]

To help accelerate SAF production, it is necessary to assess potential output volumes. These are a function of feedstock availability and of the possible scale-up of different production technologies. A global assessment of these factors can identify the most pressing barriers to SAF production, the most promising avenues to scaling production, as well as guide the prioritization of the actions that can have the greatest impact on production volumes.

This analysis focuses primarily on the availability of sustainable feedstocks and the technology rollout and readiness. Considering the current policy and regulatory landscape, each location's local feedstock potential is matched with the most suitable SAF production pathway. Based on this assessment, regional blueprints are generated.

1.2 Background

On 4 October 2021, at the 77th IATA Annual General Meeting in Boston, IATA member airlines passed a resolution to achieve net zero carbon emissions from their operations by 2050. The International Civil Aviation Organization (ICAO) adopted the same goal in 2022 with the Long-term aspirational goal (LTAG). This alignment and collaboration between States and the air transport industry are unique and indispensable for reaching the target. In addition, ICAO's Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) was adopted in 2016 as the first global market-based measure to address aviation's CO_2 emissions.

It is necessary to view the decarbonization of air transport and all industries as part of the global energy transition rather than as industry-specific endeavors. The global focus must be on increasing the production of renewable energy and renewable fuels, particularly as these concern air transport. Providing all industries with access to renewable energy will accelerate economic development and deliver better welfare outcomes for all.

Air transport's climate impact is largely defined by the useful life of aircraft, the long lead time for aircraft development, and the large amount of energy required to fly. As long as aircraft propulsion relies on the combustion of a liquid fuel, the main challenge consists of replacing fossil-based jet fuel with a renewable alternative. Fortunately, such alternatives do exist and are ready today to meet the highest level of quality, though not in sufficient quantities as of yet.

SAF will be the primary solution for air transport's carbon abatement through 2050. Unblended SAF can, on average, reduce the CO_2 emissions of aviation fuel by 70% to 80% over its lifecycle compared to fossil-based jet fuel, offering the greatest potential for reducing carbon emissions over the next three decades. An

[1] IATA, 2025. Global Outlook for Air Transport, https://www.iata.org/en/publications/economics/reports/global-outlook-for-air-transport-june-2025/
[2] IATA, 2024. Net Zero CO_2 Emissions Roadmaps, https://www.iata.org/en/programs/sustainability/flynetzero/roadmaps/

important advantage of SAF is that it does not require any modifications to existing fuel infrastructure and can be blended directly with fossil-based jet fuel, making it considered a "drop-in" fuel.

This contrasts with alternative modes of propulsion, such as electric and hydrogen, which require significant investments in specific infrastructure to enable their use. Currently, Hydroprocessed Esters and Fatty Acids (HEFA) is the dominant SAF production pathway, with a share of over 90% of the current or upcoming SAF capabilities. Given the technological maturity and established commercial scale of HEFA SAF, its dominant share is expected to continue into the next decade until new pathways achieve commercial maturity.

Scaling SAF production is a complex interplay of technology, policy, and market dynamics. It is built on a foundation of feedstocks, which represent a wide array of potential input materials. A comprehensive, credible, and robust assessment of feedstocks that can be used to produce SAF is necessary to allocate prioritized support to the most promising areas and production pathways.

2 Methodology

This analysis is a bottom-up assessment, focusing on the fundamentals of feedstock availability, technology rollout and readiness, as well as overarching regulation and policies (Chart 1).

Assessing **feedstock availability** requires defining the types of feedstocks available in different geographic areas and identifying supply chain constraints. Analyzing local feedstock availability and the various uses that compete for the same feedstock enables the identification of geographic SAF production hotspots.

Technology rollout and readiness involve assessing each technology's scalability and regional suitability. The regional blueprints and the potential global SAF production forecasts are based on the rollout and readiness of new and existing production routes.

Finally, a review of the **current regulatory landscape** gives insight into the potential for further development of feedstock availability and technology rollout across different regions.

Chart 1: Framework for assessing feedstocks, technology and policy, and regulation

Source: Worley Consulting, IATA Sustainability & Economics, 2025

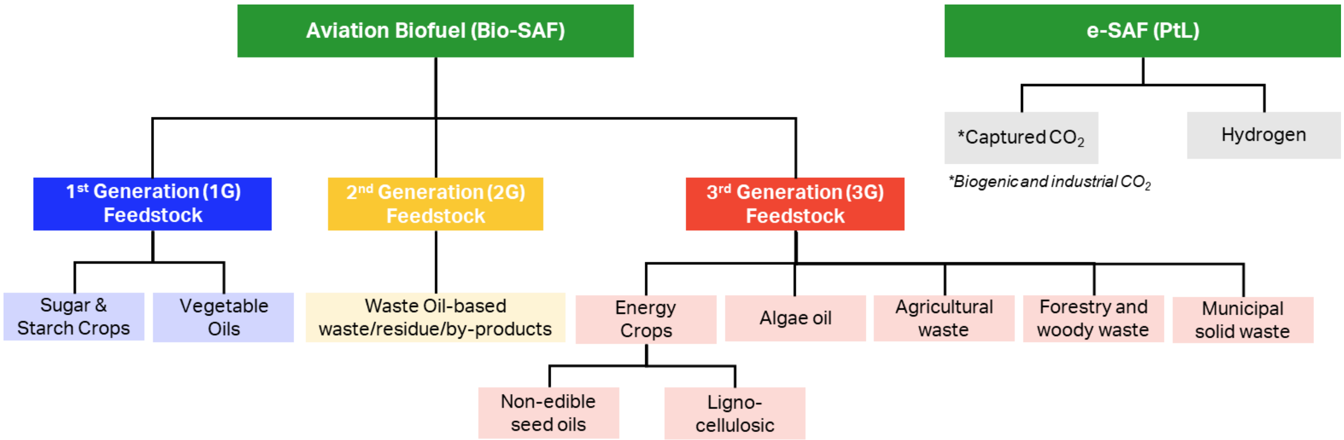
The assessment determines the optimal SAF technology for each region and generates blueprints that integrate local conditions regarding infrastructure, scalability, economics, and markets.

Based on regional blueprints, the global SAF production potential has been projected through to 2050. Using 2030 as the baseline, the forecast incorporates IATA's short-term SAF production estimates, which account for over 300 announced SAF projects worldwide. A success factor has been applied to these estimates to develop a conservative scenario for 2030.

3 Global SAF feedstock assessment

Assessing the global feedstock potential is complicated by the lack of harmonized data and the different assumptions being used by various reporting entities. This analysis adopted a bottom-up approach to ensure global consistency using standardized metrics and assumptions.

Chart 2: Feedstock classification



Source: Worley Consulting, IATA Sustainability & Economics, 2025

The assessment identifies three categories of primary resources (Chart 2):

1. **Biomass Feedstocks** – including food crops cultivated specifically for bioenergy, oil-based wastes, residues, and by-products, as well as agricultural and forestry residues, wood waste, and municipal solid waste (MSW).
2. **Feedstocks for Power-to-Liquid (PtL)** – the availability of major CO_2 sources and renewable electricity capacity for hydrogen (H_2) production.
3. **Energy Crops** – non-food crops with potential for biofuel production

The biomass feedstock assessment excludes energy crops and scenarios involving direct or indirect land-use change (e.g., the deliberate conversion of forests or grasslands into croplands) or the use of marginal or degraded land for energy crop cultivation due to the uncertainty regarding availability and potential uptake.

3.1 Biomass feedstock

Biomass feedstocks are globally abundant renewable resources that can be used to produce transport fuels. Biofuel production has traditionally focused on land transport, and both the biodiesel and bioethanol industries have established global markets successfully. The use of biomass feedstocks for SAF production is expected to increase significantly.

There are three main types of biomass feedstocks:

- **1st Gen (1G) Feedstock (Food-grade fats and oils)**: This category presents moderate emission reduction potential. It includes canola, rapeseed, soybean, and palm. The HEFA conversion process for these lipids and oil feedstocks is technologically mature and cost-effective. These feedstocks can compete with the food supply chain, which in turn can lead to concerns over land use and deforestation. Robust sustainability criteria exist that address such issues, and these must be adhered to when producing 1G feedstocks to be used for transport fuels.

- **2nd Gen (2G) Feedstock (Waste fats, oils, and greases):** These feedstocks have a high emission reduction potential but are relatively limited in availability. They include used cooking oil (UCO), animal fat, industrial grease, as well as residues like palm oil mill effluent (POME). Compared to 1G feedstocks, wastes are considered more sustainable for SAF production thanks to their higher potential for GHG reductions, in addition to the lack of land-use impact. On the downside, the related supply chains can be inefficient and costly, while overall supply is curtailed by the reliance on industrial waste streams and by competition from other transport sectors.
- **3rd Gen (3G) Feedstock (Biological/Agricultural wastes and energy crops from degraded land):** These feedstocks also have a high potential for emissions reduction and are more abundant, although their use in transport fuel production is the least developed of the three. They include MSW, agricultural and forestry residues, algae, and cover crops grown on degraded and marginal land. In most cases, their supply chains are either in the early stages of development or non-existent. In the case of MSW, there are existing supply chains, but the feedstock itself suffers from a lack of homogeneity and requires additional processing.

Biomass feedstock assessment

When assessing feedstock availability, there are three layers that consider existing biomass logistics infrastructure, geographical distribution, and specific policy drivers:

- Unconstrained feedstock availability,
- Potential feedstock availability for bioenergy and biofuels,
- Potential feedstock availability for SAF production.

Unconstrained feedstock availability represents the theoretical maximum supply of potential biomass. It does not take current allocations or competing sectoral demand into account.

To estimate the **feedstock availability for bioenergy and biofuels**, the biomass already committed to other essential primary sectors (e.g., agriculture, livestock, and recycling) must be subtracted from the unconstrained total. Some biomass feedstocks are currently used in sustainable land management practices, such as soil protection and restoration. Livestock and timber industries make use of agricultural and forestry residues, and MSW is commonly directed toward recycling or energy recovery. As a result, only a portion of the unconstrained feedstock is realistically available for bioenergy and biofuels production.

Potential feedstock availability for SAF production further reduces following those allocated to the power and heat sectors, as well as in the manufacturing of biochemicals and other biofuels, such as methanol, biomethane, and biochar.

The assessment was conducted strictly within current regional contexts and did not account for potential future developments[3]. Focusing on the existing regional landscape helps avoid speculative projections and ensures that the results reflect existing constraints and operational realities, mitigating against the risk of overestimating availability.

Biomass feedstock supply chain considerations

Supply chain dynamics affect the availability and accessibility of feedstock for SAF production. Due to land-use constraints and food security concerns, crop-based feedstocks offer only limited scalability for SAF production. The bulk of viable feedstock sources is expected to stem from waste and residue streams,

[3] Including infrastructure upgrades, policy reforms, technological advancements, or shifts in land use and agricultural practices that could influence feedstock availability over time.

especially agroforestry residues and MSW. However, significant supply chain complexities limit the accessibility and economic viability of these resources.

One of the major challenges lies in the logistics of feedstock collection and aggregation, especially when sourcing from decentralized and diverse agricultural and forestry systems. Although many regions possess abundant biomass potential, the fragmented nature of production, scattered generation sites, and underdeveloped infrastructure create substantial barriers to efficient transport and consolidation. These difficulties are further compounded by the seasonal availability of agricultural residues, the absence of standardized collection practices, and insufficient storage infrastructure.

Smallholder farms, which dominate much of the agricultural landscape in many regions, often lack the resources, incentives, or organizational structures necessary to participate in formal biomass markets. This highlights the need for intermediary aggregation hubs, cooperative models, and digital coordination tools to streamline logistics and ensure a consistent, year-round feedstock supply. Additionally, the development of robust infrastructure, such as rural road networks, storage facilities, and preprocessing centers, is likely to be required to reduce costs and improve supply chain reliability. Sustainability considerations are equally critical in the utilization of biomass feedstock. For example, the overharvesting of residues can lead to soil degradation, reduced agricultural productivity, and biodiversity loss.

MSW collection and processing present similar or greater challenges related to supply chains. Handling MSW involves managing incoming feedstock, separating out recyclable materials, such as metals, and transporting those recyclables to appropriate recycling centers. This process typically requires significant manual waste handling processes, with trucks to deliver the waste and additional trucks to haul sorted materials away. In some regions, there are tipping fees as economic incentives for waste segregation; however, in most regions, waste management practices are still evolving.

Addressing these challenges through strategic infrastructure development and policy support will be key to unlocking the full potential of waste-based feedstocks.

3.2 PtL feedstocks

The production of PtL fuels is reliant on a combination of captured CO_2 and H_2, the latter of which is usually produced through electrolysis using renewable power. In terms of CO_2, globally, there is an abundant amount from industrial sources that has the potential to be captured in a relatively cost-effective manner. However, there are barriers relating to transportation, technology scale-up, and storage infrastructure, while sustainability considerations may also restrict its utilization in different regions. Despite the significant global potential for renewable energy, meeting the renewable power demands of PtL fuels (and e-SAF, specifically[4]) and associated criteria will be challenging as renewable capacity will need to increase substantially.

Carbon dioxide (CO_2)

Industrial CO_2, biogenic CO_2, and direct air capture (DAC) are the three main sources of CO_2 feedstock for e-SAF production. Global CO_2 availability is not a constraint, but the affordability of its capture is. Only the large-scale capture of high-purity CO_2 is currently considered affordable. As a result, only around 20% of global industrial CO_2 emissions are cost-effective to capture. The primary sources of industrial CO_2 include manufacturing and construction, oil and gas production, and waste incineration.

The primary high-purity biogenic CO_2 sources include fermentation, biomass power plants, pulp and paper facilities, and the biogenic fraction of cement production. Europe's existing sustainability criteria regulation

[4] **In terms of naming conventions, we refer to power-to-liquid (PtL) as the technology pathway and e-SAF as the resulting fuel produced.**

places restrictions on the use of fossil CO_2 for e-fuels; however, the rest of the world currently considers fossil CO_2 an acceptable feedstock.

Renewable energy

e-SAF production will need an ample supply of renewable energy in addition to CO_2. As the global energy transition advances, PtL projects will increasingly compete with the growing global demand for renewable energy. Regions with significant installed renewable energy capacity and the potential to increase it further, such as the People's Republic of China (PR China), the United States (US), and Brazil, are likely to have a greater ability to facilitate e-SAF production and help establish the pathway. An important consideration is the price of renewable power, which can differ depending on regional and project conditions.

Water availability

Water is used in e-SAF production, and its availability will likely dictate the geographical location of PtL facilities. Coastal regions and areas that have suitable transport to meet water demands for hydrogen production through desalination will likely dominate this production pathway. It is important to note that the use of freshwater as a hydrogen feedstock is likely to be restricted, given the growing number of water-stressed areas worldwide.

3.3 Potential feedstocks excluded from the study

For the biomass component of this study, the focus has been on feedstocks from food crops cultivated specifically for bioenergy, oil-based wastes, residues, and by-products, agricultural and forestry residues, wood waste, and MSW.

Other feedstocks could potentially be used for producing SAF, but their chemical characteristics, availability, and technological readiness reduce the practicality of certain biomass. Wet organic wastes such as sewage sludge, animal manure, organic liquid effluents (wastewater), biogas, and algae were not included in the analysis of feedstocks for SAF. While future SAF production from these feedstocks may occur, further research and development efforts will be required.

Although energy crops have significant potential, the market is still emerging, and there is uncertainty around the types of energy crops best suited and the amounts likely to be cultivated. To understand the potential availability of energy crops that could be grown and subsequently used to produce biofuels, an assessment was undertaken with the support of Supergen Bioenergy Hub[5], a consortium of academia specializing in sustainable bioenergy systems. It was determined that energy crops, including cover crops, should not be included in the global estimates to avoid excessive speculation in the forecast.

4 SAF technology overview

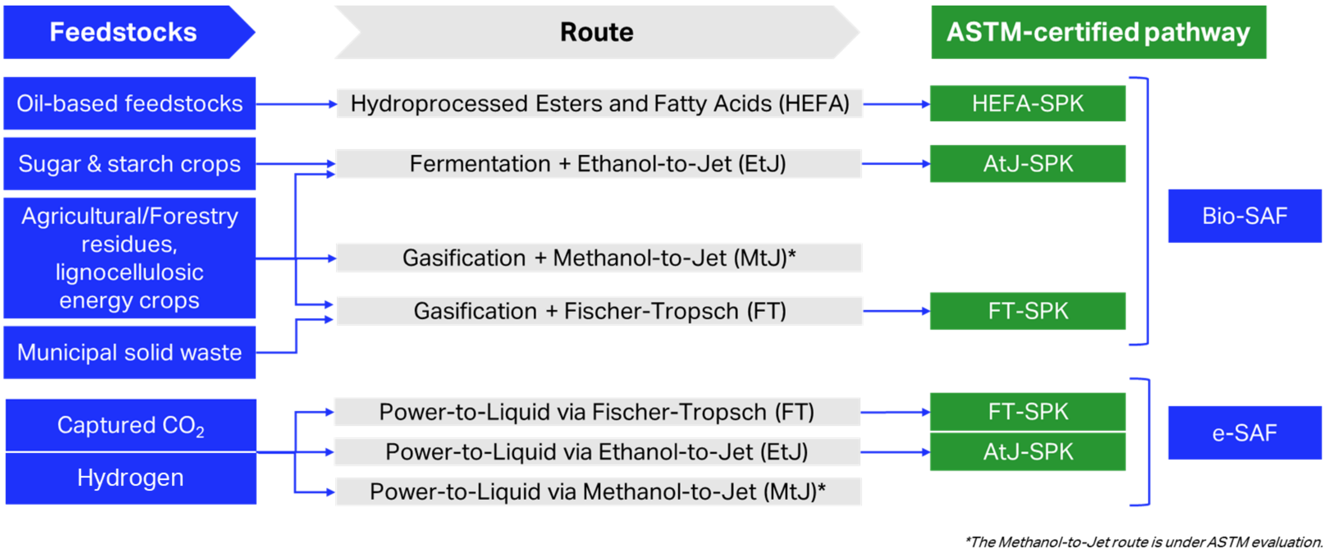
The technology assessment involves examining all potential SAF production routes and evaluating their technical details and commercial suitability. The evaluation is conducted in three stages. First, analyze and compile all existing and possible routes to SAF. Second, assess these routes for commercial suitability to arrive at a consolidated list. Third, evaluate these routes by scoring them against key criteria such as technology

[5] https://www.supergen-bioenergy.net/

readiness level (TRL)[6], ease of feedstock pre-treatment, carbon yield of SAF, and the capital expenditures (CAPEX) efficiency of the process.

Of the 40+ technology routes analyzed, the most commercially promising were selected for use in the global and regional SAF forecasts (Chart 3). Several other potential processes and routes for SAF production, such as pyrolysis, catalytic hydrothermolysis, and hydrothermal liquefaction, were assessed but excluded from the forecasts due to reasons including limited commercial readiness, low SAF yields from the feedstock, and unfavorable market conditions. These novel routes may be implemented in the long term or for smaller volumes, especially if the challenges with their implementation are overcome.

Chart 3: Key SAF production routes



Source: Worley Consulting, IATA Sustainability & Economics, 2025

4.1 Technology assessment

Bio-SAF: Oil-based feedstocks (HEFA)

Oil-based feedstocks[7] are used to produce SAF via the HEFA technology, which follows steps similar to conventional refining, with the addition of isomerization and dewaxing to achieve a quality that meets the standards of conventional aviation fuel.

HEFA is the leading pathway for SAF production now and in the near term, and benefits from an established logistics network for transporting oils. The technology has long been used for renewable diesel production and has a high TRL of 9. It offers the lowest levelized cost[8] compared to other pathways, with costs currently 2–2.5 times that of conventional aviation fuel.[9] Feedstock accounts for the lion's share of total production costs, and the price of the feedstock can vary significantly with market supply and demand dynamics. HEFA is especially

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[6]Technology Readiness Level (TRL) is a scale used to assess the maturity of a technology, ranging from TRL 1 (basic concept proven) to TRL 9 (fully commercialized and deployed). As SAF routes and technologies are at varying stages of commercialization, TRL is a key indicator of a technology's maturity, and is important for defining the rate of deployment over the 2030 to 2050 timeframe.
[7] The term "oil-based feedstocks" refers to both 1st generation vegetable oils (e.g., canola, soybean, rapeseed) and 2nd generation waste oils and greases (e.g., UCO, tallow, industrial grease). It does not include 3rd generation oils such as algae oil or non-edible seed oils. For more information, see Section 3.1.1 on feedstock classification.
[8] Levelized cost, often referred to as levelized cost of a product (LCOX), is a financial metric that represents the average total cost of building and operating a facility to produce a specific product over its lifespan, divided by the total amount of product output. LCOX helps compare the economic viability of different technologies by providing a standardized cost per unit of product generated. This product could be anything from electricity (LCOE) to hydrogen (LCOH), or in the context of this report, it refers to the levelized cost of SAF.
[9] According to Worley Consulting's analysis.

well-suited to regions with ample availability of waste and virgin oils (where its cost will be lower) and where existing refining experience can be found. However, some regions, such as Europe, face restrictions on the use of virgin oils due to sustainability criteria.

