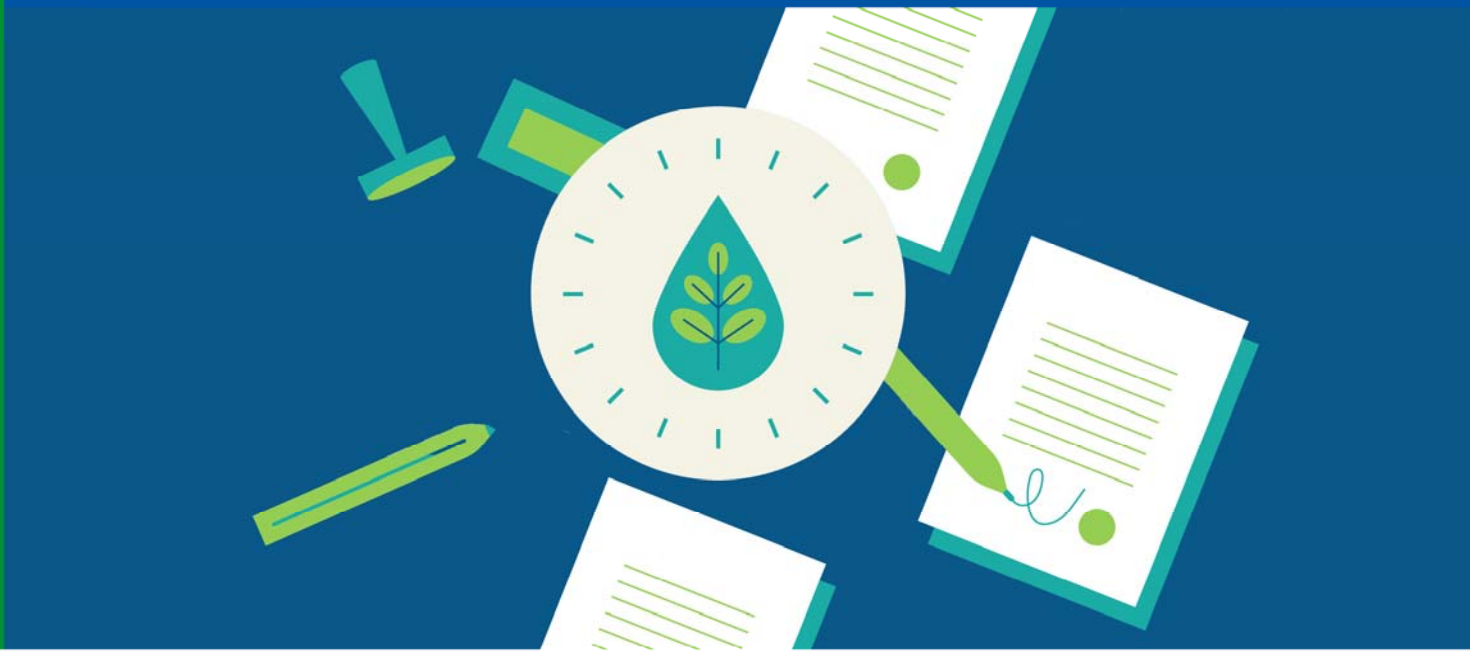
INTERNATIONAL CIVIL AVIATION ORGANIZATION

ICAO GUIDANCE ON POLICY MEASURES FOR SUSTAINABLE AVIATION FUELS (SAF) DEVELOPMENT AND DEPLOYMENT



ICAO COMMITTEE ON AVIATION ENVIRONMENTAL PROTECTION

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ICAO guidance on policy measures for SAF development and deployment

This guidance has been developed by the ICAO Committee on Aviation Environmental Protection (CAEP) based on various studies developed since 2016. Based on these developments, it summarizes potential policies and coordinated approaches for the deployment of SAF. It provides a toolbox of guidance material for use by ICAO Member States and can be used in combination with the ICAO SAF Rules of Thumb, a set of heuristics that can be utilized to make order-of-magnitude estimations related to SAF costs, investment needs and production potential that could inform policymakers and project developers.

