A quiver of policy tools needed to hit sustainable aviation fuel targets

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Introduction

Sustainable aviation fuels (SAFs) are a key tool for reducing emissions from aviation and are set to expand to over 2% of global aviation demand by 2030 in the IEA's main case forecast based on legislated SAF support policies. This growth is being driven primarily by mandates, incentives and financial support in the United States, Europe and Japan. Nearly all expected production to 2030 is based on mature commercial technologies – specifically hydroprocessed esters and fatty acids (HEFA) – using feedstocks such as vegetable oils and residue oils.

In the IEA's forecasted accelerated case[1], which includes the implementation of planned SAF support policies, SAF use would further double, approaching 5% of global aviation demand by 2030. Such growth would make a significant contribution toward ICAO's aspirational target of a 5% reduction in international aviation CO_2 emissions by 2030, with announced SAF projects offering more than enough capacity to meet this level of demand. However, even this more optimistic trajectory falls well short of the IEA's Net Zero Emissions by 2050 Scenario, which depends on SAFs providing near 25% of total aviation fuel demand by 2035.

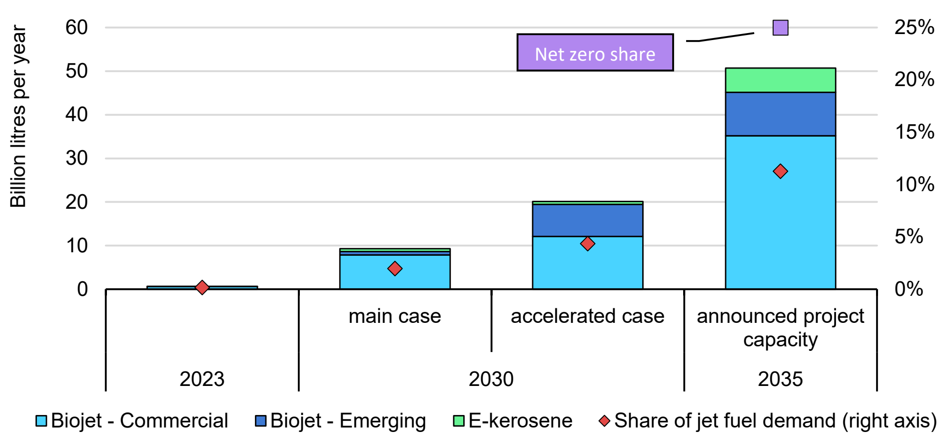

FIGURE 1: Sustainable aviation fuel demand, 2023 to 2035 main, accelerated case and announced capacity. Source: IEA (2024) Renewables 2024[2], IEA (2024) Oil 2024[3] and IEA (2024) World Energy Outlook[4]. Announced project capacity adapted from Argus Direct[5] (2024) Global sustainable aviation fuel & renewable diesel refinery database. Note: "Commercial" includes HEFA and "Emerging" includes alcohol-to-jet and Fischer-Tropsch. The "main case" is based on legislated policies and existing markets conditions including costs, feedstocks and production capacity. The "accelerated case" assumes planned policies are legislated and actions are taken to remove market barriers such feedstock availability and capacity additions to meet new demand.

1 https://www.iea.org/data-and-statistics/data-tools/renewable-energy-progress-tracker
2 https://www.iea.org/reports/renewables-2024
3 https://www.iea.org/reports/oil-2024
4 https://www.iea.org/reports/world-energy-outlook-2024
5 https://direct.argusmedia.com/

Despite growing momentum, three interrelated challenges threaten to limit the pace and scale of SAF deployment beyond the main case forecast and post 2030. First, commercial SAFs are near triple the price of fossil jet fuel[6] and only a handful of countries have established clear SAF targets backed by enforceable penalties or incentives to compensate the cost gap. Second, most planned facilities rely on a narrow subset of the potential sustainable biomass feedstock base, and there is limited innovation support to diversify feedstocks and reduce the costs of new processing technologies. Third, even where SAF requirements exist, many lack accompanying financing frameworks capable of catalysing project investment.

To address these challenges and to enable SAF deployment, three core policy enablers must be deployed in tandem. **Performance-based policies** to compensate the cost gap and reward fuels with the lowest lifecycle emissions, **innovation and feedstock diversification** support to expand the set of economic and scalable production pathways and, **targeted financial instruments** to reduce investment risk, and support project construction.