HEFA feedstocks can be processed either in standalone SAF plants, which typically take 3–5 years to build and start production, or through co-processing in existing refineries with modest modifications. The latter could deliver significant and immediate CO_2 emissions reductions if adopted more widely. Moreover, innovation is ongoing to improve SAF yields through new catalysts and process enhancements. However, to realize the full potential of HEFA, the feedstock supply chain should be streamlined, especially the collection and availability of waste oils such as UCO and animal fat, which currently face challenges in aggregation and securing sufficient volumes. In parallel, identifying and developing new scalable feedstock sources will be essential to support long-term growth.

Bio-SAF: Sugar and starch crops (EtJ)

Ethanol production from the fermentation of sugar and starch crops is well established and commonly used for ethanol blending in gasoline. Ethanol can be converted to SAF via the Ethanol-to-Jet (EtJ) pathway, which involves four key steps: dehydration, oligomerization, hydrogenation, and fractionation.

The ethanol supply chain is mature, and transport is straightforward thanks to its liquid form at room temperature. The technology has a relatively high maturity, with a TRL of 7-8, and several projects are advancing toward operational status. This technology is particularly suitable for regions with an established ethanol production track record, such as Brazil, the United States, and India.

Sustainability remains a key consideration regarding the scaling of EtJ because food crop-based ethanol can compete with food security, and some regions, including Europe, may limit the use of sugar and starch crops for SAF production. The levelized cost of the EtJ pathway is highly dependent on the feedstock (ethanol) price. Despite these challenges, this route, especially when utilizing sustainable 1G ethanol, could become competitive with HEFA, though, as of yet, the ethanol-based facilities are less advanced in the project lifecycle.

Bio-SAF: Agroforestry residues (FT and EtJ)

Agroforestry residues, an abundant and low-cost feedstock resource, can be used to produce SAF through either the Fischer-Tropsch (FT) via gasification route or the EtJ route. For the FT route, agroforestry residues are first converted into syngas via gasification. The syngas then undergoes FT synthesis to produce wax, which is upgraded into SAF. In the EtJ route, agroforestry residues are first converted to ethanol using an advanced fermentation process that breaks down the cellulosic feedstock, followed by the same key steps as when converting ethanol to SAF: dehydration, oligomerization, hydrogenation, and fractionation.

The FT via gasification technology is mature, with a TRL of 7-8, thanks to successful experiences with coal gasification and FT synthesis. The TRL of the EtJ technology is also 7-8, similar to the EtJ process based on sugar and starch crops. EtJ will be especially relevant in regions where sustainability criteria and regulations incentivize the use of agroforestry residues, such as the EU.

While agroforestry residues are abundant even after subtracting the quantities allocated to current uses, the supply chain is challenging because of the difficulties involved in aggregating and transporting large volumes of these feedstocks. That, combined with the high minimum capacity typically required for FT production and the limited availability of the cellulosic ethanol needed for the EtJ route, restricts the potential of this pathway.

The levelized cost of production is similar for both the FT via gasification and the EtJ routes utilizing agroforestry residues. While FT is highly dependent on facility CAPEX, the EtJ route is more sensitive to the feedstock price. Cellulosic ethanol production is currently significantly more expensive than sugar and starch-based ethanol.

Bio-SAF: Municipal Solid Waste (FT)

MSW is an abundant and low-cost feedstock that can be used to produce SAF through the FT via gasification route. The process typically involves converting MSW into syngas via gasification. The syngas then undergoes FT synthesis to produce wax, which is upgraded into SAF.

The MSW FT via gasification technology has a TRL of 7-8. Harnessing MSW for SAF production presents an opportunity to support broader waste management goals by providing an outlet for these materials. While the individual process steps are well understood, using MSW as a feedstock presents new challenges due to its variable composition and impurities.

The supply chain can leverage established aggregation of MSW in landfills, though transportation and handling the feedstock may be difficult. Pre-processing MSW requires managing incoming feedstock, separating recyclable materials, and transporting those recyclables to appropriate recycling centers. Co-locating facilities near existing waste-handling sites will help minimize distribution and logistical hurdles. However, high impurities and variations in feedstock quality have led to technical complications, such as corrosion, along with the increased need to purify the generated syngas. These difficulties have contributed to delays and even cancellations in some recent MSW-based SAF projects.

e-SAF (FT, MtJ, and EtJ)

PtL routes produce SAF using captured CO_2 and hydrogen, typically generated through electrolysis. Several PtL routes are possible, including FT, Methanol-to-Jet (MtJ), and EtJ via syngas fermentation. The TRL of these routes varies: FT is the most mature, followed by MtJ, despite still pending ASTM approval, and finally EtJ. The choice of route depends on the facility design. Both MtJ and EtJ support a hub-and-spoke model where intermediate feedstocks are produced at distributed locations, then aggregated for the conversion to SAF. The FT route, however, requires large-scale centralized operations due to elevated minimum plant capacity requirements. FT is expected to play a critical role in achieving 2050 SAF targets, given its scalability.

A major advantage of e-SAF is that it is not limited by biomass feedstock availability. It can utilize various sources of CO_2 and take advantage of locations with abundant renewable electricity. Due to the use of renewable electricity, a significant benefit of e-SAF is its lower carbon-intensity potential compared to other SAF technologies and to conventional jet fuel. In addition, it enables regions with limited biomass feedstock to participate in the SAF economy.

Among the key challenges to overcome is its low technology readiness (TRL 7), the lowest among all the key pathways included in this study. The reverse water-gas shift (RWGS) step is currently one of the main limiting factors,[10] due to the limited number of technology providers and strict requirements for catalysts. Alternative technologies, such as CO_2 electrolysis or direct methanol synthesis from CO_2, are also being investigated.

The capture and transport of CO_2, the necessary expansion of renewable electricity capacity, and the required upgrades to power grids all place further constraints on the scaling of this production pathway. In the EU, stricter rules around renewable electricity usage, such as requirements for additionality and temporal matching, are also driving up power costs. The levelized cost of production is sensitive to renewable power prices and high CAPEX items, such as the electrolyzers, resulting in the current costs being 4 to 5 times higher than those of HEFA SAF.

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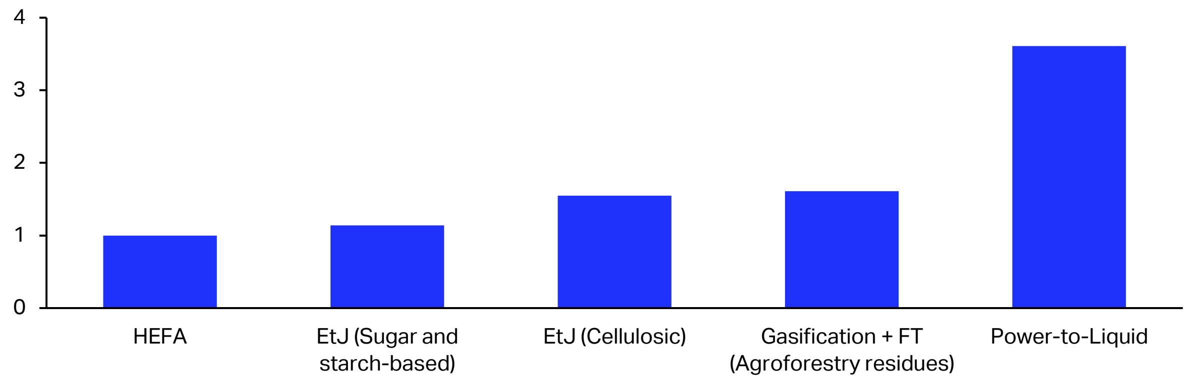
[10] **The RWGS reaction is the reverse of the water-gas shift reaction. It involves the following chemical equation:**
$CO_2 + H2 \rightleftharpoons CO + H2O$

4.2 Indicative cost comparison by production route

A techno-economic assessment of each production route is not in the scope of this study. It is assumed that the technology rollout will not be limited by the cost of production. Cost elements such as CAPEX and operational expenditure (OPEX) have not been directly incorporated into the global or regional SAF production potential forecasts. However, CAPEX was used as part of the screening criteria when selecting which technology routes to include in the forecasts. It is also assumed that a combination of financial support mechanisms, market-based incentives, carbon pricing, or other measures will be in place to ensure the commercial viability of projects across chosen production routes. Nevertheless, a ranking of the overall levelized cost of SAF by production route is provided, compared to the lowest-cost option: HEFA (Chart 4). Factors that influence the levelized costs include facility capacity, licensor, location, and financing mechanisms.

Chart 4: Indicative levelized cost of SAF by production route,[11] Indexed HEFA = 1



Source: Worley Consulting, IATA Sustainability & Economics, 2025

4.3 Technology rollout rates

All production routes except HEFA still require further technological development before they can be deployed at scale. These emerging technologies must first demonstrate technical and commercial viability during a growth phase, building the confidence needed for large-scale commercial production.

To develop global and regional SAF production forecasts, a technology rollout lifecycle was created for all selected production routes. Then, each rollout lifecycle was multiplied by a regional, technology-specific success factor. The regional technology-specific success factors were determined based on a multicriteria analysis of each region, which supported the development of the regional blueprint. The multicriteria analysis included examining levers such as policy, SAF project experience, and the maturity of the renewable energy infrastructure.

The technology rollout lifecycle, including the duration of each phase and the rate of production scale-up, varies across SAF production routes and regions. Each lifecycle is defined by a growth phase followed by a ramp-up phase.

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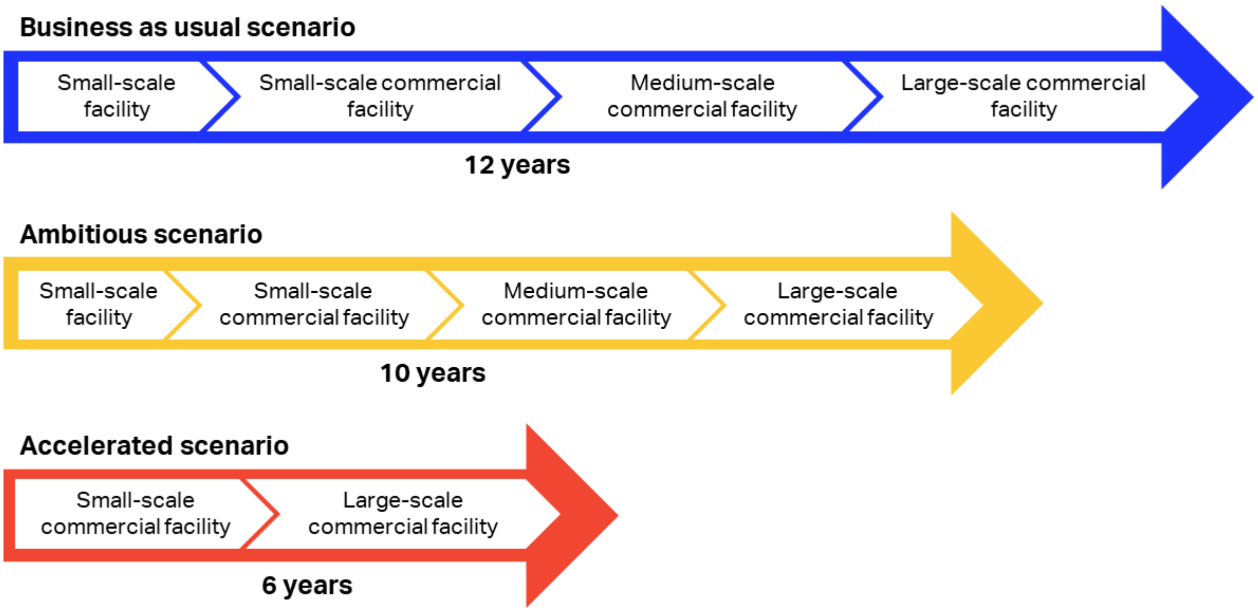
[11] Indicative levelized costs are shown relative to the lowest-cost option, HEFA SAF. The figures are based upon an analysis of Worley Consulting's cost database, leveraging global project expertise and relationships with vendors. They include capital, operating, and other expenditures throughout the project lifecycle. The cost comparison is indicative; every SAF project is unique and will depend on the individual project landscape.

Growth phase

Transitioning technologies from pilot scale to commercial production requires coordinated efforts to progress through project phases, securing financing, offtake agreements, feedstock supply, and electricity interconnections. The technology rollout depends heavily on the initial growth phase between the first pilot facility and the first large-scale commercial facility. Hence, the status of each technology in the growth phase was assessed, recognizing that each technology is at a different point. The current number of technology vendors, the scale of plants, the number of facilities that can feasibly be built in parallel, project timelines, and success rates were also considered in the analysis. The results are grouped in three scenarios (Chart 5):

- The **business-as-usual** scenario: facility conception, design, and construction are assumed to follow a typical rollout, with sufficient time between each to maximize learnings and reduce future project risks.
- The **ambitious** scenario: the time between the successful operation of one facility and the financial investment decision on the subsequent facility is reduced, which could present a greater risk to project success. Technologies with a high level of uncertainty, a low level of maturity, or those that have already experienced operational challenges, are unlikely to follow this scenario.
- The **accelerated** scenario: the demonstration and medium-scale project phases are bypassed to achieve a 6-year growth phase. This scenario is currently deemed highly unlikely due to the low maturity of the technologies involved and the associated high risks.

Chart 5: Lifecycle of technology rollout in the growth phase



Source: Worley Consulting, IATA Sustainability & Economics, 2025

Ramp-up phase

Once facilities demonstrate commercial success at scale, the renewable fuels industry gains the confidence needed in the production route to support a broader, more traditional rollout. Historical data from similar industries that have scaled successfully were used to develop the estimates for potential ramp-up in SAF production capacity out to 2050. The ramp-up phase is assumed to follow a simple compound annual growth rate (CAGR) and is based on appropriate past examples of large-scale market expansion.

While the ramp-up rate that the SAF scale-up requires has been witnessed previously, it has only occurred in cases of highly focused and accelerated deployment within target markets. The US ethanol industry achieved a

15% CAGR[12], where abundant feedstock, strong policy support, and market dominance aligned. Another example is PR China's renewable energy rollout, driven by a coordinated, nationwide strategy that resulted in a 20% CAGR[13]. Achieving similar growth in SAF will require an equally deliberate and enabling environment, with strong government and private sector support. Promoting SAF production across all regions and maximizing the utilization of all feedstock types will be key.

5 The role of policies

The adoption of SAF is slowed down currently by high feedstock prices, high CAPEX costs, technological uncertainties, and risks associated with the unstable policy environment. Moreover, the expected returns on investments in renewable energy production are significantly lower than those in fossil-fuel production. Market forces cannot alone deliver the desired outcomes, as evidenced by the present reality. Government policies are needed to overcome these hurdles, as they did so successfully in the creation of the wind and solar energy markets.[14]

Policy instruments generally target either supply or demand. Most frequently, a combination of these is used to develop new energy markets. Technology-push policies are most beneficial in the early stages of market creation when technologies are immature. These policies include funding for research and development (R&D), grants, and fiscal support to drive innovation and reduce costs. Demand-pull policies, such as feed-in tariffs and subsidies, are best sequenced later in the process when the supply of the product in question is assured to some degree. Policies can also focus on reducing price uncertainty, thereby reducing the risk taken by producers. Successful policy mixes often optimize the sequencing, scaling, and targeting of policy actions and minimize the number of instruments that target multiple goals simultaneously.[15] Most important of all is arguably the ability to achieve a policy environment that is stable enough and that provides sufficient clarity to potential investors to give them the confidence to engage in new markets.

Policies to support new energy markets should, of course, be tailored to local circumstances, form an integral part of an overall energy strategy, and be aligned with international standards. This entails assessing the availability of renewable energy and feedstocks and the needs of other industries for the available feedstock. For example, road transport has greater flexibility in decarbonizing, with electrification being the preferred option. On the other hand, air transport requires a liquid fuel as long as aircraft propulsion involves jet engines. This argues for policies that encourage refineries to prioritize SAF over renewable diesel, for instance. Such policies can be instrumental in supporting air transportation's energy transition. Examples of different types of policies and their likely impact on SAF production can be found in Table 1.

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[12] Historic biofuel production data can be found here: https://ourworldindata.org/grapher/biofuels-production-by-region?facet=entity&uniformYAxis=0
[13] Global and country-level electricity production statistics allow for an understanding of the different compound annual growth rates from 2000-2020, data sourced from: https://ourworldindata.org/grapher/annual-change-renewables?tab=line
[14] IATA, 2025, A reflection on policies used to support the creation of new renewable energy markets - Lessons for aviation? https://www.iata.org/en/publications/economics/reports/climate-regulatory-frameworks/
[15] IATA, 2024. Net Zero CO_2 Emissions Policy Roadmap. https://www.iata.org/en/programs/sustainability/reports/policyroadmap2024/

Table 1: Policies and their likely impact on SAF production

TYPE	INSTRUMENT	IMPACT
FINANCIAL SUPPORT MECHANISMS		
Economic Incentives	- Tax credits, grants, guarantees, and subsidies for feedstock suppliers or SAF producers	- Reduces SAF production costs, encourages SAF production, and stimulates the supply of sustainable feedstocks
Financial Instruments	- Contracts for difference and other revenue-certainty mechanisms - Guarantees and insurance de-risking investments	- Attracts capital to SAF production projects - Improves project bankability and encourages private-sector participation
DIRECT/INDIRECT SUPPORT		
Research and Development Support	- Government funding for R&D in SAF technologies	- Encourages essential R&D into diverse and sustainable feedstock sources - Advances in feedstock processing and conversion technologies
Infrastructure, Supply Chain & Commitments	- Government & Private/Public investment in digital, capital, logistics, and transportation infrastructure, including SAF accounting mechanisms and registries - Public-private partnerships (PPPs) can share investment risks, promote supply chain confidence through mechanisms such as the SAF Registry[16]	- Facilitates reliable feedstock distribution - Reduces supply chain bottlenecks, improving scalability - Ensures production and distribution networks can handle increasing SAF demand
MANDATE AND TARGETS/REQUIREMENTS		
Regulatory Mandates, Targets & Blending Requirements	- Mandates at a regional or national level	- Can create demand certainty but at a risk of negative consequences, particularly if used on its own or in the early stages of market development[17] [18]
Sustainability & Feedstock Regulations	- Certification schemes banning or limiting particular feedstock	- Supports environmental goals and compliance with sustainability standards - Encourages the production and supply of sustainable feedstocks
PUBLIC AWARENESS AND CAMPAIGNS		
Public Awareness and Education Campaigns	- Government and industry-led campaigns to promote SAF	- Increases public and industry support for SAF adoption
International Collaboration and Agreements	- Bilateral and multilateral agreements to support SAF production and use	- Facilitates global market access and cooperation - Harmonizes standards and practices across regions

Source: IATA Sustainability & Economics, 2025

Based on current policies, we assessed the potential for further development of specific technologies across different countries. In some cases, existing policy frameworks create favorable conditions for advancing certain technologies, often due to the availability of specific feedstocks or their anticipated future potential. However, when policies prioritize the use of these feedstocks in other sectors, it can limit their availability for SAF production and constrain technological advancement in this area.

[16] CADO SAF Registry, https://www.cado.org/en/
[17] ICCT, 2025, https://theicct.org/pr-eu-saf-mandate-risks-falling-short-without-action-on-investment-barriers/
[18] IATA, 2025, Access to SAF in Europe, https://www.iata.org/contentassets/d13875e9ed784f75bac90f000760e998/brief-access-to-saf-in-europe-rfeua.pdf

6 Global feedstock availability and SAF production outlook

6.1 Biomass feedstock for SAF production

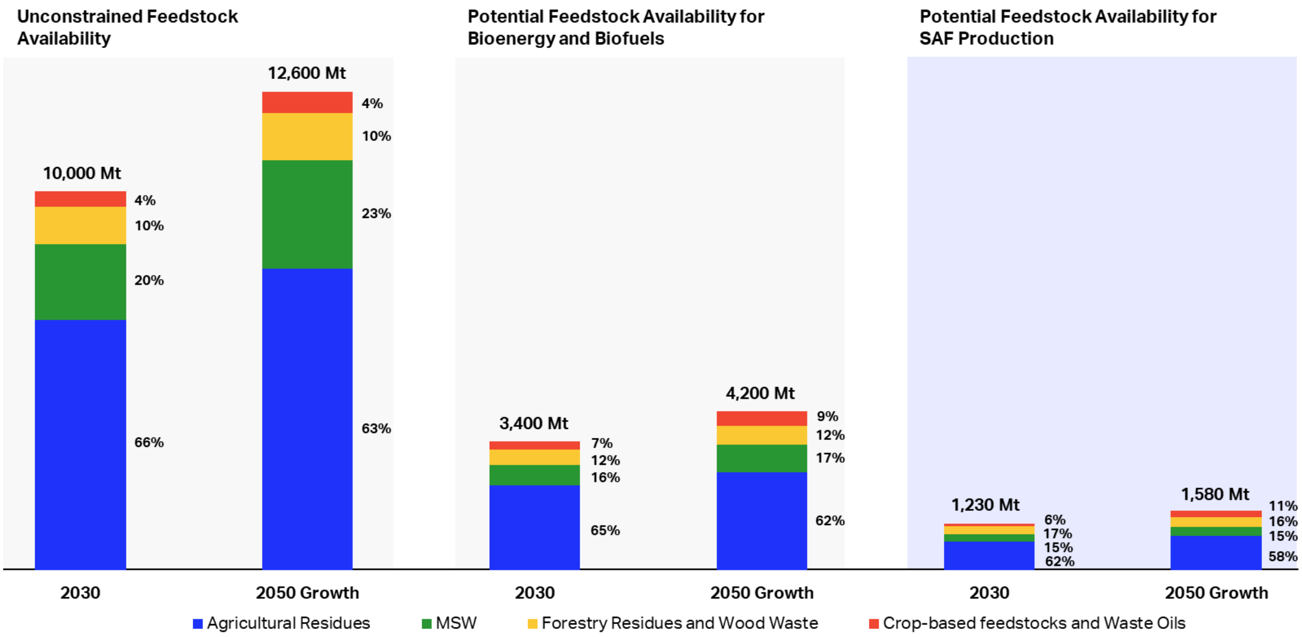
Potential unconstrained biomass feedstock availability is estimated at around 10,000 Mt in 2030, increasing to over 12,000 Mt in 2050 (Chart 6). However, various industries are already using approximately 60% of total biomass resources.