ICAO GUIDANCE ON POLICY MEASURES FOR SAF DEVELOPMENT AND DEPLOYMENT

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Version History

Date	**Version n°**	**Remarks**
June 2022	1	First Version of the document
March 2023	2	- addition of policy examples in Section 5. - updates on Appendices B, C and D related to “Policy Approach Examples” for the European Union, United Kingdom and United States respectively - minor edits and corrections to the text
October 2024	3	- update of the guidance following the evolution of several regulatory frameworks detailed in the documents and comments received from experts of the Technology, Production and Policy (TPP) subgroup of the CAEP Fuels Task Group (FTG) - update of the name of the guidance in the context of the ICAO Global Framework for SAF, LCAF and other Aviation Cleaner Energies.

1. Introduction

Sustainable aviation fuel (SAF) is being pursued globally as an element of a comprehensive basket of measures to address aviation's impact on climate change and the environment. Use of SAF by the global aviation industry has the potential to provide significant life-cycle reductions in aviation greenhouse gas emissions as well as reductions in pollutants that impact air quality. SAFs are liquid hydrocarbon jet fuels that are fully fungible with existing conventional kerosene and can be 'dropped in' to existing fueling infrastructure and aircraft jet engines without any modification. A rigorous evaluation process has been established for qualifying a wide variety of SAF pathways as safe for use by the aviation industry. ASTM International D7566 is recognized by the industrial sector as the leading specification for SAF. For more general information on SAF please see ICAO's SAF website.

While SAFs have been confirmed to be technically feasible, broadening the availability and cost-effective production of SAF remains a significant challenge. As of the writing of this document, SAF production capacity is limited by a number of barriers including significantly higher costs of production for SAF in comparison to conventional kerosene; limited feedstock and fuel production infrastructure; and, perceived high risks and costs to finance SAF infrastructure. As long as these barriers exist, policy interventions will be required to develop SAF production beyond small scale.

In general, a supporting policy framework is in place in those States where SAF production has been initiated. For the build-out of a sustained global SAF production industry, though, additional supporting policies will be necessary. Due to different climates, agricultural systems, resources, and economic factors, the opportunities for SAF production may be unique in each specific State. The political barriers, existing regulatory structure, and economics are also likely to be unique in each State. As such, there is not a single path to successful SAF policy implementation. Rather, a considered and customized strategy can be effective.

This policy guidance document is intended as a support reference for ICAO Member States seeking to develop SAF production or part of the SAF supply chain such as feedstock production. It is provided as an introduction and primer on the types of policy mechanisms and their impacts. It provides examples of SAF policy approaches being utilized and considered around the world. It also provides links to additional resources that may be useful. It is a resource for use in consideration of what potential policy instruments could play a role in addressing barriers and catalyzing SAF production in an interested State.

Over the course of the period of development of this document (2020-2024), a dramatic acceleration in SAF policy activity occurred in both States and public/private coalitions. This document attempts to capture the current status on SAF policies, but it is expected that a high level of SAF policy activity and development will continue over the next decade. Where possible, live weblinks are provided to resources that are anticipated to be updated as circumstances merit.

2. Policy Guidance Task Background

This guidance has been developed by the ICAO Committee on Aviation Environmental Protection (CAEP) based on various studies performed since 2016. These included:

- assessments of existing policy instruments incentivizing deployment of SAF;
- review of barriers or disincentives to SAF production;
- identification of potential policies which have been demonstrated to be feasible, effective and practical, based on best practices, lessons learned and proven positive results from the

implementation of those policy instruments, which might include policies developed for other sectors, applicable to air transport;

- identification of common elements and general recommendations to facilitate the implementation of those policies and incentive mechanisms by Member States or regions using effective policy approaches when considered beneficial;

- various techno-economic analysis (TEA) of policy options to foster the deployment of SAF.