Performance based policies

Long-term demand policies act as the foundation of SAF strategies; but they are only effective when paired with penalties and incentives to compensate the cost gap and establish clear performance requirements to ensure compliance. Performance based policies strengthen this foundation by enabling fair and transparent comparisons between SAF pathways based on their lifecycle greenhouse gas (GHG) intensity, not simply their origin or volume. SAFs vary widely in emissions performance depending on the feedstock used, conversion technology and choice of energy inputs. While all pathways can offer potential for GHG reductions, aligning financial incentives with GHG performance encourages continuous improvement and rewards the most effective solutions. Critically, this approach often encourages more efficient use of limited feedstocks, directing them to applications with greatest emissions impact per litre.

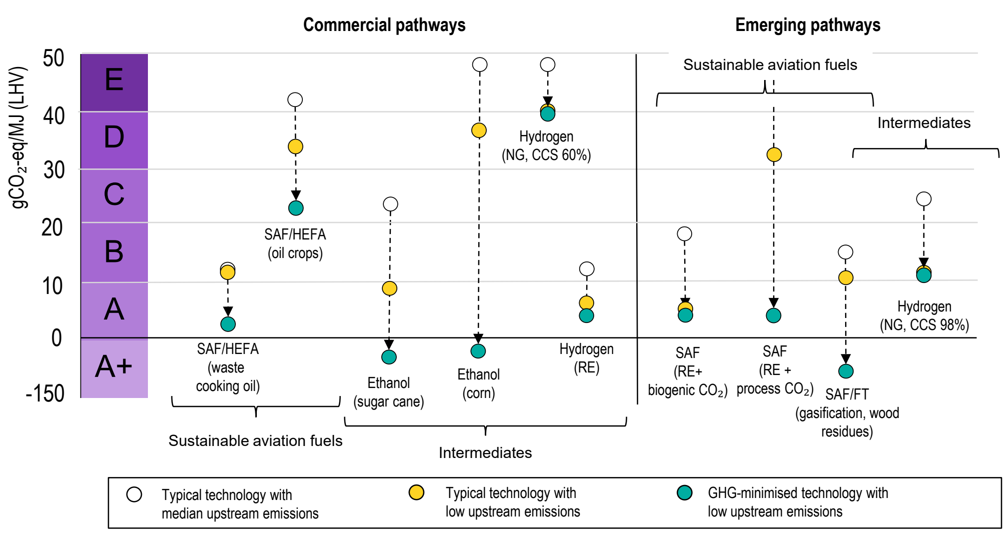

FIGURE 2: Example of a quantitative GHG intensity labelling system for selected sustainable fuel pathways. Source: IEA (2024) Towards Common Criteria for Sustainable Fuels[7]. Note: Fossil jet fuel has a life cycle carbon intensity of 89 gCO_2-eq/MJ[8].

6 https://www.iea.org/reports/renewables-2024
7 https://www.iea.org/reports/towards-common-criteria-for-sustainable-fuels
8 https://www.icao.int/MID/Documents/2022/CORSIA-SAP Seminar/4.CEF_Intro_v1.pdf

Performance based policies can take many forms, including minimum GHG thresholds, carbon intensity reduction targets and performance linked incentives. The EU's ReFuel Aviation regulation for instance sets use targets and requires SAFs with 70% or greater improvement over fossil fuels. In the United States the Inflation Reduction Act (IRA) provides a base incentive of USD 0.33 per litre for SAFs meeting a 50% improvement threshold, with payments up to USD 0.46 per litre for fuels with superior performance. This approach rewards incremental improvement but does not guarantee fuel uptake or total emission reductions. Brazil takes yet another approach in its National Program for Sustainable Aviation Fuel[9], requiring annual GHG reductions that airlines must meet with SAFs, guaranteeing emission reductions but not volumes.

Given the international nature of aviation, domestic performance based policies must be designed with compatibility in mind. Here, CORSIA, plays a critical role by establishing minimum GHG thresholds and clearly defining lifecycle methodology to allow for cross-border compatibility.

There is also value in aligning sustainable fuel carbon accounting practices across aviation, maritime, road and industrial sectors since many of the fuels share supply chains and single production facilities can serve multiple uses. For instance, the IMO's recent net-zero regulations for global shipping[10] announcement includes developing a set of default emission factors for sustainable fuels with considerable methodological overlap with pathways covered by CORSIA. There is good potential for broad alignment, since direct emissions over a fuels lifecycle is well understood.