As a result, less than 35% is expected to be available for bioenergy and biofuels, estimated at 3,400 Mt in 2030 and 4,200 Mt in 2050. Converting all these feedstocks into SAF would result in a potential theoretical maximum of more than 800 Mt in 2050. However, competing industries, existing legislated commitments, and the decarbonization ambitions of different sectors make this figure impractical.

After considering the competing needs of the bioenergy and biofuel sectors, the global biomass feedstock potentially accessible for SAF production further reduces to around 12% of the original unconstrained potential. That equates to around 1,230 Mt by 2030 and 1,580 Mt by 2050. If fully utilized, this could support the production of over 300 Mt of bio-SAF in 2050.

As much as an estimated 58% of the potential biomass feedstocks available for SAF production will arise from agricultural residues. Forestry residues and wood waste trail behind at 16%, followed by MSW at 15%. Crop-based feedstocks and waste oils are currently the only feedstocks used in commercial biofuel production and will likely represent 11% of the biomass feedstocks used to produce SAF in 2050.

Chart 6: Potential availability of global biomass feedstocks for SAF production in 2030 and 2050



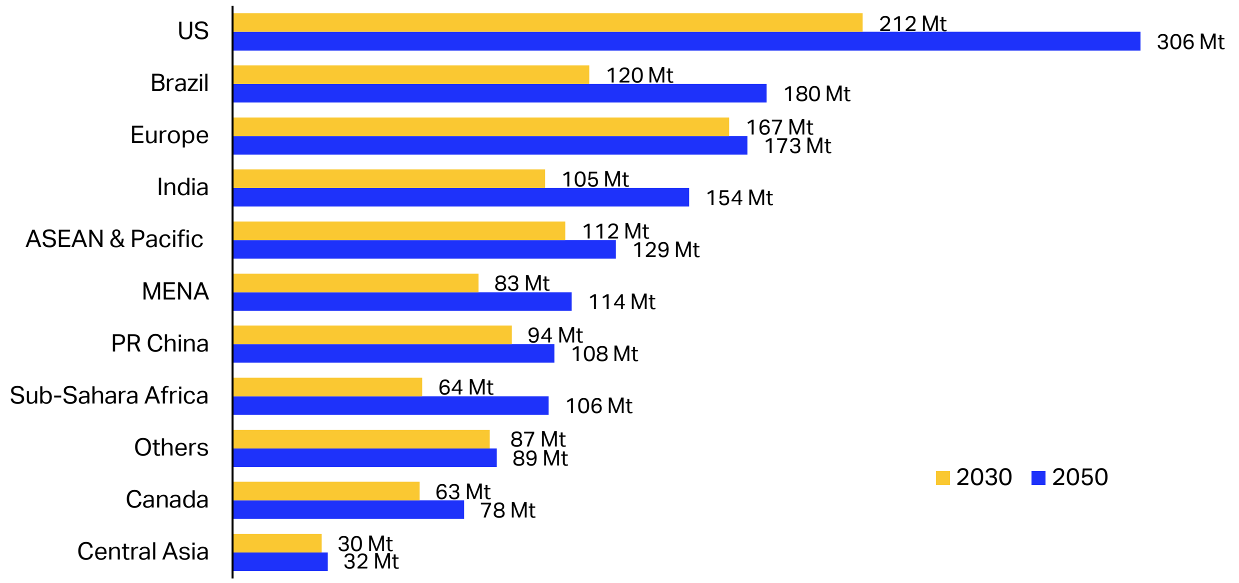
Source: Worley Consulting, IATA Sustainability & Economics, 2025

While every region can generate biomass feedstock for SAF production, some countries and regions emerge as hotspots. The US, Brazil, Europe, and India are likely to dominate, accounting together for more than 50% of the global total availability (Chart 7). The US is expected to lead with more than 200 Mt of biomass available for SAF production in 2030 and around 300 Mt in 2050, or 17% and 19% respectively of the global total.

PR China, and the Association of Southeast Asian Nations (ASEAN), particularly Indonesia and Malaysia, are also expected to emerge as critical feedstock hotspots. Together, these countries would account for approximately 240 Mt of biomass feedstock for SAF production by 2050, representing about 15% of the global total. These countries have existing biofuel industries and offer substantial potential for producing SAF from biomass. The Middle East and North Africa (MENA) and sub-Saharan Africa have an expected combined feedstock availability of 220 Mt in 2050, accounting for approximately 14% of the global total. These regions have the resources to support the production of SAF from waste and residue feedstocks, which will need to be harnessed.

Growth in biomass feedstocks through 2050 is likely to stem from an increase in agricultural residues thanks to crop production and improved yields, alongside enhanced utilization of forestry residues. Adding to the supply will be greater waste oil and MSW generation, a result of population growth, urban area expansion, and changes in consumption patterns. The growth estimates are also supported by established infrastructure and a shifting demand toward SAF production. Some regions will likely benefit from more sugar and starch-based ethanol being allocated to the SAF market, provided it meets sustainability criteria.

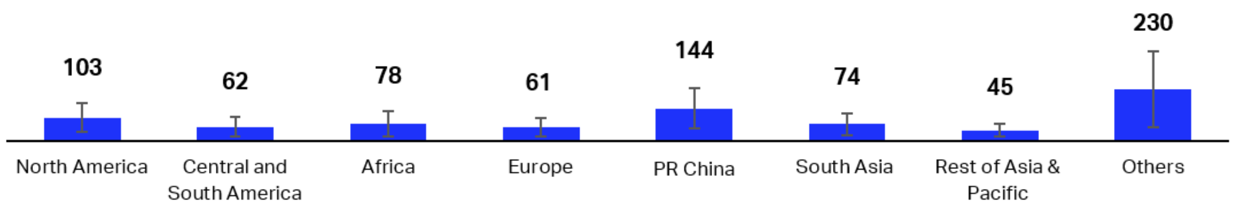
Chart 7: Regional potential availability of biomass feedstock for SAF in 2030 and 2050



Source: Worley Consulting, IATA Sustainability & Economics, 2025

If energy crops are successfully established on marginal or degraded land, they could add to the potentially available feedstocks for SAF. Their inclusion could expand the oil-based feedstock supply for HEFA technology as well as cellulosic feedstocks for technologies such as EtJ and gasification. Energy crop variety and scale will differ between regions depending on biomass yield, adaptability to diverse climates, and compatibility with SAF conversion technologies developed across the globe (Chart 8).

Chart 8: Potential energy crops by 2050, Mt



Source: Supergen Bioenergy Hub, Worley Consulting, IATA Sustainability & Economics, 2025

6.2 Biogenic CO_2 for PtL production

The potential available biomass feedstock for SAF production, if fully utilized, would yield a little over 300 Mt of SAF by 2050, which is around 200 Mt short of the estimated 500 Mt required to meet net zero. This demonstrates the necessity to develop other types of production pathways, such as PtL, and to unlock other types of feedstocks required to achieve the air transport industry's net zero ambitions.

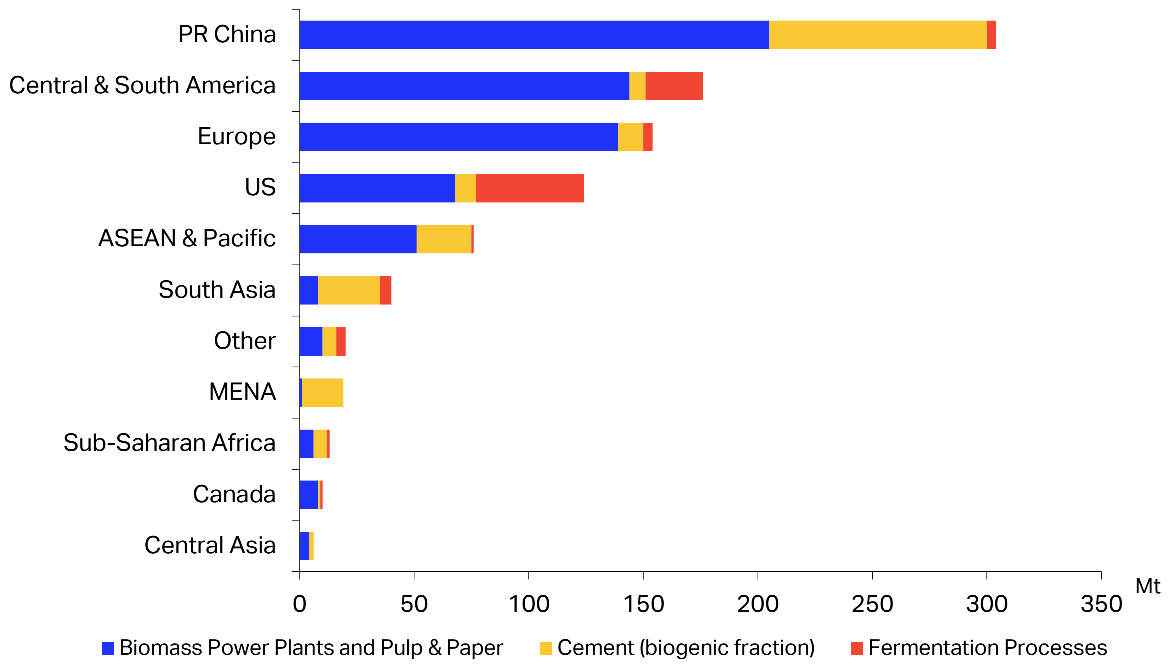
Should industrial CO_2 sources continue to be accepted under sustainability frameworks, they would offer an abundant supply of CO_2 for e-SAF production, with more than 5,000 Mt of industrial CO_2 that could be cost-effectively captured. However, leveraging this opportunity will require significant investment in supply chain infrastructure. Additionally, current sustainability regulations restrict the use of industrial CO_2 in certain areas, such as Europe, limiting its potential. These regions are promoting the use of biogenic CO_2.

If CO_2 use were limited to just non-fossil sources, such as biogenic CO_2, the available feedstock would be significantly reduced. Meeting e-SAF requirements under these circumstances would require a substantial share of the global biogenic CO_2 supply. This would lead to increased competition among sectors for these limited resources, including e-methanol and bioenergy production with carbon capture and storage (BECCS) projects.

When considering just existing biogenic sources, the estimated total availability is limited to around 1,000 Mt of biogenic CO_2 that can be cost-effectively captured and used (Chart 9). With current carbon capture technologies operating at approximately 90% efficiency, over 900 Mt of biogenic CO_2 could therefore be captured and potentially redirected for SAF production. Utilizing all of this would enable the production of an estimated 170-200 Mt of e-SAF when combined.

The development of DAC technologies could alleviate concerns about the availability of non-fossil CO_2. However, its broader adoption will depend on overcoming significant difficulties related to technological scalability, energy requirements, and high capture cost.

Chart 9: Biogenic CO_2 availability in Mt, 2050



Source: Worley Consulting, IATA Sustainability & Economics, 2025

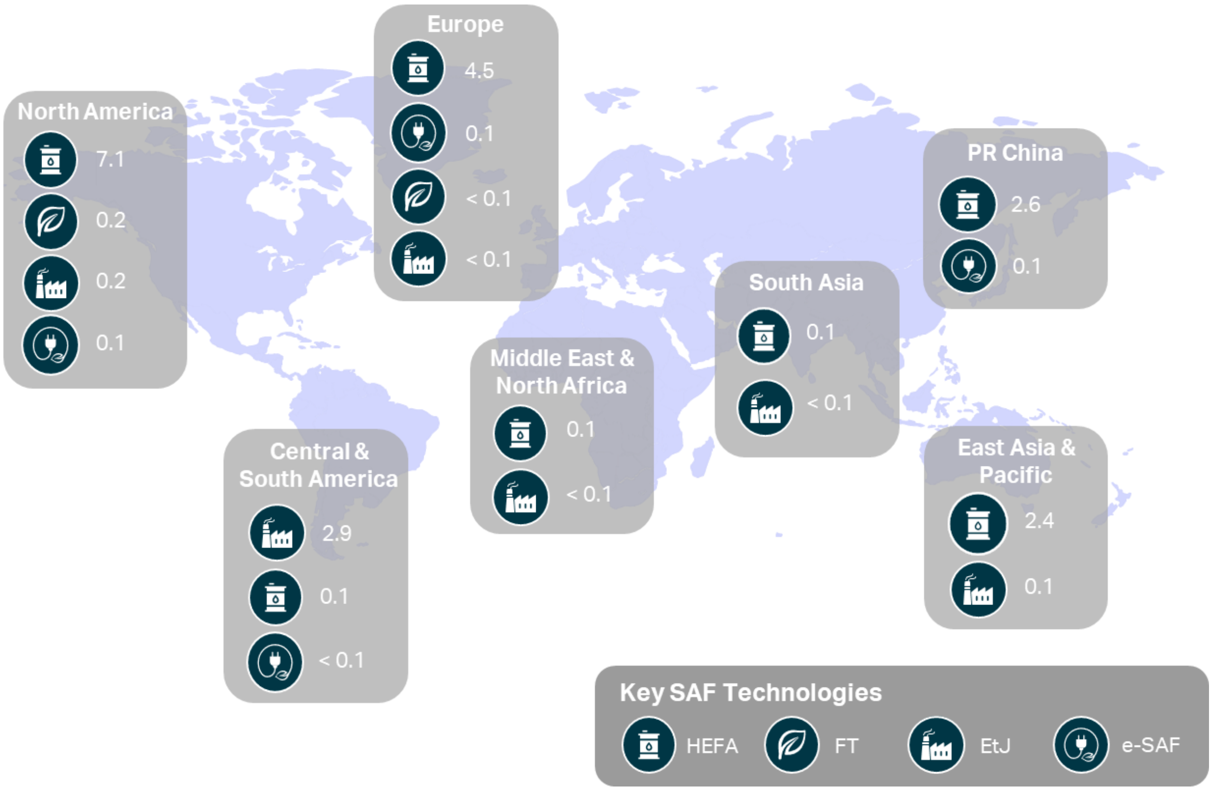
PtL is unlikely to contribute large volumes of e-SAF in 2030, but this is expected to increase significantly by 2050. This production pathway is not without its challenges and will consume large amounts of renewable power. Without taking any other competing industries into consideration, global renewable power generation capacity would need to nearly double to produce up to 200 Mt of e-SAF.

6.3 Global SAF production potential in 2030

By 2030, global SAF production capacity is expected to reach around 20 Mt with the project success factor applied (Chart 10).[19] HEFA refineries (both standalone and co-processing) are likely to still dominate the market, accounting for about 95% of total volume. This output could be increased further with the appropriate policies and regulatory harmonization. Of the remaining non-HEFA market, EtJ is estimated to contribute approximately 2%, followed by PtL at 2% and FT at just 1%. Current support mechanisms for new technologies exist, but they remain insufficient to enable accelerated commercial-scale deployment.

Regionally, around 36% of the global 2030 SAF capacity will be in North America, driven by targeted incentives. Europe is set to account for 23%, followed by South America at 15%, PR China at 13%, and East Asia and the Pacific at around 12%. The MENA region and South Asia are anticipated to contribute less than 1% under current policy conditions despite the potential.

Chart 10: Estimated regional SAF capacity in 2030 based on announced projects with success factor applied, Mt



Source: Worley Consulting, IATA Sustainability & Economics, 2025

[19] The outlook, based on project data from the IATA SAF database, incorporates technology-route-specific success factors, developed with Worley Consulting, to reflect the likelihood of project success, considering factors such as technology maturity and funding. Additionally, projects in very early phases, including demonstration and pilot stages, as well as those that have shown no activity in the past two years, have not been included. The outcome represents a conservative scenario for SAF production capacity by 2030, based on a realistic assessment of project development progress.

6.4 Global SAF production potential in 2050

SAF production technologies follow distinct rollout trajectories consisting of a growth phase and a ramp-up phase (Table 2). Most technologies are assumed to follow an ambitious growth phase scenario, except for the MSW FT and HEFA route. A business-as-usual growth phase has been applied to the MSW FT route due to significant scale-up challenges, feedstock aggregation barriers, and project cancellations and delays. The oil-based HEFA pathway is already at commercial scale and therefore does not require a growth phase. Besides the HEFA route, all SAF production pathways require further scaling-up and deployment to reach TRL 9 and demonstrate commercial readiness. Accelerating this timeline is key to enabling the modeled growth.

The ramp-up phase follows a CAGR assumption that reflects the expected pace of capacity expansion once the technologies are proven to be commercially viable. The ramp-up assumptions are based on experiences in other sectors. For example, similar growth trajectories have been observed in the US ethanol industry, the European biofuel sector, and PR China's renewable energy sector, all of which benefited from strong policy support and clear market focus. Achieving comparable scaling in SAF will require close collaboration between public and private stakeholders.

Table 2: Core forecast assumptions for each key technology used in the SAF production forecast[20]

Key SAF Technologies	Growth Phase Scenario	Ramp-up Phase CAGR
Bio-SAF: Oil-based (HEFA)	n/a	15%
Bio-SAF: Sugar and Starch crops (EtJ)	Ambitious	15%
Bio-SAF: Agroforestry Residues (FT, EtJ)	Ambitious	15%
Bio-SAF: MSW (FT)	Business as Usual	15%
e-SAF (FT, MtJ, EtJ)	Ambitious	20%

Source: Worley Consulting, IATA Sustainability & Economics, 2025

Although ramp-up rates at the required level have been demonstrated in select industries and specific geographies, achieving the required scale will be necessary across all regions. Competition from emerging sectors is a major factor, particularly regarding e-SAF production and a growing demand for renewable energy from industries advancing in the energy transition.