Based on these developments, this document summarizes a subset of the potential policies and coordinated approaches for the deployment of SAF. It provides a toolbox of guidance material for use by ICAO Member States and can be used in combination with the ICAO SAF Rules of Thumb, a set of heuristics that can be utilized to make order-of-magnitude estimations related to SAF costs, investment needs and production potential that could inform policymakers and project developers. The Rules of Thumb are described in more detail in a later section of this document.

3. What defines an effective SAF policy?

SAF production is currently limited by a number of challenges to further development and deployment including:

a) the cost differential with conventional kerosene and the current higher costs of production for SAF;

b) limited availability of cost-effective and sustainable SAF feedstocks (e.g. biomass, waste, or residue) and feedstock conversion infrastructure;

c) limited investment and high costs of financing of SAF fuel production infrastructure; and,

d) acceptability and competition for resources, as well as incentives with other sectors (e.g. road transport, renewable power).

As long as the cost of production for SAF is greater than conventional kerosene, feedstock and production infrastructure is not built and SAF is not prioritized, policy intervention will be required to develop SAF production beyond its current small scale.

SAF's economic barriers can be addressed through a range of policy options. As SAF has emerged relatively recently compared to alternative fuels for ground transportation, SAF may need to be included as an 'add-on' to existing renewable fuels policies. The characteristics of effective SAF-enabling policy discussed below reflect what would be considered desirable for any type of renewable fuel policy.

Based on input from ICAO CAEP experts, three key themes influence policy effectiveness:

1. Feasibility: practicable and uncomplicated to implement

2. Effectiveness: successful in producing a desired or intended result

3. Practicality: the policy targets the outcome rather than a theory or set of ideas

Additionally, to be effective, SAF-specific policies/programs should:

- Be stable, predictable, and consistent in implementation in order for the private sector to be willing to make investments.

- Be of a sufficient duration to reflect project development timelines (e.g. 10 years or longer provides a degree of predictability for investors/developers).

- Be "stackable" with other incentives – i.e., allowing credit to be received from multiple reinforcing incentives at the same time is helpful.

- Be technology-neutral to enable diverse production pathways and supply chains to develop.

- Link incentives to performance (e.g. higher GHG emission reduction performance should be recognized).

- Allow access to a compliance credit market to mediate prices between renewable fuels and fossil fuels by ascribing a compliance value.

- Recognize needs of pre-revenue companies through clear access to non-dilutive capital via grants and loans.

- Incorporate mechanisms to encourage significant advances in SAF production capacity expansion, further technology innovation, and drive efficiencies to provide sufficient supply to achieve decarbonization of the aviation sector.

- Ideally, be at least national in scope to allow innovation and project development where it can be accomplished effectively; Subnational government (regions, provinces, states, and localities) may act in the absence of, or as a complement to, national action. Supranational approach could also be an adequate approach in some areas to combine resources and efforts and create added value from increased efficiency and economies of scale.

- Be designed with broad political support/bi-partisan (in two party systems) support to reduce reversal risk. A broad range of benefits including rural development, job creation, environment and technology innovation are common bases of support.

- Be customized to the unique resources, economic and social factors, political barriers and existing regulatory structure. There is no single path to successful SAF policy implementation but considered and customized strategies can be effective.

4. Qualitative metrics for assessing policy effectiveness

A qualitative metric is used by experts to assign 'descriptive' characteristics containing elements of informed opinion and experience. The qualitative metrics should serve to identify "potential policies" which have been demonstrated to be feasible, effective, and practical.

Eight metrics were identified by CAEP FTG experts to define policy effectiveness. The FTG proposes the following qualitative metrics to be used as a "check-list" instrument for States in evaluating actual or potential policy options, as a tool to assess the feasibility, effectiveness, and practicality of applying such options to their national contexts and conditions. Applying a LOW / MEDIUM / HIGH or simple numerical score to policies using these metrics is a simple effectiveness ranking method.