However, some of the most contentious lifecycle variables — especially ILUC for biofuels, additionality requirements for electrolytic hydrogen, or the role of fossil-based CO_2 feedstock for e-fuels — require careful political and methodological decisions. Where quantitative data is unavailable or uncertain, such as the case with ILUC, risk-based approaches — when based on objective and transparent indicators — can be used to certify low-risk agricultural practices across feedstock types. Ultimately, performance frameworks must be supported by broader governance structures that protect environmental integrity and preserve public trust.

Innovation to diversify feedstocks and reduce costs

Accelerating the uptake of SAFs will depend on deploying a diversity of innovations ranging from agricultural practices to new conversion technologies. In the IEA's Net Zero by 2050 Scenario, biomass use for the energy sector is limited to 100 EJ to avoid conflicts with other uses of land, notably for food production and biodiversity protection. This amount falls within the lower range of global estimates of global sustainable bioenergy potentials. Considering competition with other bioenergy uses the amount is sufficient to meet one third of aviation demand by 2050. However, nearly all SAF capacity expected to be commissioned by 2030 relies on vegetable oils and residue oils. These are the same feedstocks relied upon by renewable diesel and biodiesel producers, leading to intensifying competition. Combined demand would drive up residue oil use to near 80% of collectible supply and vegetable oils up seven percentage points from 2023 levels to 27% of global supply under current policy settings by 2030. Ethanol feedstocks are under less pressure as growing biofuel demand matches growth in global sugar and starch production to 2030.

A range of policy levers can help unlock the potential of improving yields through approaches such as sequential cropping and enabling production on degraded and marginal land. These include restrictions on unsustainable land-use. For example, CORSIA's sustainability criteria[11] and Brazil's RenovaBio[12] prohibits the removal of native vegetation for biofuel feedstocks production. Another approach is to create dedicated pathways for sequential cropping and for crops grown on marginal or degraded land, as included in CORSIA and the EU's feedstock eligibility criteria. In addition, financial support can help reduce the

9 https://www.planalto.gov.br/ccivil_03/_ato2023-2026/2024/lei/l14993.htm
10 https://www.imo.org/en/MediaCentre/PressBriefings/pages/IMO-approves-netzero-regulations.aspx
11 https://www.icao.int/environmental-protection/CORSIA/Pages/CORSIA-Eligible-Fuels.aspx
12 https://atosoficiais.com.br/anp/resolucao-n-758-2018

risk of adopting new seed varieties and planting techniques. For instance, the United States has provided funding[13] for research into winter oilseed crops including efforts to integrate them into existing rotations. De-risking new seed varieties and planting methods are also needed to expand planting, such as US financial support for such studies[13].

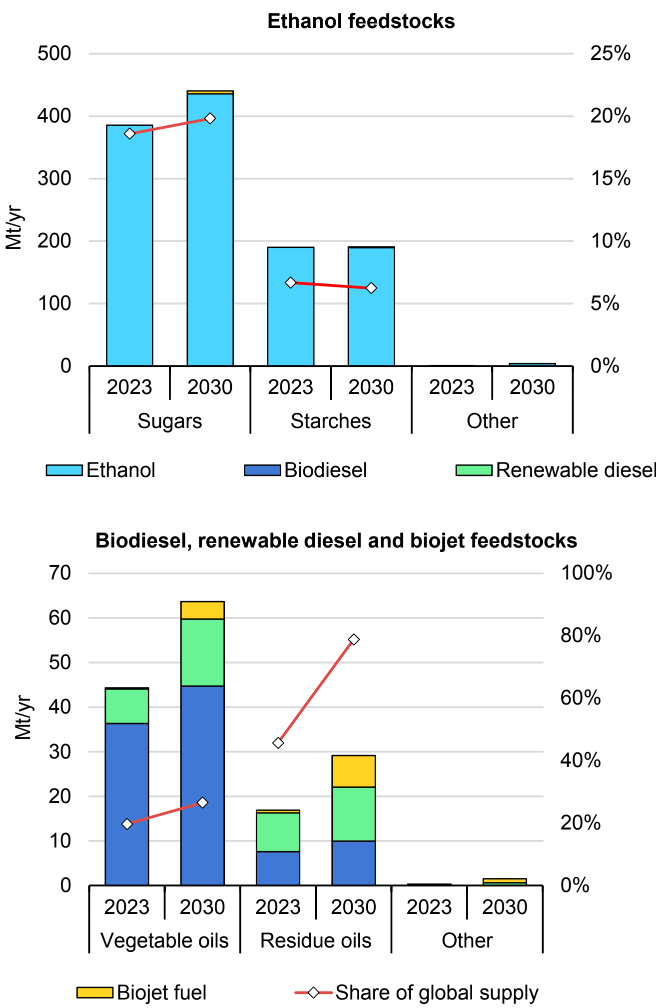

FIGURE 3: Global biofuel feedstock demand, main case, 2023 to 2030. Source: IEA (2024) Renewables 2024[14] see for detailed notes. Note: Share of global supply based on FAO (2024) Agricultural Outlook 2024-2033 including feedstock supply for food, feed and industrial uses.