Table 3: Estimated biomass feedstock availability and projected volumes for each key SAF technology in 2050, Mt

Key SAF Technologies	Feedstock for Bioenergy & Biofuels	Feedstocks for SAF Production	Theoretical Maximum Bio-SAF[21]	Core SAF forecast
Bio-SAF: Oil-based (HEFA)	189	82	63	63
Bio-SAF: Sugar and Starch crops (EtJ)	197	84	45	36
Bio-SAF: Agroforestry Residues (FT, EtJ)	3,097	1,171	176	108
Bio-SAF: MSW (FT)	717	240	38	29
e-SAF[22] (FT, MtJ, EtJ)	-	-	-	176

Source: Worley Consulting, IATA Sustainability & Economics, 2025

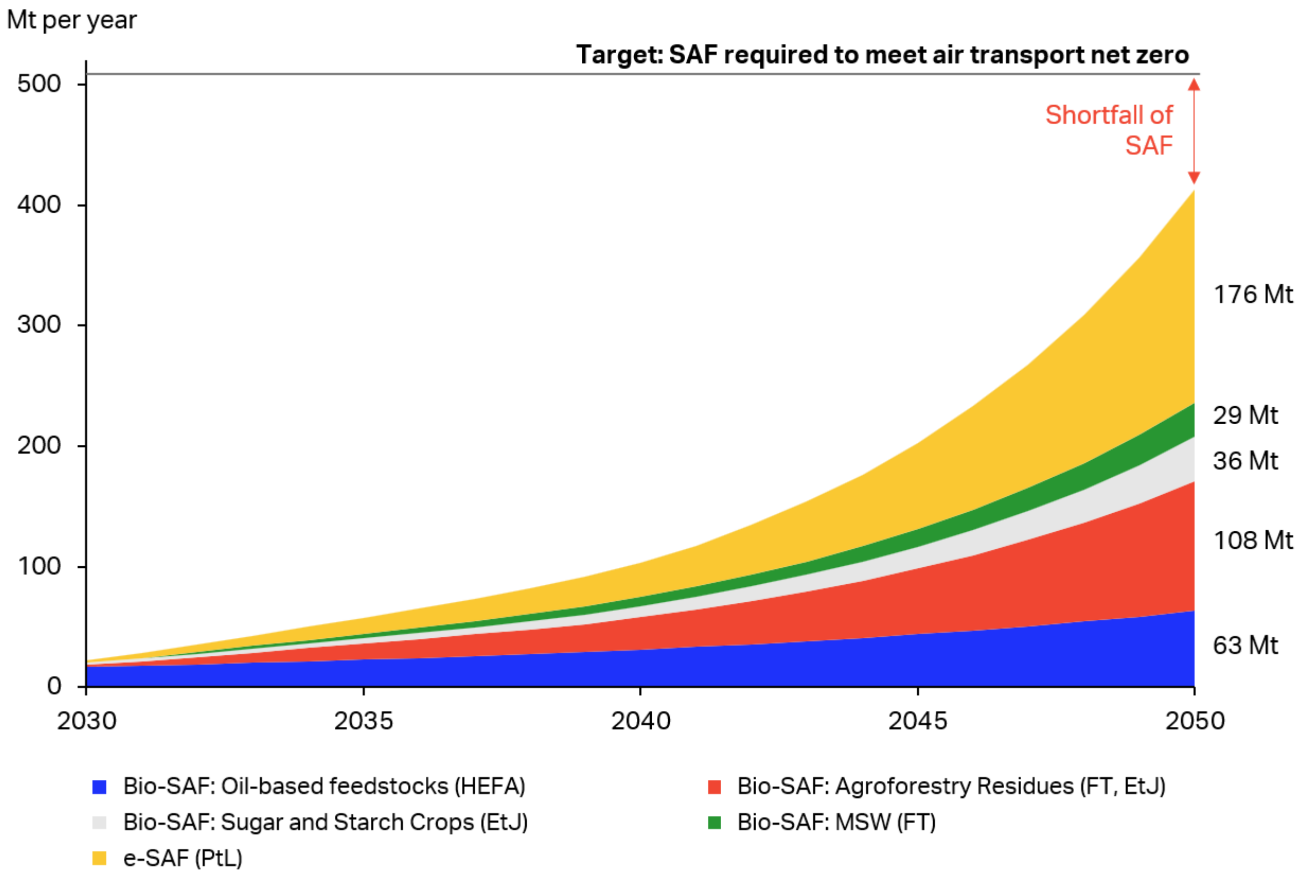
[20] A detailed techno-economic assessment of individual SAF production routes is beyond the scope of this analysis (see Section 4.3). Cost factors such as CAPEX and OPEX have not been explicitly modeled in the global or regional production potential forecasts. However, CAPEX was considered during the initial screening of eligible technologies. It is assumed that adequate financial support mechanisms, market-based incentives, carbon pricing, or other measures will be in place to ensure the commercial viability of projects across selected production routes.
[21] Theoretical Maximum Bio-SAF figures are indicative as they are based on analysis of typical SAF production yield. Every SAF project is unique, and yields will depend on the individual project landscape and chosen technology licensor. Theoretical maximum represents full utilization of all feedstocks available for SAF production unconstrained by technology rollout.
[22] Unlike bio-SAF technologies, e-SAF is not limited by biomass availability – instead access to renewable electricity and captured carbon dictates the successful expansion of e-SAF.

Table 3 shows the estimated amount of biomass available for SAF production and what this means in terms of the theoretical maximum amounts of SAF that could be produced. For example, in terms of oil-based HEFA, there is an estimated 189 Mt of feedstock available for bioenergy and biofuels, of which 82 Mt could be used for SAF production. If all of this 82 Mt was converted into SAF, 63 Mt represents the theoretical maximum of oil-based HEFA that could be produced. Without any constraints, more than 300 Mt of bio-SAF can be produced if all the feedstocks available for SAF were successfully converted.

Even with an ambitious expansion of e-SAF and many of the bio-SAF pathways, this core forecast indicates that global SAF production potential may achieve just over 400 Mt by 2050, revealing a significant shortfall compared to the 500 Mt required to decarbonize (Chart 11). Bio-SAF accounts for around 57% of the total SAF production in 2050. Agroforestry residues are expected to be the dominant bio-SAF feedstock, contributing toward approximately a quarter of the total SAF. Sugar and starch crops are estimated to be responsible for 9% of the total SAF, with MSW slightly lower at 7%.

Oil-based HEFA is projected to account for just over 15% of the SAF in 2050 and is the only pathway that is projected to fully utilize the oil-based feedstocks available for SAF, as assumed within this analysis. Of the five technology pathways, e-SAF is projected to contribute the single largest amount of SAF in 2050, accounting for just over 40%.

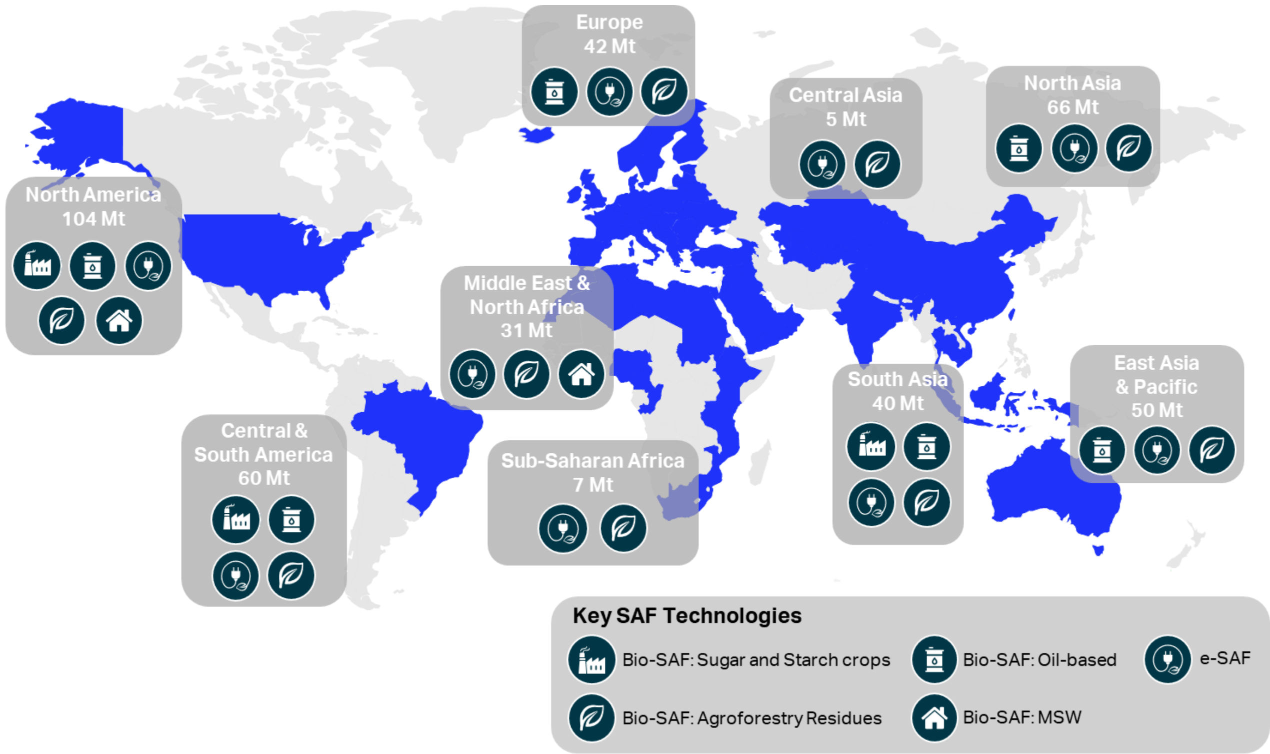
Chart 11: Estimated global SAF production potential, core forecast



Source: Worley Consulting, IATA Sustainability & Economics, 2025

When considering the regionality of the core forecast, the vast size and resource base of North America, North Asia, and Central and South America result in them having the highest potential for SAF production by 2050, collectively estimated at 230 Mt of SAF (Chart 12). Europe, South Asia, and East Asia & Pacific will also play a critical role due to their established SAF infrastructure and policy frameworks, and are expected to contribute 132 Mt. The Central Asia and Sub-Saharan Africa SAF markets are not projected to be as well established as other regions but are still estimated to both contribute at least 5 Mt and 7 Mt, respectively.

Chart 12: Estimated regional SAF production in 2050, core forecast



Source: Worley Consulting, IATA Sustainability & Economics, 2025

Although achieving around 400 Mt of SAF production in 2050 would represent the successful formation of a significant global SAF market, it would still fall short of the estimated volumes required for airlines to reach net zero. Bridging the gap between the forecasted SAF production potential and the expected 2050 SAF demand of 500 Mt will therefore require several key challenges to be tackled.

Other than oil-based HEFA, under the core forecast assumptions, none of the production pathways are projected to utilize all available biomass feedstock for SAF production in 2050. Although there is an estimated potential for over 300 Mt of bio-SAF to be produced by 2050, the core forecast projects that only around 70% of this is achieved. The binding constraint on total SAF production, and particularly bio-SAF, is the technical capacity rollout, with more optimistic assumptions allowing for greater volumes of available feedstock to be exploited. Indeed, if freed of the technology constraint, maximizing the potential bio-SAF production – increasing the forecasted 236 Mt of bio-SAF closer to its theoretical maximum – could see the total volume of SAF produced in 2050 reach around 500 Mt.

Sugar and starch crops offer rapid growth potential in regions like North and South America, where sustainable agricultural practices and supply chains are already in place. Agroforestry residues also present a significant opportunity, particularly in North America, Central and South America, MENA, and Europe. Accelerating the rollout of EtJ, particularly in these key regions, would increase the exploitation of the agroforestry residues available to SAF production.

Further gains could be achieved by prioritizing bio-based feedstocks currently used in other sectors, such as road transport and marine sectors, or by unlocking new sources, particularly oil-based energy crops, which can leverage the mature HEFA production pathway. Regions with established biofuel industries and abundant feedstock resources will likely emerge as key biomass hubs. If demand for biomass feedstocks from other bioenergy and biofuel industries is lower than expected, or if the feedstock is prioritized for the SAF industry, the potential SAF production within these key hubs could be even higher.

However, long-term demand cannot be met with bio-SAF alone. Significant volumes of e-SAF will be required, meaning PtL technologies must play a critical role in production. Their scalability depends on access to large amounts of renewable electricity and CO_2, as well as the need for significant cost reductions. Allowing the use of both fossil and biogenic CO_2 in all regions would avoid placing unnecessary limitations on a vital technology for SAF production, although this would need to be coupled with a continued ramp-up of renewable capacity, particularly in areas with good access to captured CO_2. Without significant cost reductions and targeted policy support, the widespread deployment and commercial viability of e-SAF will remain limited.

6.5 Enablers to reach SAF production potential

Ramping up from around 2 Mt of SAF production in 2025 to 500 Mt in 2050 hinges on a successful transition enabled by industrial partnerships, policy support, technology deployment, infrastructure development, and supply chain coordination. The enablers below highlight the systemic actions needed to close the gap.

Enablers unlock SAF potential

- Industrial partnerships to de-risk projects through supply/demand guarantees between fuel producers and airlines
- Policy incentives in support of SAF that promote the uptake of new technologies through funding or price support
- Building durable trust among stakeholders, supporting engagement, collaboration, information sharing, transparency, and value sharing
- Shifting value beyond solely financial to include environmental and social value [23]
- Development of renewable power capacity and grid infrastructure
- Government and private sector support for SAF, promoting production in all regions and maximizing the utilization of all feedstocks
- Maximizing commercially developed production routes and feedstocks, while supporting the development of new feedstocks and technologies
- Strengthening Original Equipment Manufacturer (OEM) and equipment supply chains and fostering early collaboration with project developers
- Supporting global access to biomass feedstock by addressing any logistics, infrastructure, and supply chain bottlenecks
- Standardization, replicate designs, and build in parallel

Reaching as much as 500 Mt of SAF production in 2050 will require a truly collaborative approach, particularly in ensuring the successful construction of first-of-a-kind (FOAK) SAF projects. Private sector partnerships that can help de-risk projects, supported by governments through policy incentives, will help unlock the necessary capital to begin the construction of FOAK plants. This, in turn, will allow the technologies required to unlock new feedstocks and achieve 2050 SAF production targets to reach commercialization.

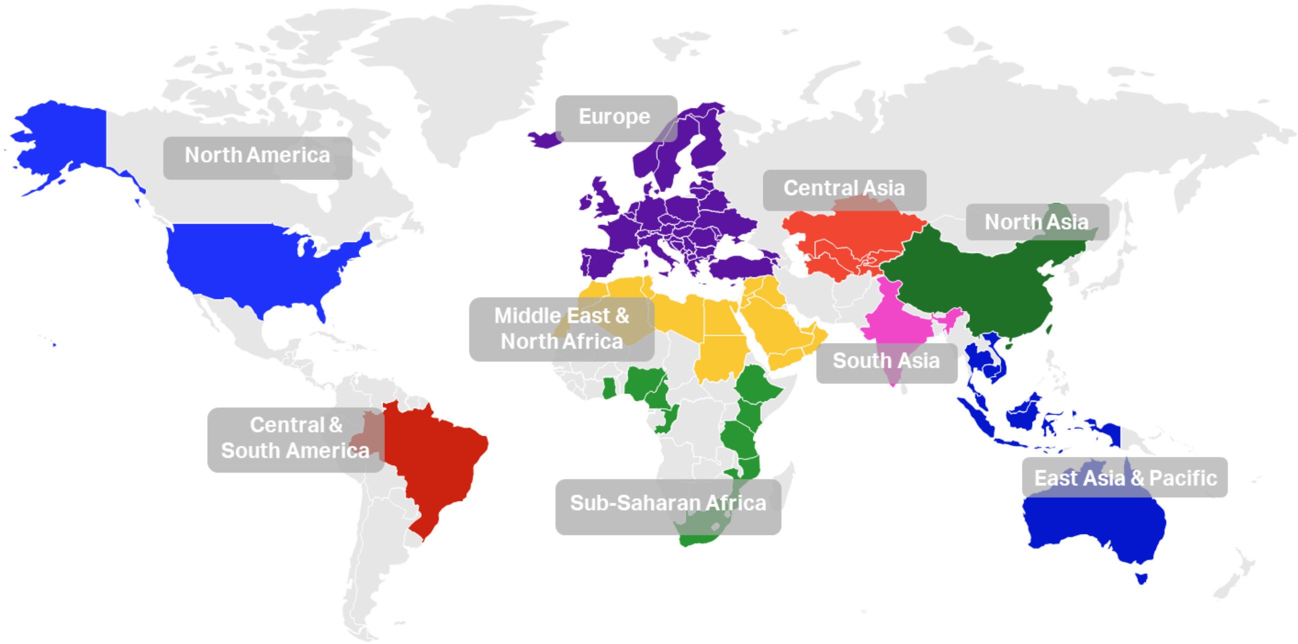
Although this will act as a catalyst, the growth of the SAF market will be dependent upon key infrastructural developments. These include establishing and improving global access to biomass feedstocks, particularly in regions that have the potential to be major producers of SAF, and significantly expanding global renewable power capacity. Constructing replicable plant production designs, removing barriers to large-scale deployment, and cultivating a transparent and collaborative environment for stakeholders should allow the SAF market to expand quickly and efficiently.

[23] This implies using a social discount rate in the cost-benefit analysis, representing the rate at which society is willing to trade present for future consumption. It is used to determine the present value of future costs and benefits, especially for projects with long-term impacts such as climate change mitigation. Lower discount rates favor long-term investments, while higher rates prioritize immediate returns.

7 Regional feedstock availability and SAF blueprints

Estimated SAF production growth is concentrated in hotspot countries within each region, identified based on feedstock availability, technological maturity, policy and financial support, and access to reliable data (Chart 13). While other countries within regions have shown some regulatory momentum, progress is slow and data can often be lacking, making the identified hotspots within this research vital for better understanding the energy transition.

Chart 13: Regions and key countries considered for SAF blueprints



Source: Worley Consulting, IATA Sustainability & Economics, 2025

7.1 Central Asia

The Central Asia[24] region's total area is 400 million hectares (Mha),[25] and more than 80% of its territory is occupied by deserts and steppes.[26] Agricultural land covers approximately 280 Mha (70% of the total land area), mostly rangelands used for pastoralism, whereas croplands account for less than 10%.[27]

However, the region experiences high pressure on the limited natural resources, such as forests, pastures, biodiversity, soil, and water. These ecosystems are increasingly overused, contributing to land degradation, declining water resources, and the loss of fertile soil.[28] Although the region has implemented several land policy reforms that increased the area of cropland and reduced land degradation, some Central Asian countries still face food insecurity and high food dependence, particularly in Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan.

There are currently no targeted incentives or policies for SAF production in Central Asia, with the main limitation being existing fuel standards, specifically the blending of jet fuel with SAF. However, a growing

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[24] Central Asia region consists of Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan.
[25] 1 hectare (ha) = 0.01km²
[26] UNCCD, 2023, Regional Factsheet, Central Asia, https://www.unccd.int/sites/default/files/2023-11/Fact%20sheet%20Central%20Asia%20EN.pdf
[27] Hamidov, et al., 2016, Impact of agricultural land use in Central Asia: a review, https://link.springer.com/content/pdf/10.1007/s13593-015-0337-7.pdf
[28] GIZ, 2022, Integrative and climate-sensitive land use in Central Asia, https://www.giz.de/en/downloads/giz2023-en-factsheet-ILUCA.pdf

number of companies are exploring possible projects, and Kazakhstan has recently volunteered to join ICAO's carbon offsetting and reduction scheme for international aviation (CORSIA).[29]

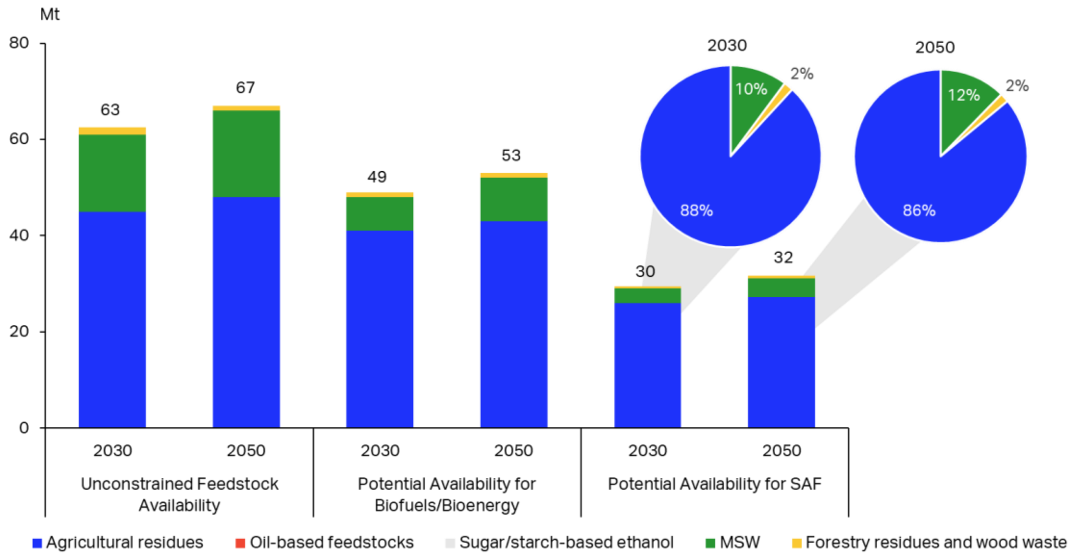
Feedstock availability

Central Asia is located in an arid and semi-arid climate zone. Despite its potential, unlocking the country's capability to accumulate feedstock for SAF may face significant regulatory, infrastructure, and environmental challenges.

By 2030, the unconstrained feedstock is expected to account for 63 Mt, with around 30 Mt of potential feedstock available for SAF (47% of the total). Most of the potential feedstock available for SAF will come from agricultural residues, accounting for 88% of the total (Chart 14). MSW and forest-based feedstocks only account for a small fraction, given as 10% and 2%, respectively.

The potential availability of feedstock is expected to remain relatively similar by 2050, reaching 32 Mt and making up around 48% of the total unconstrained feedstock. MSW will play a more significant role in this, accounting for 12% of the total potential feedstock for SAF. Meanwhile, forestry residues will remain at 2% (Chart 14).