1) **Flexibility:** Characteristics of this style of policy will demonstrate scope for adjustment to different situations and priorities. Policies with higher flexibility may be able to evolve or adapt quickly. It is possible that special authority may be assigned to monitor and evaluate the policy on an on-going basis. A low flexibility policy, on the other hand, is designed in a rigid manner, implemented for a long-term period, generally remains unchanged, and changes can only be made by high level authorities.

2) **Certainty:** These characteristics relate to the time frame, legal conditions and/or political decisions. Policy certainty is typically important to investors or project stakeholders. Greater policy certainty can be associated with more economic value being ascribed to a particular policy and can be linked to the security level for investors. Lower certainty policies may have the inverse effect for investors and provide less incentive for capital investment. Medium to long-term policy certainty can set investor expectation and will increase investor interest.

3) **Financial costs and benefits:** Policy effectiveness should consider costs and benefits (including social costs). Policies that rely on government financial support should be assessed on the benefits they deliver towards the stated policy objective or for the government.

4) **Price sensitivity to externalities:** The sensitivity of a policy to externalities should be understood before implementation to avoid unintended impacts. Price-based policy can be less volatile if a floor and ceiling price is established. The higher the sensitivity to externalities, the more potential unintended consequences.

5) **Ease of implementation:** Policy implementation can be affected by administrative, governance and procedural issues. The number of agencies involved in implementing or administering a policy can impact effectiveness. States should be conscious of the relationship within their State of local, regional and national jurisdictions and ensure that responsibilities between national, regional and local jurisdictions do not create barriers if policy governance is not clear.

6) **Contribution to SAF deployment and GHG reduction:** Contribution to commercial deployment of SAF will be higher if a policy sets clear criteria on target quantity of SAF to be deployed, sustainability achievement, commercial parameters and timeframe. This should be supported by a set of legal instruments. Contribution to deployment will be lower if no quantitative target is specified and if not supported by any legal basis. Policies that incentivise greater verified GHG reduction achievement relative to conventional fuels may be more effective. Similarly, a policy that considers, respects and addresses social and economic consequences may deliver broader economic benefits relative to a policy that focuses singularly on environmental achievement.

7) **Unintended consequences:** Effective policies need to address the risk that implementation of the policy could lead to unintended consequences. These consequences can be economic, environmental or social. The most effective policy will have mechanisms to recognize and mitigate the impact of unintended consequences.

8) **Robustness of policy:** Effectiveness of a policy can be influenced by how robust the policy is. Robust policies are ones that, once implemented, have a regulating system to ensure that its objectives are achieved and appropriate procedures have been followed.

5. SAF policy options / examples

Long-term, stable policies are necessary to create a sustained market for SAF. The best policies for SAF development are likely to vary for each State and region based on their unique combination of climate, resources, political, social and economic factors. In the case of States with already well-developed renewable energy policies (e.g. for ground transportation) or carbon legislation, there may be an opportunity for inclusion of SAF in those existing mechanisms. For States that are looking to support renewable energy for the first time, there is an opportunity to take a well thought out and planned approach that best fits a State's circumstances.

Grouped broadly, policy mechanisms can: 1) Stimulate growth of the SAF supply (e.g. via R&D, investment, finance); 2) Create SAF demand (e.g. via mandates, subsidies and commitments); and, 3) Enable the SAF marketplace (e.g. via standards, industrial alliances, green labels). Those mechanisms can be implemented through different type of measures – and their combination – such as capacity measures (increasing or decreasing the accessibility to something), taxes[1] and other prices measures (such as emissions-based levy), funding and incentives or regulations.

A description of policy options and examples follows. A summary of this content also appears in table form in Appendix A. While this list is intended to be comprehensive it should not be taken as exhaustive of all potential policy options.

5.1 Stimulating growth of SAF supply

The following policy types are targeted at increasing SAF feedstock and fuel production capacity and supply through R&D, investment, production incentives, and tax treatment.