On the conversion side, innovation in processing technologies is critical to widen the SAF feedstock base. Emerging routes include alcohol-to-jet, Fischer-Tropsch synthesis using solid biomass, and electrolytic routes to jet fuel (e-kerosene). In aggregate, these pathways could contribute up to 10 EJ of sustainable fuels by 2050. Production from such first-of-kind facilities will be more expensive than today's commercial SAF pathways. However, targeted support can help reduce costs[15] through economies of scale and learning, eventually nearing those of HEFA facilities. Guaranteed demand using mandates (as in the UK[16]), capital support for first-of-a-kind projects (as in the United States[17]) and technical approvals through ASTM or equivalent standards are all needed to support new projects. Equally important is the integration of new pathways into existing regulatory frameworks, as seen in California's LCFS, which incorporates novel SAF routes through protocol updates.

Finance

Even with demand policies and innovation support, targeted financial instruments are essential to mobilise investment. SAF developers face several risks: uncertain long-term demand, evolving regulatory frameworks and, variable SAF and credit prices. These dynamics make it difficult for developers producing a new product for a new market to secure financing at competitive terms, particularly in emerging markets where policy support may be less stable.

For instance, in the United States the Department of Energy has supported two major SAF projects with near USD 3 billion in flexible loans via its Title 17 Clean Energy Financing Program[18]. In Brazil, BNDES announced dedicated support of near USD 1.2 billion for sustainable aviation fuel development, building on similar supports for ethanol facilities. India's ethanol expansion offers a relevant model as well, its interest subvention scheme[19] and guaranteed pricing, enabled ethanol capacity to expand nearly fivefold

13 https://portal.nifa.usda.gov/web/crisprojectpages/1032231-fueling-winter-canola-cultivar-availability-to-meet-new-demand-for-oil.html
14 https://www.iea.org/reports/renewables-2024
15 https://iea.blob.core.windows.net/assets/17033b62-07a5-4144-8dd0-651cdb6caa24/Renewables2024.pdf
16 https://www.gov.uk/government/collections/sustainable-aviation-fuel-saf-mandate
17 https://www.energy.gov/eere/bioenergy/articles/first-ethanol-alcohol-jet-synthetic-aviation-fuel-production-facility?nrg_redirect=472803
18 https://www.energy.gov/lpo/title-17-clean-energy-financing
19 https://pib.gov.in/PressReleasePage.aspx?PRID=2109157#:~:text=Under%20this%20modified%20Ethanol%20Interest,being%20borne%20by%20the%20Central

in five years. The United Kingdom is in the process of developing a revenue certainty mechanism[20] that sets a fixed, long-term price for SAF, regardless of market dynamics.

Other mechanisms can help aggregate demand and signal long-term market confidence. Tradable certificates, such as RSB's Book & Claim Programme[21], allow obligated parties or voluntary buyers to support SAF deployment without physical blending, opening doors for international supply chains. Green capital markets are also playing a growing role. Neste, for instance, issued a €700 million green bond[22] to finance its Rotterdam SAF expansion, aligning proceeds with sustainability criteria under its Green Finance Framework.

Conclusion

The first wave of regulations and incentives is only beginning to spur investment in sustainable aviation fuels, but it is already clear that a coordinated and comprehensive policy approach is essential.

Performance-based policies can compensate the cost gap with fossil jet fuel and ensure fuels are rewarded for their actual GHG benefit. Innovation and feedstock diversification enable long-term growth without compromising land or food systems by unlocking feedstock pathways and making them cost competitive. And financing tools create the conditions for developers to take investment risks and build the infrastructure needed for scale. Together, these elements form a robust policy ecosystem — one capable of driving sustained growth and achieving near-term and long-term targets.

20 https://www.gov.uk/government/consultations/saf-revenue-certainty-mechanism-approach-to-industry-funding/sustainable-aviation-fuel-revenue-certainty-mechanism-approach-to-industry-funding
21 https://rsb.org/programmes/book-and-claim/
22 https://www.neste.com/news/neste-corporation-issues-a-eur-700-million-green-bond-with-5-year-maturity