Chart 14: Estimated Availability of Biomass Feedstock in Central Asia in 2030 and 2050



Source: Worley Consulting, IATA Sustainability & Economics, 2025

Potential feedstock availability for SAF

Central Asia, with its significant land resource potential, faces challenges in energy crop production due to its harsh climate. The region is a major wheat producer, with Kazakhstan being the ninth-largest wheat exporter globally.[30] Key cereal crops include wheat (21 Mt) and barley (3 Mt), while cotton and corn production are around 5 Mt and 3 Mt, respectively.[31] In 2023, **agricultural residue** generation was estimated at 45 Mt, potentially reaching 48 Mt by 2050. Currently, only 10% of crop residues are utilized,[32] leaving around 40 Mt

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[29] https://caa.gov.kz/en/blog/post/kazakhstan-actively-participates-impact-aviation-global-warming
[30] World Population Review, 2025, https://worldpopulationreview.com/country-rankings/wheat-exports-by-country
[31] FAO, accessed in 2025, Kazakhstan, https://www.fao.org/faostat/en/#country/108
[32] Laldjebaev, et al., 2021, Renewable energy in Central Asia: An overview of potentials, deployment, outlook, and barriers, https://www.sciencedirect.com/science/article/pii/S2352484721002924?ref=pdf_download&fr=RR-2&rr=91b9c7b88e400032

available for biofuel and bioenergy, primarily from wheat straw. This resource could be directed toward SAF production, as there is little demand for other emerging uses. Kazakhstan is exploring alcohol-to-jet fuel projects using crop residues, but the region's fragmented supply chain and logistical challenges hinder scalability and economic viability.

Forests cover less than 10% of Central Asia, totaling approximately 23 Mha,[33] and are vital for preventing soil erosion, combating desertification, supporting biodiversity, and providing livelihoods. **Forestry residue and wood waste** availability is estimated at around 1 Mt per year.[34] However, they face degradation due to excessive fuelwood harvesting and overgrazing, which has led to restrictions on clear-cuts for industrial wood.[35] Despite some reforestation initiatives, the sector's growth is limited by a focus on conservation, keeping traditional forest product production and byproduct generation minimal.

MSW is a potential biofuel and bioenergy feedstock available in the region. Regional MSW is generated at volumes estimated between 13-14 Mt currently, with disposal both in legally operating landfills and unofficial waste dumps. Unconstrained availability is likely to follow population growth in the region, with a 2% annual rate reported for Central Asia,[36] reaching around 18 Mt by 2050. Kazakhstan, the key market in the region, is currently generating nearly 4.5 Mt of MSW annually, followed by Uzbekistan, around 4 Mt yearly.[37] Although MSW generation is substantial, waste management infrastructure remains inefficient. This leads to poorly managed landfills, inadequate collection services, and low recycling rates, which can contribute to illegal dumping and pollution. A long-term waste management strategy would improve infrastructure and recycling, potentially supporting SAF projects. Central Asia, particularly Kazakhstan, is advancing recycling and exploring waste-to-energy and biogas projects, though SAF availability may be constrained by competing uses.[38]

Key challenges

The region's harsh climate can pose challenges for additional crop production, including energy crops, which might hinder the evolution of the food crop-based fuel market by 2050. Similarly, the region lacks efficient supply chain networks for the collection, aggregation, and transport of agricultural residues, which are often scattered across rural or remote areas. This fragmentation and logistical bottlenecks can pose challenges to the scalability and economic viability of SAF production, particularly through EtJ. Inefficient waste management practices, as well as issues with logistics and infrastructure, can pose challenges in collecting MSW for SAF production. Therefore, the upcoming waste management strategy will be crucial for developing the necessary infrastructure.

Blueprint SAF outcome

Given the challenges with the supply chain and infrastructure in the region, SAF production is expected to reach 5 Mt in 2050. Due to the low amount of biomass availability within the region, PtL technologies are expected to play an important role, with around 65% of this coming from e-SAF.

[33] UNECE, 2019, State of Forests of the Caucasus and Central Asia, https://unece.org/DAM/timber/publications/sp-47-soccaf-en.pdf
[34] FAOSTAT, 2023, https://www.fao.org/faostat/en/#home
[35] UNECE, 2019, State of Forests of the Caucasus and Central Asia, https://unece.org/DAM/timber/publications/sp-47-soccaf-en.pdf
[36] Eurasian Research Institute, accessed in 2025, UN population prospects: case of Central Asia, https://www.eurasian-research.org/publication/un-population-prospects-case-of-central-asia/
[37] UNEP, 2017, Waste management outlook for Central Asia, https://zoinet.org/wp-content/uploads/2018/02/CA-waste-eng.pdf
[38] For example, in Uzbekistan, ongoing projects aim to process 4.7 Mt of solid waste annually (including industrial waste, animal manure, etc.), generating 2.1 billion kilowatt-hours of electric power by 2027. Source: Reuters, 2024, Uzbekistan announces $q.3 bln in waste-to-energy projects, https://www.reuters.com/sustainability/climate-energy/uzbekistan-announces-13-bln-waste-to-energy-projects-2024-10-21/?utm_

7.2 East Asia & Pacific

For the East Asia & Pacific region, the feedstock assessment was conducted for the ASEAN[39] countries, and Australia. Japan, South Korea, and Singapore were not included in the regional blueprint as they are expected to import bio-SAF feedstock due to their low biomass resource potential.

Within the region, ASEAN holds a significant share of biomass resources, with abundant and diverse feedstocks for SAF. Indonesia, Malaysia, Thailand, Vietnam, and the Philippines lead in feedstock availability, with Indonesia and Malaysia benefiting from strong palm oil industries that provide substantial oil-based feedstocks. The region is currently focusing on maximizing HEFA SAF production, leveraging well-established oil-based feedstock supply chains and significant production capacity to serve export markets.

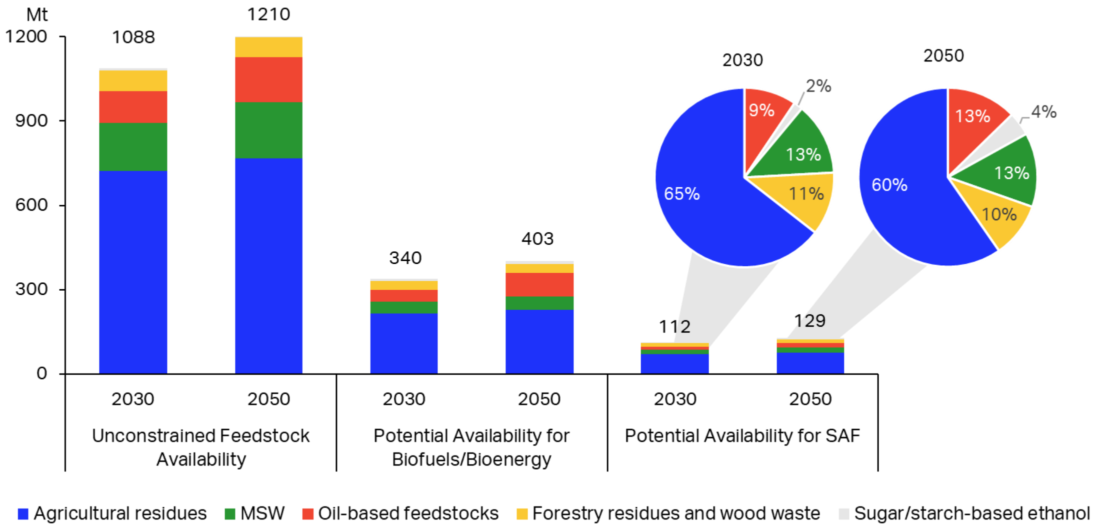
Several policy tools are currently being adopted or considered in countries in the region, particularly through the setting of SAF targets. However, their approaches are largely uncoordinated. Singapore targets 1% SAF for all departing flights from 2026, increasing to 3-5% by 2030, supported by a levy for SAF purchases. Other countries, such as South Korea and Indonesia, have announced roadmaps that require all departing international flights to use a mix of 1% SAF from 2027. The Japanese Ministry of Trade and Industry has set a 10% SAF blending target for domestic airlines by 2030.

Feedstock availability

Unlocking the region's vast oil-based and agroforestry residues resources could enable around 112 Mt of SAF biomass feedstock by 2030 and 129 Mt by 2050.

The potential available biomass feedstock for SAF accounts for approximately 10% of the total unconstrained feedstock available in the ASEAN region and the Pacific in 2030. Most of this feedstock consists of agricultural residues, representing 64% of the total potential. MSW and oil-based feedstocks are expected to constitute an additional 13% and 9%, respectively.

Chart 15: Estimated Availability of Biomass Feedstock in ASEAN & Pacific in 2030 and 2050



Source: Worley Consulting, IATA Sustainability & Economics, 2025

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[39] The Association of Southeast Asian Nations (ASEAN) includes Cambodia, Indonesia, Lao PDR, Malaysia, Philippines, Thailand, and Vietnam.

In 2050, the potential feedstock might rise modestly to 11% of the total unconstrained feedstock available in the region. Agricultural residues are still the primary source (60% of total), followed by MSW (13%), oil-based feedstocks (13%), and forestry residues and wood waste (10%) (Chart 15).

ASEAN holds a significant share of biomass resources in the Asia-Pacific, with abundant and diverse feedstocks for SAF. **Bioethanol** production is still in its nascent stages, with an annual output of around 3 Mt[40]. Although the Philippines, Thailand, and Vietnam have introduced bioethanol production using sugarcane and cassava, the region could significantly expand by leveraging these crops and agricultural residues. To maximize SAF potential, the region will require an increase in cellulosic ethanol production, as well as gasification and FT pathways.

ASEAN, led by Indonesia and Malaysia, is a top palm oil producer, contributing to over 80% of the world's palm oil production, as per 2023, making the region a key **oil-based feedstock** supplier.[41] However, any further expansion of the production is limited by land-use change[42] deforestation and sustainability issues. POME and Palm Fatty Acid Distillate (PFAD) have been increasingly used for producing transport fuels, including SAF, although strong competition from the biogas market may limit the utilization of POME.[43]

Both ASEAN and the Pacific regions have a strong agricultural base. Australia, the 6th largest country by land mass, offers diverse feedstocks, including **sugar/starch-based crops, waste oils, and agricultural residues** like wheat straw and rice husks. ASEAN countries could also use residues from rice, corn, cassava, sugarcane, and palm oil for SAF. Although a significant portion of these agricultural residues is already used in various sectors, around 30% of ASEAN's agricultural residues remain available for bioenergy, with this share expected to rise moderately as crop yields grow.[44] However, both regions face competition from existing industries already using much of this biomass. Australia also exports large volumes of oil-based feedstocks, limiting availability for local SAF production.

Forestry is a major source of biomass in Indonesia, Malaysia, Thailand, and Vietnam. Around 25% of **forestry residues** from the timber industry could be sustainably collected and used for biofuels and bioenergy[45], which, when further supplemented by wood waste, provides approximately 30 Mt to the biofuels market annually. However, the availability of these residues may be limited due to competing uses, such as the expansion of co-firing plants, as well as supply chain constraints[46], harvesting practices, and efforts to reduce illegal logging.[47]

Currently, large volumes of combustible **MSW** are landfilled across the ASEAN region and the Pacific. Due to urbanization and population growth, the generation of MSW is expected to increase by 20% by 2050. While no SAF is currently produced from MSW, this feedstock could be used for SAF in the future if waste management improves and informal dumping decreases. Additionally, the region's active exploration of waste-to-energy (WtE) technologies may increase the availability of MSW for SAF production.

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[40] AESAN Centre for Energy, 2022, The 7th ASEAN Energy Outlook, 2020-2050, https://asean.org/wp-content/uploads/2023/04/The-7th-ASEAN-Energy-Outlook-2022.pdf
[41] AESAN Centre for Energy, 2024, Fueling national and regional ambitions with shared biofuels strength within ASEAN countries, https://aseanenergy.org/post/fuelling-national-and-regional-ambitions-with-shared-biofuel-strength-within-asean-countries/
[42] Land use change involves human activities transforming the natural landscape, typically focusing on the land's functional role in economic activities.
[43] Nasrin et al. 2022. A critical analysis on biogas production and utilisation potential from palm oil mill effluent. https://www.sciencedirect.com/science/article/pii/S095965262201647X
[44] IRENA, 2022, Scaling up biomass for the energy transition: Untapped opportunities in Southeast Asia, https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2022/Feb/IRENA_Biomass_Energy_Transition_2022_.pdf
[45] IRENA, 2022, Scaling up biomass for the energy transition: Untapped opportunities in Southeast Asia, https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2022/Feb/IRENA_Biomass_Energy_Transition_2022_.pdf
[46] Much of the biomass is located in remote or mountainous areas, making collection and transport logistically challenging and economically unviable without targeted investment. Source: https://asean.org/wp-content/uploads/2025/04/12634962-RPT-6-Techno-Economic-Assessment-Final-Report_April-2025.pdf
[47] GHD, 2025, Promoting the production of Sustainable aviation fuels from agricultural waste in the ASEAN region, https://asean.org/wp-content/uploads/2025/04/12634962-RPT-6-Techno-Economic-Assessment-Final-Report_April-2025.pdf

Key Challenges

The ASEAN and the Pacific region have significant volumes of oil-based feedstocks and are highly dependent on acceptance of these feedstocks in target markets. This dependency poses a potential limitation to SAF production. Ongoing deforestation, partly driven by converting forest land to agricultural use, remains a significant concern in many AESAN countries. If not addressed, this trend could reduce the long-term availability of forestry biomass.[48] Additionally, there is limited support for mitigating risks associated with the production of more advanced fuels.

SAF Blueprint Outcome

Each country in the region is expected to focus on its own strengths and available feedstock resources. Due to the high volumes of oil-based feedstocks, HEFA is expected to play a key role in this region, from both co-processing and greenfield facilities. In countries with high renewable energy potential, e-SAF is also estimated to play a key role, with e-fuels providing an opportunity to export their renewable energy resources. In this region, it is crucial to unlock the utilization of abundant agricultural residues through the scale-up of cellulosic ethanol production and gasification + FT routes to fully maximize SAF potential. By 2050, SAF production in the ASEAN and Pacific regions is forecasted to reach 50 Mt, with around 65% coming from Bio-SAF.

7.3 Europe

Europe[49] has a total land area of around 600 Mha, with the European Union accounting for over 400 Mha.[50] The region has a diverse mix of forests and cropland, with forest land covering around 40% of the total land, whereas cropland covers about 25% of the EU area.[51] Forest cover is most extensive in northern and mountainous regions, while cropland is concentrated in many farming areas, such as eastern and southern Europe.

The biofuel and bioenergy sectors in Europe, mainly in the EU, UK, and Nordic countries, are well-developed, with significant amounts of biodiesel and bioethanol produced and used for road transport. Additionally, feedstocks such as solid biomass are already harnessed for combined heat and power applications. Although crops are eligible for use in road transport, the region has a stricter policy framework for SAF feedstocks. This excludes food crops, instead focusing on wastes and residues such as waste oils, agricultural and forestry residues, and MSW.

The SAF policy framework in Europe includes measures such as ReFuelEU Aviation and the UK SAF mandate, which both place mandated targets on jet fuel suppliers to supply SAF that meets specific feedstock eligibility and sustainability criteria. Other notable measures are the inclusion of aviation in the EU ETS, introducing carbon costs for aviation, and the EU Deforestation-Free Regulation (EUDR), which disincentivizes imports of commodities linked to deforestation.

Across Europe, funding mechanisms exist to advance the development and commercialization of SAF projects. Grant programs provide capital for new technologies, while the EU SAF Clearing House supports pathways in securing ASTM approvals and sustainability assessments.

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[48] European Parliament, 2020, Forest in Southeast Asia, https://www.europarl.europa.eu/RegData/etudes/BRIE/2020/652068/EPRS_BRI(2020)652068_EN.pdf

[49] In this assessment, we included the assessment of 41 countries: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czechia, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, and Sweden. Non-EU Nordic countries in Europe: United Kingdom, Iceland, Liechtenstein, Norway, Switzerland, Albania, Belarus, Bosnia and Herzegovina, Moldova, Republic of, Montenegro, North Macedonia, Serbia, Türkiye, and Ukraine. It excludes Russia.

[50] Statista, accessed in 2025, Countries in Europe by area, https://www.statista.com/statistics/1277259/countries-europe-area/

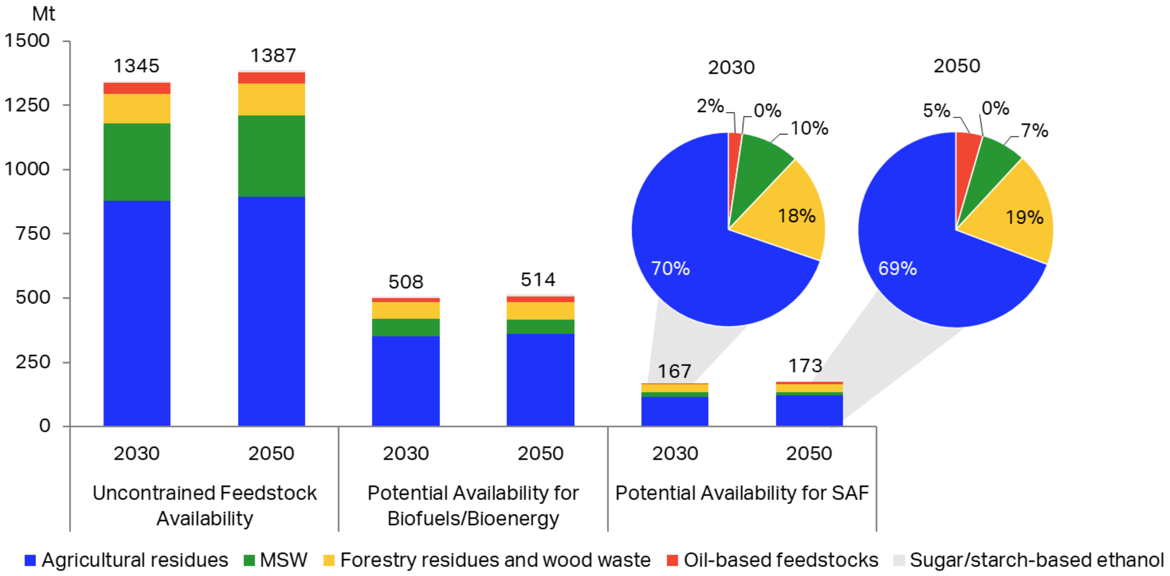
[51] Eurostat, accessed in 2025, Land cover statistics, https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Land_cover_statistics#Land_cover_in_the_EU

Feedstock availability

Biomass feedstock availability in Europe shows limited growth between 2030 and 2050, with the potential volume for SAF only increasing from 167 Mt in 2030 to 173 Mt in 2050. Agricultural residues represent the largest share of available feedstock for SAF, followed by forestry residues. Despite an unconstrained feedstock potential of over 1,300 Mt in 2030, only around 10% is realistically available for SAF, reflecting the significant existing competition from other bioenergy uses and sustainability constraints.

In 2030, agricultural residues are expected to be the largest available source for SAF, contributing around 70%, primarily a result of harvesting crops such as wheat, corn, and barley. Forest-derived feedstocks and MSW are also expected to represent significant amounts of resource, accounting for about 18% and 10%, respectively (Chart 16). In 2050, agricultural residues are expected to remain the leading source, with the overall shares of other feedstocks broadly similar to 2030.

Chart 16: Estimated Availability of Biomass Feedstock in Europe in 2030 and 2050



Source: Worley Consulting, IATA Sustainability & Economics, 2025

With a strict sustainability policy framework on land use change regarding using food crops as feedstocks, the regional focus will be on utilizing waste streams such as agricultural and forestry residues and **waste oils**. However, waste oils are a limited resource, with demand rapidly outpacing sustainable supply. While Europe aims to fully explore and expand its domestic waste oil potential, there will likely remain a need for imports, managed under strict sustainability frameworks.

Approximately 70% of Europe's bioresources come from **agricultural residues**, primarily from wheat, corn, and barley. It is estimated that 30% of agricultural residue generation could be available for bioenergy and biofuel purposes[52]. However, competing markets such as power generation in district heating systems, farm boilers, and co-firing plants are widespread in North-Western Europe. Additionally, other emerging bio-based industries could further limit availability for SAF.

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[52] **ICCT, 2021, Waste and residue availability for advanced biofuel production in the EU and the UK, https://theicct.org/sites/default/files/publications/eu-uk-biofuel-production-waste-nov21.pdf**

Europe's **forestry sector** is central to its bioeconomy and renewable energy strategies, with residues and wood waste widely used for power and heat. With 65-70 Mt potentially available for biofuels and bioenergy between 2030 and 2050, this resource faces growing competition, not only from traditional energy uses but also emerging bio-based industries such as bio-methanol. If strategically allocated to SAF, up to 50% of the biomass available for biofuels and bioenergy could help meet Europe's SAF targets.

With a large generation of **MSW** and substantial availability of combustible MSW already disposed of in landfills, Europe could capitalize on this resource to achieve its decarbonization ambitions through initiatives like the biogas/biomethane plan, which targets the production of 35 billion cubic meters per year by 2030. Although MSW is expected to grow, regulations promoting recycling and composting will limit the share available for fuel production. This will result in limited feedstock for SAF, which is estimated at 20% of the total potential accessible for biofuels and bioenergy purposes.

As for e-SAF feedstocks, Europe faces strict sustainability criteria, with potential implications for costs and competitiveness. Current regulations include restrictions on the use of fossil CO_2 for e-SAF. This adds pressure on existing biogenic CO_2 amounts, raising competition for supply. By 2050, Europe is expected to have about 150 Mt of available biogenic CO_2, representing around 15% of global availability. Additionally, the successful scaling of e-SAF will depend on renewable electricity and hydrogen, where sustainability requirements, environmental planning processes, and energy costs require consideration.

Key challenges

Strict and often fragmented regulations pose a barrier to a functional and efficient SAF market, which would benefit from simplification and harmonization. Regarding feedstocks, there is competition for bio-based resources from other markets such as power generation, including district heating systems and power plants in Northwestern Europe. Acknowledging aviation as a hard-to-abate sector and ensuring feedstocks are strategically allocated to support its decarbonization are key actions for SAF deployment within the region.

Regulatory requirements for biogenic CO_2 in e-SAF production limit feedstock availability, an issue further exacerbated by the expected competition for CO_2 that e-SAF will face from alternative e-fuels and carbon dioxide removals. Additionally, Europe's reliance on imported energy has contributed to high electricity prices, which can be a significant barrier to competitive e-SAF production.

Unintended consequences from existing policy mechanisms can also cause challenges. Current mandates are intended to give demand certainty for SAF, allowing potential producers to unlock the investment required to build SAF production facilities. However, this has so far proven insufficient in successfully advancing projects to a financial investment decision (FID), especially in the case of novel SAF production technologies. This, coupled with the relatively constrained set of eligible feedstocks in Europe, has caused concerns over the cost of compliance under policies such as ReFuelEU Aviation and the UK SAF mandate, which began in January 2025.

SAF Blueprint Outcome

Europe is one of the more advanced regions in terms of enacting SAF policy and outlining its approach to developing the SAF market. There are also an increasing number of projects announced, although uncertainty remains over how many of these will be successful in producing SAF within the region. Additional policy mechanisms to enable and accelerate the scale-up of new SAF production technologies may still be required.

With legislation already in place, Europe is expected to focus on SAF produced from a diverse set of wastes and residues, as well as e-SAF. Recent novel biomass additions to the eligible feedstock lists, including cover crops, represent a deviation from the initial proposed feedstocks; however, their overall impact is still uncertain. By 2050, Europe is estimated to have a SAF production potential of 42 Mt, with around 50% of this coming from bio-SAF.

7.4 Middle East and North Africa

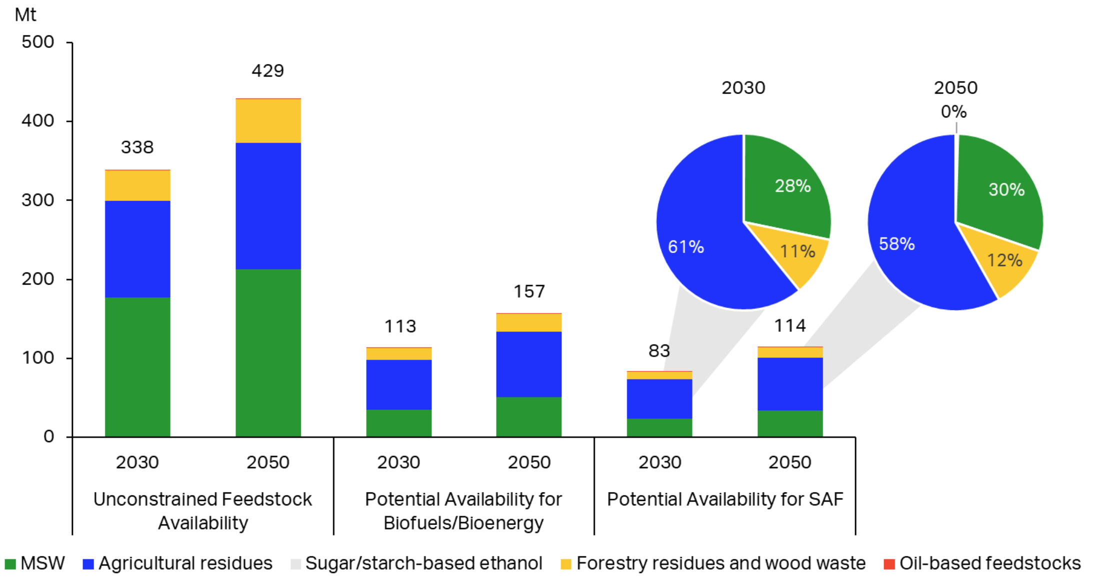
The MENA region[53] spans over 1,400 Mha, with deserts and arid lands making up more than 84% of the territory. Agricultural land covers approximately 300 Mha, primarily used for pastoralism, while croplands account for less than 5%.[54] Despite efforts to implement land policy reforms and improve agricultural practices, food insecurity remains an issue.[55]

As a major player in the energy industry, the region is expected to advance SAF production to maintain its position in an evolving energy landscape. Several nationally owned energy companies have a considerable influence on global energy markets, so government support is expected to accelerate the SAF industry if it is considered a strategic aim.

Feedstock availability

The MENA region is largely arid and thus has constraints on food crop-based biofuel production. Bioresources for SAF will likely be based on wastes and residues, in addition to potential progress on non-food energy crops. With efforts to enable the use of agricultural residues and MSW, the region could unlock around 83 Mt of SAF biomass feedstock by 2030 and 114 Mt by 2050.

Chart 17: Estimated Availability of Biomass Feedstock in MENA in 2030 and 2050



Source: Worley Consulting, IATA Sustainability & Economics, 2025

In 2030, the potential available biomass feedstock for SAF is expected to represent about 25% of the total unconstrained feedstock. Most of these feedstocks are from agricultural residues, accounting for 61% of all potential feedstock, mainly from corn stover, sugarcane bagasse/straw, rice husks, wheat straw, and date palm

[53] MENA regions consist of countries in the Middle East and Northern Africa. Due data availability, only the following were included in the assessment Algeria, Egypt, Libya, Morocco, Sudan, Tunisia and Western Sahara.
[54] World Bank Group, 2023, Land Matters: New report highlights deepening land crisis in MENA region, https://www.worldbank.org/en/region/mena/publication/land-matters-new-report-highlights-deepening-land-crisis-in-mena-region
[55] ME Council, 2023, Food insecurity in the MENA, https://mecouncil.org/publication/food-insecurity-in-the-middle-east-and-north-africa/

residues. MSW and forest-based feedstocks are expected to constitute about 28% and 11%, respectively (Chart 17).

The potential feedstock for SAF is projected to increase by 40% by 2050. Agricultural residues will continue to dominate, comprising 58% of the total SAF feedstock. Meanwhile, MSW, forestry residues, and wood waste feedstocks are expected to account for approximately 30% and 12%, respectively.

Agriculture is vital to many MENA economies, especially around the Mediterranean, despite the region's arid climate. This agricultural activity generates significant biomass resources, which can be harnessed for sustainable energy production.[56] Of the total biomass, **agricultural residues** make up around 60% of the region's bioresources for SAF, primarily from corn stover, sugarcane bagasse, rice husks, wheat straw, and date palm waste. Egypt contributes about 40% of these residues, followed by Iran with 35%. Due to the moderate likelihood of competition with power generation and other biofuels such as bio-methanol, most of the agricultural residues could be largely available for SAF.

Forestry residues are limited due to the region's arid climate and the resulting low quantity of forests. Nonetheless, the region produces wood products, such as timber and fuelwood. Through sustainable practices, logging and wood processing waste could offer some potential for SAF.

MENA can leverage significant amounts of **MSW** as a scalable feedstock for SAF. Over 150 Mt of MSW are generated per year[57] , and this figure is projected to increase due to urbanization and population growth. Currently, the recycling rate in the region is low, with Egypt's rate at around 9%.[58] Although waste management practices in the region are evolving, a significant portion of MSW is landfilled or dumped openly. Some countries are implementing advanced systems that focus on recycling and energy recovery. Following this model and establishing advanced collection facilities that can handle the substantial volume generated in the region, especially in Egypt and Saudi Arabia, could transform MSW into a critical feedstock for producing SAF.

UCO and animal fats are underdeveloped and relatively small markets in the region, which has almost no infrastructure and relies on informal waste management practices. The potential for growth of the UCO market in the region is uncertain, however countries such as Egypt, Saudi Arabia, and Morocco may look to develop further. UCO can be used for HEFA co-processing, which would allow the existing refineries in the region to produce SAF in the short and medium term.

One of the key strengths of the MENA region lies in its significant potential for renewable energy, particularly solar power. This abundant resource could support the production of **e-SAF**, provided that the limited availability of biogenic CO_2 is addressed, potentially through the deployment of DAC technologies. In this context, the announced projects aimed at producing green hydrogen for export to Europe will be crucial. They will help build the necessary expertise and lay the foundation for a robust e-SAF production ecosystem in the region.

Key Challenges

The MENA region faces significant infrastructure challenges in establishing a reliable SAF feedstock supply chain. Bioresources are often dispersed across remote areas, making access both costly and logistically complex. This geographic dispersion, combined with limited accessibility and underdeveloped waste management systems, hampers efficient collection, recovery, and transportation. Moreover, recycling rates remain low, and waste management practices are still evolving, which poses additional barriers to producing

[56] EcoMENA, 2023, Agricultural biomass resources in the MENA countries, https://www.ecomena.org/agricultural-resources-mena/
[57] EcoMENA, 2023, Waste-to-Energy outlook for the Middle East, https://www.ecomena.org/waste-to-energy-perspectives-for-middle-east/
[58] Hemidat et al., 2022, Solid waste management in the context of a circular economy in the MENA region, https://www.mdpi.com/2071-1050/14/1/480

SAF from MSW. Establishing a SAF industry that could utilize the MSW would present several co-benefits, including developing improved waste management systems, addressing key socioeconomic issues, and reducing reliance on landfills. Finally, the limited availability of biogenic CO_2 may constrain e-SAF production in the short to medium term. However, the deployment of DAC technologies offers a promising pathway to overcome this limitation.

SAF Blueprint Outcome

Bio-SAF production in the MENA region is expected to focus on agricultural waste streams and MSW-based feedstocks. In parallel, e-SAF is projected to play a pivotal role in the region's SAF strategy by leveraging MENA's substantial renewable energy potential. Current forecasts indicate that the region could produce up to 31 Mt of SAF by 2050, with nearly 60% derived from e-SAF pathways.

7.5 North America

The estimated potential for SAF production in North America by 2050 is 104 Mt, with over 65% expected to come from bio-SAF. This assessment examines feedstock availability in the United States and Canada, with a deeper focus on the US, recognized as one of the key global hotspots for SAF feedstock availability and SAF production potential.

United States

The US is the third-largest country in the world, spanning a total land area of approximately 920 Mha. About 45% of the land is used for agriculture, including cropland and pastures. The country is a major producer and consumer of bioenergy, which accounts for around 4% of its total energy supply.[59] In 2022, 342 Mt of biomass were used for energy and bio-based chemicals, with corn grain for biofuels and forestry/wood and wood waste for heat and power remaining the top bioenergy sources.[60]

The One Big Beautiful Bill Act (OBBBA), approved in 2025, will supersede the SAF provisions established under the Inflation Reduction Act (IRA), enacted by the Biden Administration in 2022. The OBBBA will provide federal tax credits to farmers and fuel producers, which incentivize the production of SAF. However, this bill has introduced some significant changes, focusing on bio-based fuel production, rather than stimulating the production of new technology SAF, including PtL. Additionally, the bill limits the sourcing of eligible feedstocks to just the US, Canada, and Mexico. As a result, US incentives may make the country a more appealing destination for feedstocks, reducing the volumes available for Canada and Mexico, potentially hindering SAF development in these markets.

Under the Renewable Fuel Standard (RFS), SAF producers can generate Renewable Identification Numbers (RINs), which provide additional credit mechanisms to support production. These RINs can be stacked with the SAF tax credits established by the IRA and subsequently under the OBBBA, and other state-level initiatives such as the California Low Carbon Fuel Standard (LCFS), creating a stronger financial incentive for scaling SAF supply in the US market.

With a diverse range of suitable feedstocks, the US has strong potential to meet its SAF production targets of approximately 9 Mt by 2030 and up to 100 Mt by 2050, under the US SAF Grand Challenge Roadmap. Achieving these ambitions will require the development of a robust SAF market built on a mix of feedstocks, including corn ethanol, various oils, crop and forestry residues, MSW, energy crops, and renewable electricity for PtL

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[59] IEA Bioenergy, 2024, Implementation of bioenergy in the United States – 2024 Update, https://www.ieabioenergy.com/wp-content/uploads/2024/12/CountryReport2024_USA_final.pdf
[60] USDA, accessed in 2025, US bioenergy statistics, https://www.ers.usda.gov/data-products/us-bioenergy-statistics

pathways. Additionally, the US is home to a significant number of announced SAF projects, accounting for around 25% of the global announced capacity.

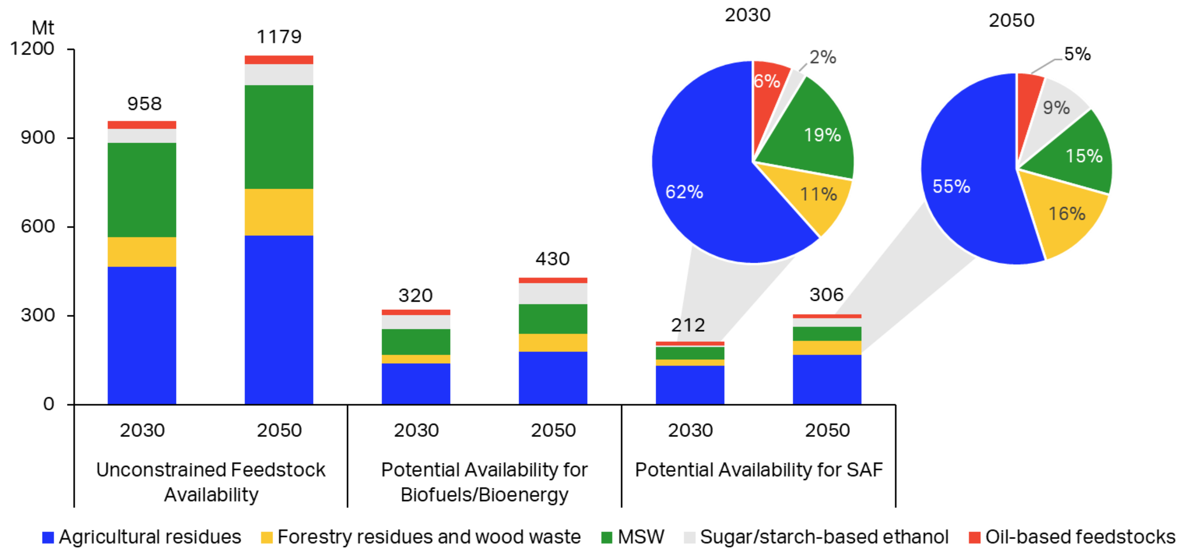
Feedstock availability

The country holds significant biomass resources that could be used for producing SAF. The unconstrained feedstock availability in the US translates into over 200 Mt of biomass feedstock potentially available for SAF in 2030, with a potential growth to over 300 Mt in 2050.[61] The growth will come from increased volumes of agricultural crop residues, sugar/starch crop feedstock, forestry residues, and wood waste (Chart 18).

By 2030, SAF could be produced from approximately 22% of the total unconstrained biomass feedstock supply. A significant portion, about 62%, of this potential comes from agricultural residues. MSW and forest-derived materials are also notable contributors, making up around 19% and 11% of the SAF feedstock potential, respectively.

Looking ahead to 2050, the share of biomass feedstock suitable for SAF is anticipated to grow slightly, reaching 26% of the total unconstrained supply in the region. Agricultural residues are expected to remain the primary source, representing 55% of the total. In addition, forestry residues and wood waste are likely to account for about 16%, while MSW is projected to contribute around 15%.

Chart 18: Estimated Availability of Biomass Feedstock in MENA in 2030 and 2050



Source: Worley Consulting, IATA Sustainability & Economics, 2025

The US **food-crop biofuel feedstock** market excels in current production capacity and potential growth. As biofuel consumption in road transport declines due to EV adoption and electrification efforts, food crops will likely shift to the SAF market. The country is a leading producer of corn ethanol[62], contributing to more than 50% of global ethanol production[63], and can leverage a mature and well-established market and supply system

[61] Animal manure, as a potential feedstock, was excluded from this analysis. Under the OBBBA, animal manure is eligible for the premium tax credit of 1.75 USD/gallon, which could promote SAF made from biogas.
[62] Feedstock for ethanol production consists almost entirely of corn grain (98%), with small contributions from sorghum, and agricultural residue.
[63] USDA, 2023, Global demand for fuel ethanol through 2030, https://ers.usda.gov/sites/default/files/_laserfiche/outlooks/105762/BIO-05.pdf?v=58942

capable of supporting SAF. The recent changes in the OBBBA will likely contribute to the further development of the corn ethanol market in the US.[64]

As a major producer of soybean oil, of which 60% is allocated to the biodiesel/renewable diesel market[65], the country has a robust supply chain to support the SAF market growth. To address the limited growth of food-based oils, the US plans to introduce non-food oilseeds or intermediate oilseeds into crop rotation systems for long-term biofuel production[66]. In addition to **virgin oils, the waste oils market** will play a key role in the country's feedstock profile. Already used widely for biofuels production, local UCO and tallow supply are projected to double by 2050, due to a combination of two factors: firstly, population growth between 2030 and 2050, and secondly, improvements in collection.[67]

Total **agricultural residue** generation is projected to grow steadily, with approximately a 25% increase by 2050 due to improved crop production and yields. Approximately 35% of this residue, mainly corn stover, could be available for biofuels and bioenergy. With low competition in the bioenergy market, about 90% of this biomass could be used for SAF. Most of the agricultural residue generated is found in the Midwest Corn Belt, where well-established infrastructure and advanced agricultural practices can enable efficient collection and transportation. Centralized production in large farms supports efficient management and utilization[68].

The US has a large **forestry industry** with well-developed infrastructure and logistics requirements to support the accessibility of bioresources to the biofuels market. Forestry produces over 100 Mt of wood waste annually, mostly from processing. One-third could be used for bioenergy in the near term, potentially doubling by 2050 through logging residues and wildfire prevention. About 80% of this could be used to produce SAF, especially in the Southeast and Pacific Northwest, where existing infrastructure supports the collection and transportation of woody biomass.

The US is one of the largest producers of **MSW** globally, generating around 300 Mt of MSW per year, making combustible MSW another potential SAF feedstock. The rates of MSW disposal over the last 20 years in the US have remained steady. Around 50% of the total generated MSW (both wet and dry basis) is disposed of in landfills.[69] If recycling and composting rates remain at current levels, this landfilled MSW could potentially be available for energy recovery methods, including biofuel production.

Key challenges

The country faces several key challenges in unlocking its feedstock potential and advancing its SAF initiatives. While market-based incentives are currently in place to support SAF development, their long-term stability remains uncertain. The recent developments and the rollback of support mechanisms for the new technology, and tax value credit for SAF under the OBBBA, are further fueling this uncertainty. Regulatory inconsistencies at the state level, especially concerning financial support and carbon-related penalties, complicate interstate logistics and hinder coordinated national progress. Further uncertainty arises from support mechanisms like RINs, which are subject to volatile, market-driven pricing, making financial planning and investment in SAF projects more complex and less predictable.

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[64] Under the OBBBA, the greenhouse gas emissions associated with indirect land-use change (ILUC) are no longer factored into the lifecycle analysis for corn ethanol. This adjustment effectively removes the ILUC penalty, thereby making corn ethanol eligible for the 1 USD/gallon Clean Fuel Production Credit under Section 45Z.
[65] USDA, accessed in 2025, Soybeans and oil crops, https://www.ers.usda.gov/topics/crops/soybeans-and-oil-crops
[66] USDOE, 2024, 2023 billion-ton report, https://www.energy.gov/sites/default/files/2024-03/beto-2023-billion-ton-report_2.pdf
[67] IEA Bioenergy, 2024, Implementation of bioenergy in the United States – 2024 Update, https://www.ieabioenergy.com/wp-content/uploads/2024/12/CountryReport2024_USA_final.pdf
[68] USDOE, 2024, 2023 billion-ton report, https://www.energy.gov/sites/default/files/2024-03/beto-2023-billion-ton-report_2.pdf
[69] EPA, accessed in 2025, National overview: Facts and figures on materials, wastes, and recycling, https://www.epa.gov/facts-and-figures-about-materials-waste-and-recycling/national-overview-facts-and-figures-materials

SAF blueprint outcome

The country has a significant and diverse supply of feedstock to support all forms of SAF production. With financial support mechanisms in place for all key production routes, the future technology mix is expected to be balanced. The 2050 SAF production potential is forecasted at around 80 Mt, with around 65% being from bio-SAF, while the rest will be e-SAF. A well-developed renewable power capacity and grid infrastructure position the US to deploy e-SAF on a large scale. Investments in cellulosic ethanol, along with the development of gasification and FT technologies, are expected to unlock higher volumes of SAF in the region. This progress will be further supported by the continued expansion of renewable energy and carbon capture infrastructure.

7.6 North Asia

For the purposes of this assessment, North Asia is defined exclusively as the PR China, due to its abundant biomass feedstock availability and its position as a major global hotspot for SAF production.

People's Republic of China

PR China, the world's second-largest economy, stands as a global powerhouse in manufacturing, trade, and technological innovation. Biomass and renewable energy resources are already integral to PR China's energy sector, and the country is expected to become one of the leading producers of SAF worldwide.

PR China's domestic air traffic is thriving with a 5.4% annual growth rate and is forecasted to be the largest aviation market by 2030. This strong demand for air transport will drive domestic SAF production, which is also part of PR China's national strategy focused on energy security. Additionally, PR China has an established oil refining industry and experience with supporting technologies, which can accelerate its capability to scale up SAF production.

PR China does not currently have a specific SAF policy, although measures and tools are available in the field of sustainable fuels and climate actions that support the R&D, financing, and commercial production of SAF. The ongoing PR China SAF Deployment Pilot has mobilized wide support from the SAF value chain, which is experiencing growing participation and expansion. The 15th Five-Year Plan (2026-30) is expected to include more policies to align economic development with a broader security framework that focuses on resilience and risk reduction.

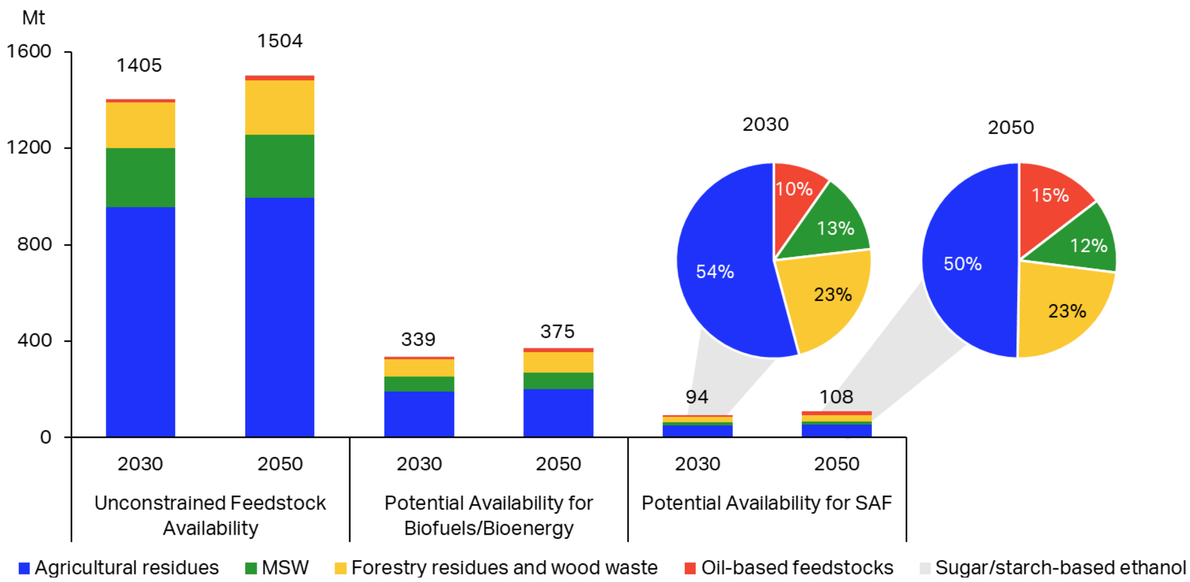
Feedstock Availability

The country has significant potential to supply feedstocks for SAF, including waste oils, agricultural and forestry residues, MSW, and potentially non-food energy crops. Between 2030 and 2050, PR China could unlock up to 100 Mt of biomass for SAF production.

While the total unconstrained feedstock potential might exceed 1,405 Mt in 2030, only 7% of this is expected to be available for SAF once competing uses and sustainability constraints are considered. Agricultural residues dominate the biomass feedstock in PR China (54% of total). However, MSW and forestry residues have the potential to play a significant role as well, accounting for 13% and 23%, respectively (Chart 19).

By 2050, the potential feedstock for SAF is estimated to increase to around 108 Mt, but the potential availability for SAF will remain at around 7% of the total feedstock. Agricultural residues will still be vital, accounting for 50%; however, at 23%, forestry residues and wood waste are also expected to contribute significantly to SAF production. PR China's developing bio-SAF market, centered around waste and residue-derived fuels, should allow the country to capitalize on its substantial agricultural and forestry residues.

Chart 19: Estimated Availability of Biomass Feedstock in PR China in 2030 and 2050



Source: Worley Consulting, IATA Sustainability & Economics, 2025

PR China's vast population and advanced collection infrastructure position it as the world's largest market for **UCO**. Availability is expected to rise as collection rates increase, driven by a mature waste oil trade, as well as high European demand.

As a major agricultural nation, PR China has substantial potential in its **agricultural residues**, particularly crop straw from corn, rice, and wheat. It is estimated that 20% of this biomass is either discarded or burned[70], presenting a significant opportunity for conversion into biofuel or bioenergy, including cellulosic ethanol and SAF. While technological advancements in crop production may moderate growth, the rising population and urbanization continue to drive potential.

Currently, **bio-based ethanol** is limited, with only small production capacity from corn, wheat, and cassava. Under its Renewable Energy Law[71], PR China has indicated a shift to non-food-based biofuel feedstocks, meaning that sugar/starch-based ethanol is not expected to be a sizable feedstock for SAF in the country.

PR China's forestry and grassland sectors have reached a total output value of over 9 trillion yuan, making the country the world's largest producer, consumer, and trader of key forest products.[72] While **forestry residues** are abundant, they are commonly recycled and also widely used for power and heat generation, particularly in the northeast and eastern regions, limiting their practical availability for SAF. Despite these competing uses, it is estimated that up to 40% of forestry residues could be accessible for biofuels, with a portion potentially supporting SAF development.

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[70] IEA Bioenergy, 2016, The potential of biofuels in China, https://www.ieabioenergy.com/wp-content/uploads/2017/01/The-Potential-of-biofuels-in-China-IEA-Bioenergy-Task-39-September-2016.pdf

[71] Zhao, 2018, Assessment of potential biomass energy production in China towards 2030 and 2050, https://backend.orbit.dtu.dk/ws/portalfiles/portal/134278021/Assessment_of_Potential_Biomass_Energy_Production_in_China_towards_2030_and_2050.pdf

[72] China SCIO, 2025, China plants 4.45 Mha of trees in 2024, http://english.scio.gov.cn/pressroom/2025-01/27/content_117687908.html

MSW generation in PR China is substantial and rising, driven by urban growth and population increase. As part of its Green Development Strategy[73], the government is expanding biogas and WtE infrastructure, with over 300 WtE plants currently generating electricity and heat.[74] While this reduces landfill use, it also creates strong competition for MSW, limiting its availability for SAF.

PR China has the world's largest renewable energy production capacity, which, by the end of 2024, had reached nearly 1.9 billion kilowatts, representing a year-on-year increase of over 20%.[75] This approach to renewable energy expansion, coupled with significant CO_2 availability and an established domestic electrolytic hydrogen equipment supply chain, makes the region ideally positioned to implement e-SAF production at scale.

Key Challenges

Producing food crop-based feedstocks comes with its own set of challenges, particularly regarding land and water availability, as these resources are also needed for food production. PR China's preference to move away from these types of feedstocks for biofuels mitigates against these pressures, but it places a greater reliance on the successful commercialization of the technology pathways required to unlock advanced feedstocks such as agricultural and forestry residues. Also, an expansion of biogas and waste-to-energy facilities may limit SAF output from municipal solid waste within the country.

Blueprint Outcome

PR China is well-positioned for near-term SAF production, leveraging significant volumes of waste oils and agricultural residues through HEFA and gasification + FT pathways. PR China has significant current renewable energy capacity and substantial experience in deploying renewables at scale. An ongoing commitment to increase the expansion of renewables at pace, coupled with the domestic production of electrolytic hydrogen equipment, makes PR China well placed to support the development of e-SAF. By 2050, PR China's SAF production potential is estimated at 66 Mt, with e-SAF accounting for about 60%.

7.7 South and Central America

This region encompasses a total of 21 countries[76], rich and diverse in biomass resources. With a projected availability of 1,700 Mt of unconstrained feedstock by 2030, rising to 2,100 Mt by 2050, the region could supply approximately 168 Mt of feedstock for SAF by 2030 and 217 Mt by 2050. Detailed information on biomass resources is not readily available for each country, although it has been possible to conduct a country-specific analysis for Brazil[77], which is estimated to hold about 75% of the region's available biomass resources.

Brazil

Brazil has a total land area of 836 Mha, of which 21% is agricultural land consisting of permanent meadows and pastures, and 7% is agricultural arable land. The remaining land includes 60% forest land and 12% under other land uses.[78] The country is a major producer and consumer of bioenergy and biofuels such as ethanol,

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[73] China's green development strategy aims to align economic growth with environmental sustainability, targeting carbon peaking by 2030 and neutrality by 2060. Backed by strong policies and major investments, it emphasizes renewable energy, green finance, a low-carbon circular economy, and environmental integration across all planning and governance levels. Source: http://www.scio.gov.cn/zfbps/zfbps_2279/202303/t20230320_707666.html
[74] Lee et al., 2020, Sustainable waste management for zero waste cities in China: potential, challenges, and opportunities, https://academic.oup.com/ce/article/4/3/169/5918339
[75] https://climateenergyfinance.org/wp-content/uploads/2025/02/MONTHLY-CHINA-ENERGY-UPDATE-Feb-2025.pdf
[76] Central America and South America encompass 21 countries, with Central America including Belize, Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, and Panama, and South America including Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Guyana, Paraguay, Peru, Suriname, Uruguay, and Venezuela.
[77] While Argentina and Colombia have considerable ethanol and biodiesel markets, their growth potential is limited by land constraints. Mexico and Colombia could tap into agricultural residues, whereas Chile has opportunities to harness forestry residues for biofuel production.
[78] IEA Bioenergy, 2021, Implementation of bioenergy in Brazil – 2021 update, https://www.ieabioenergy.com/wp-content/uploads/2021/11/CountryReport2021_Brazil_final.pdf

biodiesel, biogas, and other solid biofuels, contributing significantly to the renewable energy sector. Sugarcane for biofuels and forestry resources, including wood and wood waste for heat and power, remain the primary bioenergy sources in the country.

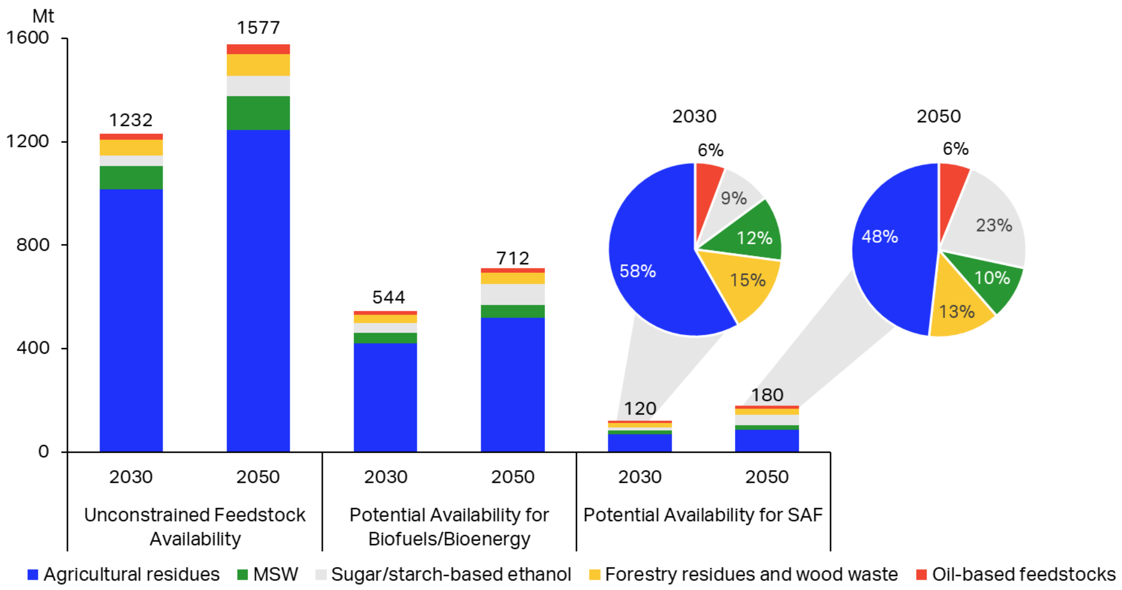
As the world's second-largest ethanol producer, it is well-positioned to scale up SAF production using a diverse range of feedstocks.[79] The country also benefits from a strong refining base and is witnessing a growing number of announced SAF projects. These are mainly intended to utilize either first-generation or advanced ethanol derived from agroforestry residues, employing the EtJ pathway. In line with these efforts, Brazil enacted the "Fuels of the Future" law[80] in 2024, launching the SAF National Program that mandates airlines to reduce their emissions against specific CO_2 reduction targets, through the use of SAF.

Feedstock availability

Brazil could supply over 120 Mt of biomass for SAF by 2030 and 180 Mt by 2050 through leveraging its feedstock resources, including ethanol, oils, agricultural and forestry residues, MSW, and emerging energy crops[81]. By 2030, it is estimated that around 10% of the total unconstrained feedstock supply could be used to produce SAF. Agricultural residues are expected to play the most significant role, contributing approximately 58% of this potential, most of which originates from sugarcane straw and bagasse. MSW and forest-derived materials also make notable contributions, accounting for roughly 12% and 15%, respectively.

Looking further ahead to 2050, the proportion of biomass feedstock suitable for SAF is projected to increase slightly to 11% of the total unconstrained supply in the region. Agricultural residues are likely to remain the dominant source, making up 48% of the total. Forestry residues are anticipated to contribute about 13%, while MSW is expected to provide around 10% (Chart 20).

Chart 20: Estimated Availability of Biomass Feedstock in Brazil in 2030 and 2050



Source: Worley Consulting, IATA Sustainability & Economics, 2025

[79] USDA, 2023, Biofuels Annual, https://apps.fas.usda.gov/newgainapi/api/Report/DownloadReportByFileName?fileName=Biofuels%20Annual_Brasilia_Brazil_BR2023-0018

[80] Brazil's Fuels of the Future Bill (Federal Law No. 14,993/2024), https://cdrlaw.org/resources/brazils-fuels-of-the-future-bill-federal-law-no-14993-2024/

[81] Another promising feedstock that was not included in the estimation is the Macauba palm, an emerging energy crop with considerable potential across South America

Looking further ahead, the 2050 outlook shows only a 50% increase in the share of SAF-eligible biomass compared to the total unconstrained potential. Furthermore, compared to 2030, the role of sugar/starch-based ethanol becomes stronger, emerging clearly as the second-largest SAF feedstock category and reaching 23% of the overall availability.

The rising share of **sugar/starch-based ethanol** in the 2050 outlook highlights Brazil's potential to leverage its sugarcane and corn ethanol industries to scale SAF production. Ethanol growth is expected mainly from corn, while sugarcane ethanol is limited by land. The country is expanding its supply chain to include feedstocks like agave and sugarcane bagasse. However, current uses of sugarcane straw and bagasse in energy and soil conditioning limit their availability, though about 20% could be redirected to SAF with targeted efforts.[82]

Beyond ethanol, Brazil is likely to integrate its established **soybean oil** supply chain into HEFA production. Cropland expansion – that meets sustainability criteria – and livestock productivity gains could triple soybean availability by 2050 to meet the country's B20 diesel and SAF targets. Waste oils like UCO and tallow, though currently underused, are growing due to biodiesel initiatives and could support SAF with better logistics infrastructure and policy focus. Oil-based feedstocks are forecast to represent 6% of the feedstock availability for SAF in 2050.

Brazil's **forest-based industry** stands out in the global economy. With a large territorial extension, forest land in Brazil accounts for approximately 60% of the land area, of which 30% is protected.[83] High volumes of forestry residues and wood waste are generated, accounting for around 50 Mt, with projected steady growth of 2% annual growth rate until 2030 and beyond likely to see this increase.[84] Despite current use in power generation, moderate competition with existing and new users of forestry residue and wood waste could allow 50–60% to be used for SAF.

In addition, significant volumes of **MSW** are landfilled and could be available for biofuel purposes. MSW generation in 2050 is expected to have grown up to 60%, driven by population growth and urbanization. With improved waste management practices, around 18 Mt of MSW could be utilized for SAF production in 2050.

Brazil's renewable energy sources contribute over 50% of its domestic supply. Additionally, its existing grid infrastructure and abundant sources of biogenic CO_2 mean that Brazil has the potential to deploy e-SAF at scale.

Key challenges

Regulatory gaps and high production costs underscore the need for continued policy support and investment. Effective biomass prioritization for the hard-to-abate aviation sector is essential, given competition from bioenergy, waste-to-energy, and other biofuel markets. Strengthening waste governance will also be key to unlocking MSW's potential as a SAF feedstock.

SAF blueprint outcome

Brazil has the potential to become a major SAF producer, leveraging its vast feedstock resources from the agricultural sector in particular. Given its established ethanol industry, mature supply chain, and extensive

[82] EPE, 2024, Combustíveis sustentáveis de aviação no Brasil, https://www.epe.gov.br/sites-pt/publicacoes-dados-abertos/publicacoes/PublicacoesArquivos/publicacao-839/Sum%C3%A1rio%20Executivo%20-%20Combust%C3%ADveis_Sustent%C3%A1veis_Avia%C3%A7%C3%A3o_Brasil_2024.pdf#search=mat%C3%A9ria%2Dprima
[83] Calderon C., Calderon R., 2024, Estimativa da produção brasileira de resíduos madeireiros, https://revistatopicos.com.br/artigos/estimativa-da-producao-brasileira-de-residuos-madeireiros
[84] Report Linker, accessed in 2025, Brazil forestry industry outlook 2024-28, https://www.reportlinker.com/clp/country/6/726263?utm

operational experience in ethanol production, Brazil is expected to favor the EtJ pathway for bio-SAF production, primarily using sugar and starch crops and agroforestry residues.

Besides Brazil, other countries in the region hold significant potential to emulate and learn from them. Argentina and Colombia have modest ethanol and biodiesel markets but could support the SAF industry. Mexico holds significant potential by leveraging abundant agricultural residues such as corn stover and sugarcane bagasse for SAF production that could favor EtJ and FT technologies. Chile, with its strong forestry sector, can utilize forestry residues like pine and eucalyptus waste through FT. Regional collaboration, investment in second-generation biofuels, and supportive policy frameworks are essential to unlock the full SAF potential across these countries.

In South and Central America, bio-SAF is expected to account for 70% of the region's estimated 60 Mt of SAF production by 2050, while e-SAF will account for the remainder.

7.8 South Asia

The South Asia region[85], particularly India and Pakistan, have substantial feedstock diversity, favorable climatic conditions, and significant agricultural activity.

Key drivers for South Asia's potential for SAF include its strong agricultural base, which generates substantial quantities of residues, such as those from agroforestry. The region is a major producer of rice, followed by corn and sugarcane in India. By 2030, the region could unlock around 150 Mt of SAF biomass feedstock. The availability could reach volumes of about 220 Mt by 2050, driven mainly by an increase in crop production to meet food and biofuel demand and a rise in MSW generation led by urbanization and population growth, particularly in India.

The feedstock assessment for South Asia covered the entire region, while a country-specific assessment was only conducted for India. The country holds over 80% of the region's biomass resources, including agricultural residues, non-edible oil crops, and sugar- and starch-rich crops suitable for ethanol production.

India

As one of the world's fastest-growing economies and the emerging third-largest aviation market, India holds remarkable potential for SAF production. Its vast and diverse landscape is home to a rich supply of biomass, from crop feedstocks to wastes and residues, making it uniquely positioned to become a key player in the SAF market.[86] Leveraging experience from its ongoing ethanol blending program and developing strategic government policies could position India as a significant center for SAF production in South Asia.

Similarly, India has extensive experience in refining, being one of the top five refining countries globally, and is currently the seventh largest exporter of refined products and second in ethanol blending in petrol.[87] This demonstrates India's ability to design, build, and utilize complex industrial facilities.

India's latest announced projects and government support through programs like PM JI-VAN[88] showcase the interest and drive toward SAF. The government also aims to subsidize commercial SAF capital costs and technology demonstration projects, offering fiscal and non-fiscal incentives to investors and land subsidies.

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[85] For this study, South Asia encompasses Bangladesh, Bhutan, India, Pakistan, Nepal, and Sri Lanka.
[86] MNRE, ASCI, 2021, Evaluation study for assessment of biomass power and bagasse cogeneration potential in the country, https://cdnbbsr.s3waas.gov.in/s3716e1b8c6cd17b771da77391355749f3/uploads/2023/05/2023053179.pdf
[87] SEAIR, accessed in 2025, India's top petroleum products export in 2025, https://www.seair.co.in/blog/petroleum-products-exported-from-india.aspx
[88] PM JI-VAN is an initiative launched by the Indian Government to promote the bioethanol production using lignocellulosic biomass and agricultural waste. Source: https://www.india.gov.in/information-pradhan-mantri-ji-van-yojana - :~:text=The%20Pradhan%20Mantri%20JI-VAN,an%20alternative%20to%20fossil%20fuels.

Additional benefits include stamp duty exemptions, land use waivers, capital and interest subsidies, goods and services tax (GST) reimbursement, skill development support, and patent fee reimbursement.[89] In line with these efforts, the Indian government has pushed for SAF mandates and aims to achieve 1% SAF by 2027, 2% by 2028, and 5% by 2030.

Feedstock availability

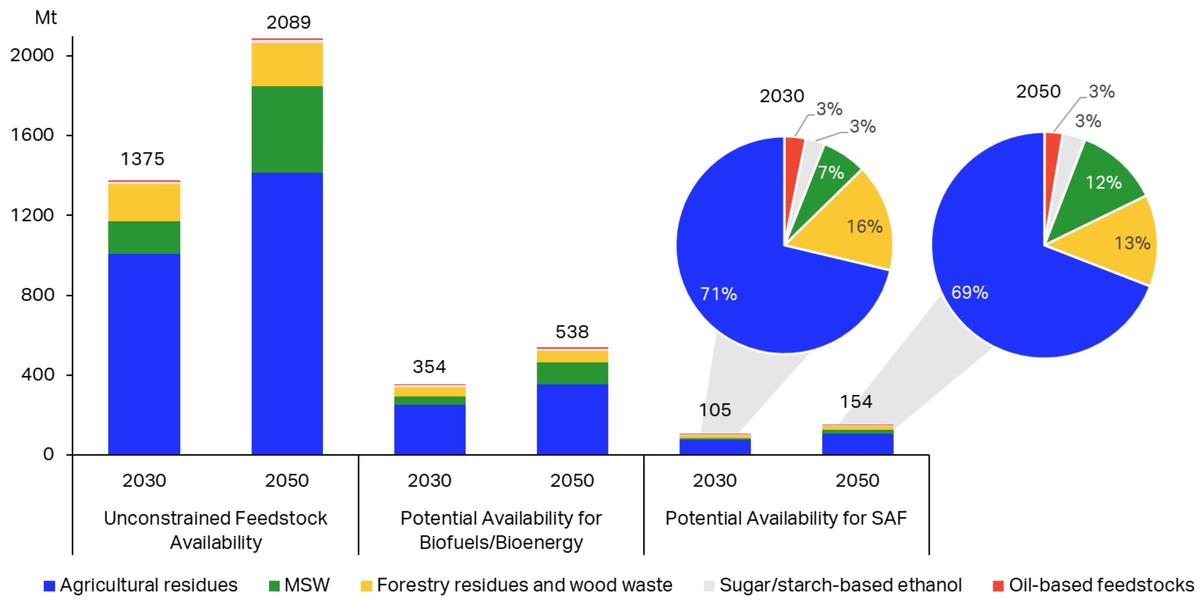
India has a wide range of potential SAF feedstocks, such as sugar/starch-based ethanol, waste oils (UCO and tallow), agricultural and forestry residues, and MSW, which could produce approximately 100 Mt of SAF biomass feedstock by 2030 and 150 Mt by 2050 (Chart 21). This potential could be further enhanced with the expansion of non-food energy crops.

While the total unconstrained feedstock potential might exceed 1,375 Mt in 2030, only 8% of this, or 105 Mt, is likely available for SAF. In 2030, agricultural residues will play a key role, with around 71% of the total potential feedstock for SAF. Forestry residues and wood waste will follow, with 16%, and MSW can comprise 7%.

By 2050, availability is expected to increase by more than 45%, reaching 154 Mt. This growth can be driven by increased availability of agricultural residues following crop production and improved yields, rising MSW supplies, and expansion of the ethanol industry.

India is the world's third-largest **ethanol** producer and is aiming to diversify and expand its ethanol feedstocks by increasing the production of sugarcane juice and starch-rich crops such as corn and cassava. This strategy could potentially double ethanol production from these sources by 2030. Agricultural residues will also support cellulosic ethanol production, further contributing to the SAF targets.

Chart 21: Estimated Availability of Biomass Feedstock in India in 2030 and 2050



Source: Worley Consulting, IATA Sustainability & Economics, 2025

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[89] S&P Global, 2025, India poised to become key SAF player if it tackles cost, policy hurdles: Johnson Matthey, https://www.spglobal.com/commodity-insights/en/news-research/latest-news/energy-transition/022125-iew-2025-interview-india-poised-to-become-key-saf-player-if-it-tackles-cost-policy-hurdles-johnson-matthey

India has the potential to access vast **oil-based feedstocks** like UCO and animal fat, with its UCO market, among the world's largest, continuing to grow as a result of ongoing urbanization and economic development. Though currently unstructured, it could supply significant SAF feedstock with better collection and procurement systems. Currently, India imports around 60% of its vegetable oil. Due to the country's high dependence on other nations for vegetable oils, it is expected that these will be limited for biofuel production in 2050. This is despite India's ambitions to increase rapeseed, soybean, palm, and sunflower oil production.

India's agricultural sector is substantial, generating large amounts of **residues from rice, wheat, corn, and sugarcane production**. However, due to its use in other sectors, only around 25% of this biomass is available for biofuels and bioenergy. The surplus is projected to increase by about 40% from 2030 to 2050, driven by rising food demand and economic growth.

Harvested wood, commonly known as fuelwood, is also a significant energy source in rural areas in India. While moderate growth is expected in the forestry sector, a reduction in fuelwood consumption may occur by 2050 if India advances its national renewable energy initiatives. Similarly, while **forestry residues and wood waste** are available, they are widely used for heating, fodder, and other traditional purposes, limiting their availability for biofuel production to an estimated 25% of the total generated.

Biomass feedstock could be further leveraged with the growth of **non-food energy crops,** like Jatropha, Napier Grass, and Pongamia, which can grow on wastelands. Ongoing research is imperative to tap into the potential of these feedstocks, backed by policy, as they have considerable potential to increase feedstock availability. However, due to the uncertainty in the magnitude of their potential contribution, especially in the mid- to long-term, these feedstocks have been excluded from the study.

MSW generation in India is projected to rise significantly to around 165 Mt in 2030 and up to 430 Mt in 2050[90] due to population growth, urbanization, and economic development. Persistent waste management challenges have prompted the government to set ambitious recycling targets and launch initiatives to use MSW for biogas production, including blending obligations for compressed biogas in the gas distribution system. As a result, the contribution of MSW as a SAF feedstock is expected to remain limited.

India also has strong renewable energy potential, with planned investments into grid infrastructure, and is in the early-stage implementation of solar and wind.[91] Similarly, India has a good availability of biogenic CO_2 from existing sources, such as their cement and ethanol industries, which could be suitable for e-SAF production.

Key challenges

The journey toward sustainable biomass utilization has many challenges. Firstly, sustainability constraints necessitate the adoption of sustainable harvesting practices to ensure that biomass resources are used responsibly. However, the path is further complicated by logistical and infrastructural barriers that hinder the efficient segregation, transport, and storage of biomass feedstocks. Adding to the complexity is the supply chain, which involves aggregating biomass from numerous smallholder sources, making the process even more intricate and inefficient.

SAF Blueprint Outcome

Existing refinery capacity can enable HEFA implementation, especially if swift modifications are made to facilitate co-processing and expand the feedstock basket. As the third-largest ethanol producer in the world,

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[90] ICCT, 2019, The potential for advanced biofuels in India: Assessing the availability of feedstocks and deployable technologies, https://theicct.org/sites/default/files/publications/Potential_for_advanced_biofuels_in_India_20191213_0.pdf
[91] IEA Bioenergy, 2022, Feedstock to biofuels, https://www.ieabioenergy.com/wp-content/uploads/2023/05/The-Feedstock-to-Biofuels-Opportunities-for-advanced-biofuels.pdf

India is expected to scale up EtJ technology routes with food crop-based, molasses-based, and advanced ethanol. In the long term, gasification + FT technology using agricultural or forestry residues may also play a role in the country, as will e-SAF, which is considered to have great potential given its renewable power resources. The technology mix will likely consider EtJ, HEFA, and PtL routes, with strong renewable power and diverse feedstocks giving flexibility to establish a SAF industry tailored to regional strengths. It is estimated that South Asia's production potential for SAF in 2050 is 40 Mt, with around 55% being from Bio-SAF.

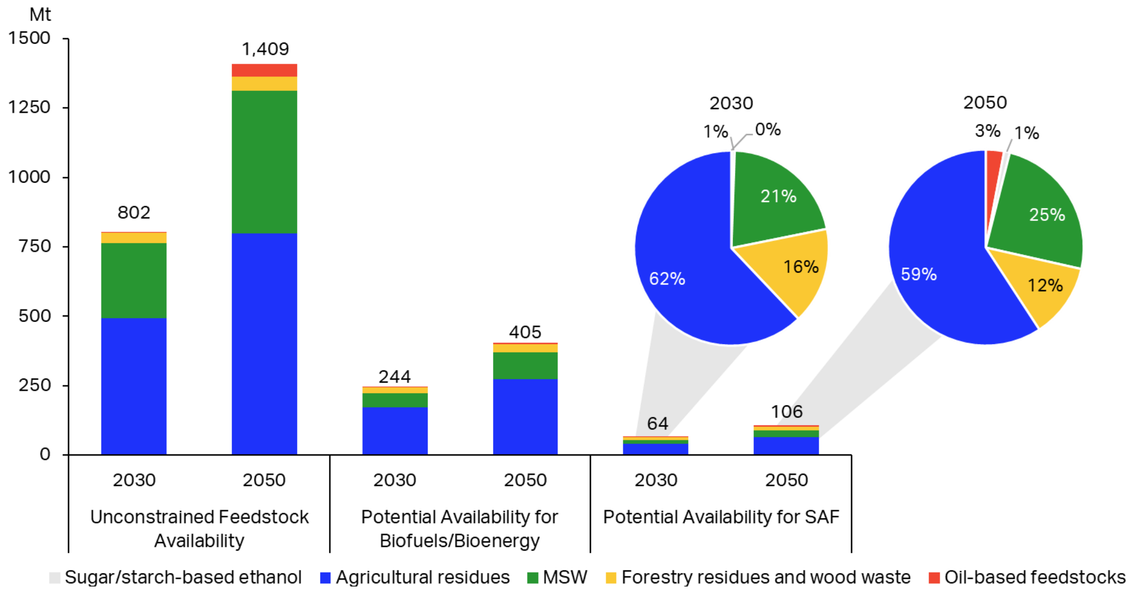
7.9 Sub-Saharan Africa

Background

Sub-Saharan Africa[92] covers approximately 2,400 Mha and is characterized by diverse climates, including arid, semi-arid, and tropical zones.[93] Its agricultural land covers approximately 1,500 Mha, with croplands accounting for about 15% of this area.[94] Despite possessing vast agricultural resources, the region faces challenges such as land degradation, soil infertility, and food insecurity. The region has significant potential for SAF production, but unlocking this will require strategic agricultural improvements, infrastructure development, and addressing existing regulatory challenges.

Policy support and country-level ambitions in Sub-Saharan Africa are largely fragmented. Currently, only a small number of nations are developing policies and roadmaps to support SAF adoption, with Ethiopia being the only nation to have a SAF blending target. This is set to begin in 2030, although the total amounts and specific details are still to be determined.

Chart 22: Estimated Availability of Biomass Feedstock in Sub-Saharan Africa in 2030 and 2050



Source: Worley Consulting, IATA Sustainability & Economics, 2025

[92] Sub-Saharan Africa includes: South Africa, Mozambique, Tanzania, Kenya, Ethiopia, Congo, Cameroon, Nigeria, Togo, and Ghana.
[93] ScienceDirect, accessed in 2025, Sub-Saharan Africa, https://www.sciencedirect.com/topics/earth-and-planetary-sciences/subsaharan-africa
[94] Chiaka, Zhen, 2021, Land use, environmental, and food consumption patterns in Sub-Saharan Africa, 2000-2015: A review, https://www.mdpi.com/2071-1050/13/15/8200

Within the region, agricultural crops, agricultural residues, forest products and residues, and other organic wastes are the main feedstocks for biofuels.[95] By 2030, the unconstrained feedstock is estimated to be 802 Mt, with around 64 Mt of potential feedstock available for SAF, accounting for 8% of the total (Chart 22).

The majority of the SAF feedstocks in 2030 are expected to come from agricultural residues, accounting for around 62% of the potential feedstock available for SAF. Similarly, MSW and forest-based feedstocks are expected to collectively represent approximately 21% and 16% of the potential SAF feedstock, respectively.

By 2050, SAF feedstocks within the region could nearly double, reaching around 106 Mt. This is a result of necessary increases in crop production to meet food demand, with a subsequent residue increase, and a rise in MSW generation prompted by urbanization and population growth. The distribution remains similar, with 59% of feedstock driven by agricultural residues, followed by MSW, accounting for 25%. Forestry residues and wood waste are estimated to constitute 12% of the total potential feedstock available for SAF, while minimal sugar/starch-based ethanol and oil-based feedstocks are projected.

Potential feedstock availability for SAF

The region has high agricultural activity, with over 400 Mt of crop production per year[96], including the main crops cassava, corn, sugarcane, rice, sorghum, and wheat. The Sub-Saharan African region has seven major crop producers, including Nigeria, South Africa, Kenya, Ethiopia, Ghana, Tanzania, Congo, Cameroon, and Mozambique, representing about 90% of total regional production. The region has an estimated food demand growth rate of around 3.9% per year, given projections of per capita consumption growth and population growth,[97] with the increased demand for food expected to be achieved domestically.[98]

Consequently, substantial quantities of **agricultural residues** are generated, which are often left unused or burned. Total residue generation is currently estimated at approximately 390 Mt, with the potential to reach around 500 Mt in 2030 and around 800 Mt in 2050. These represent a considerable source of feedstock for SAF, although sustainable land practices, including the retention of large amounts of residues on agricultural land, will take precedence. There will also be competing pressures from power and domestic heating sectors for biomass resources, reducing the available volumes of residues for SAF further.

MSW generation has increased rapidly in the region. Volumes are estimated to reach around 270 Mt by 2030 and around 520 Mt by 2050[99], with key contributors including South Africa, Nigeria, Kenya, and Ethiopia. Realizing the MSW potential as a SAF feedstock is challenged by systemic issues in waste management across the region, with limited recycling capacity, inadequate infrastructure, and low collection rates. This currently reduces the volume of MSW available for conversion to biofuels or bioenergy. Additionally, ongoing development in WtE and biogas initiatives, such as the National Biogas Programs in Ethiopia, Kenya, and Nigeria, is expected to divert significant volumes of waste away from SAF production.[100] Despite these challenges, it is projected that MSW could still contribute approximately 14 Mt of SAF feedstock by 2030, rising to 26 Mt by 2050.

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[95] IRENA, 2017, Biofuel potential in Sub-Saharan Africa, https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2017/Nov/IRENA_Biofuel_potential_sub-Saharan_Africa_2017.pdf

[96] FAOSTAT, accessed in 2025, Crops and livestock products, https://www.fao.org/faostat/en/#data/QCL

[97] USDA, 2024, Rising per capita consumption drives food demand growth rates in all regions except Sub-Saharan Africa, *https://www.ers.usda.gov/data-products/charts-of-note/chart-detail?chartId=110182#:~:text=Global%20food%20demand%20is%20projected,at%203.9%20percent%20per%20year*

[98] IFAD, 2021, African countries commit to double agricultural productivity as development banks, institutions pledges US$17 billion to increase fodd security, https://www.ifad.org/en/w/news/african-countries-commit-to-double-agricultural-productivity-as-development-banks-institutions-pledge-us-17-billion-to-increase-food-security

[99] Adedara et al., 2023, MSW collection and coverage rates in Sub-Saharan Africa Countries: A comprehensive systematic review and meta-analysis, *https://www.mdpi.com/2813-0391/1/2/24*

[100] MOWE, accessed in 2025, Biogas dissemination scale-up program, https://www.mowe.gov.et/en/sector/energy-development/programs#:~:text=The%20National%20Biogas%20Program%20of,%2C%20Oromiya%2C%20SNNPR%20and%20Tigray.

The region currently generates approximately 37 Mt of **forestry residues and wood waste** from forestry activities[101] and is estimated to follow an expected 36% increase in demand for the forestry sector by 2050.[102] Forestry residues and wood waste are used to some extent for power generation and domestic heating, especially in rural areas with limited access to modern energy. However, there is still a significant untapped resource for SAF, especially if the region develops its energy sector and the infrastructure required to support a sustainable supply chain.

Sub-Saharan Africa has pioneered the commercialization and application of the FT process and has further potential to develop and use this technology to produce SAF. To date, only a few SAF projects have been announced in the region, with little or no public updates on progress. The region also has the potential to produce renewable energy, particularly solar energy, which could be used for e-SAF. However, sizable investments in both power and CO_2 infrastructure are required to overcome the region's energy grid issues[103] and tap into its potential.

Key Challenges

Similar to other areas of its energy sector, Sub-Saharan Africa has limited regulatory support for scaling up SAF production, hindering short-term SAF production rollouts. The region faces significant challenges due to underdeveloped infrastructure, especially in remote areas where transportation and accessibility are limited. This can further limit the availability and distribution of SAF feedstock. However, established logging operations and the introduction of better road networks could enhance the use of agricultural residues, MSW, and wood-based resources for SAF production.

The high perceived risk premiums and a lack of supportive national government policies currently hinder the region's progress within the SAF value chain, although international collaboration could help unlock its significant potential.

SAF Blueprint Outcome

Sub-Saharan Africa holds substantial capacity for development, primarily due to its abundant biofuel feedstock potential and favorable conditions for cultivating energy crops. The region also boasts high renewable energy promise, although realizing this will require significant investment in infrastructure. A notable strength lies in its established expertise with the FT process, positioning it to favor this technology route for both Bio-SAF and e-SAF production. However, progress remains slow, with few SAF project announcements to date. This sluggish momentum is largely attributed to limited regulatory frameworks and insufficient policy support and investments, which risk hindering broader SAF deployment.

To help address these barriers, the ICAO ACT-SAF Program[104] is playing a supportive role by offering training, feasibility studies, and implementation assistance to help unlock the region's full SAF potential. Under the core forecast, the region could produce around 7 Mt of SAF by 2050, with approximately 75% derived from bio-based sources.

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[101] FAOSTAT data from forestry production and wood waste generation excludes what is potentially generated from roundwood production as this market seems to be developed under unsustainable wood fuel extraction, with a significant portion of the wood fuel sector operating informally, making it difficult to monitor and regulate. Source: *https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2017/Nov/IRENA_Biofuel_potential_sub-Saharan_Africa_2017.pdf*

[102] BII, 2024, Investing for impact in African forestry, *https://assets.bii.co.uk/wp-content/uploads/2024/03/21085919/BII-Insight-Sustainable-Forestry.pdf*

[103] Some industries are currently experiencing significant brownouts in the region, so direct wire solutions are likely required to fulfill energy demand needs.

[104] ICAO, accessed in 2025, ICAO ACT-SAF, https://www.icao.int/assistance-capacity-building-and-training-sustainable-aviation-fuels-icao-act-saf

8 Conclusions

As the world seeks to reduce the use of fossil energies and replace them with renewable alternatives, it is important to ensure that policymaking and investment decisions are based on the best and most robust qualitative assessments and information possible. This assessment of what is needed to achieve net zero CO_2 emissions in air transportation by 2050 finds that the estimated volumes of SAF production are set to fall around 100 Mt short of those required in 2050.

According to the analysis, biomass feedstock availability is substantial. However, not all such feedstock will be allocated to SAF production, as some quantities will benefit other uses. SAF production can therefore not rely on biomass feedstocks alone, even if production technology is successfully maximized. Bridging the gap requires both secure access to sustainable biomass feedstocks and an urgent and accelerated scaling-up of novel SAF technologies. This includes e-SAF, which, alongside bio-SAF, can help reach the targeted volumes. However, the rollout of e-SAF will depend predominantly on the availability of low-cost renewable electricity, hydrogen, and CO_2.

Establishing a global, liquid, and transparent SAF market will require coordinated action across the entire value chain. Delays in the rollout of new technologies, as well as in feedstock development, supply chains, harmonized market regulation and administration, and all other aspects of new energy-market creation, heighten the risks of insufficient supply between now and 2050. Importantly, it is also necessary to deliver attractive investment propositions that address the current relative incentive in favor of the oil and gas sector. Failing that, private sector capital will find superior returns elsewhere, and it will increasingly fall upon the public sector to fill the gap.

It is said that it takes a village to raise a child, and in that sense, the responsibility for ensuring sufficient growth in renewable energy production, renewable fuel production, and specifically SAF production regarding air transport rests with the entire global community, none more so than with policymakers.