Policy Category 1: Public funding for SAF research development, demonstration and deployment (RDD&D) to accelerate learning

Public funding can support technology innovation across the SAF supply chain including R&D that reduces SAF costs, enhances sustainability or improves yields in feedstock production, fuel conversion, and logistics of SAF supply chains. Public funding can also support technology demonstration and deployment across the SAF supply chain including direct feedstock promotion and production support.

- OPTION 1.1: Public funding for directed research and development activities

  - This could include government research and directed funding to address barriers to SAF production and use, often with defined target feedstock types and conversion processes. This can help early stage SAF production innovations. It also supports SAF economics by accelerating the learning curve for feedstock yields or production optimisation. Support can occur from establishing specific programs or supporting existing private research activities or through universities or similar institutions.

    - An example includes the European Union framework program for research and innovation Horizon Europe, which financed 119 SAF-related projects with a budget of €493 million in the period 2014-2023.

- OPTION 1.2: Public funding for directed demonstration and deployment activities

  - This could include government research and directed funding to demonstrate and de-risk new feedstock and conversion technologies. Funding can provide support to farmers to establish new crops and to fuel technology providers to scale up and integrate their fuel

[1] The ICAO Council has adopted on 9 December 1996 a policy statement of an interim nature on emissions-related charges and taxes in the form of a resolution wherein the Council strongly recommends that any such levies be in the form of charges rather than taxes, and that the funds collected should be applied in the first instance to mitigating the environmental impact of aircraft engine emissions. In ICAO Document 9082 "ICAO's Policies on Charges for Airports and Air Navigation Services", it is considered by the ICAO Council that "a charge is a levy that is designed and applied specifically to recover the costs of providing facilities and services for civil aviation, and a tax is a levy that is designed to raise national or local government revenues, which are generally not applied to civil aviation in their entirety or on a cost-specific basis".

production. This support accelerates the learning process around technology and supply chain scale up. Support can occur from establishing specific programs that support existing private sector producers.

Policy Category 2: Targeted incentives and tax relief to expand SAF supply infrastructure
SAF production infrastructure is likely to face higher financing costs and requirements due to higher perception of investment risk. Enacting financing programs and tax policies that reduce the financial risk and tax burden of SAF projects will support private sector capital investment in SAF production.

- OPTION 2.1: Capital Grants

    - A government grant given to an entity to build or buy SAF-specific infrastructure. This can support a range of production facilities, transportation, re-fueling or blending infrastructure. Capital grants reduce the financial needs and financial risks of the targeted investment.

        - The U.S. Defense Production Act Title III Advanced Drop-in Biofuels made grants of ~$75 million to prospective SAF producers.

        - The Innovation Fund entirely funded by the European Union Emissions Trading System is expected to provide funding for about €40 billion until 2030 with 3 large-scale and 3 small-scale calls completed to date. Grants for air transport decarbonization, include SAF production (e.g. large-scale e-fuel production)[2] as well as decarbonization at airports (e.g. CCS, fuel/energy infrastructure).

- OPTION 2.2: Loan guarantee programs

    - A loan backed by a government or public institution helps the project financial case, and also reduces overall project risk, making acquiring additional equity of debt easier and lowering the cost of capital.

        - The U.S. Department of Energy's (DOE) Loan Program Office and the U.S. Department of Agriculture's (USDA) Biorefinery Assistance Program providing loan guarantees are U.S. examples

        - The Canadian Government's Innovation, Science, and Economic Development (ISED) and Natural Resources Canada (NRCan) departments offer repayable and non-repayable funding for R&D, clean technology projects, and clean fuel production through its Strategic Innovation Fund (SIF), Net Zero Accelerator (NZA), and Clean Fuels Fund (CFF) programs.

        - The InvestEU Fund mobilises public and private investments through a European Union budget guarantee, providing loans, equity and guarantees for SAF production and infrastructure[3]. The Breakthrough Energy Catalyst Partnership

[2] The largest ongoing SAF projects currently funded by the Innovation Fund are located in Sweden (Biorefinery Östrand) to support the first commercial deployment of solid biomass-and-power-to- SAF technology line-up (grant of 167 million Euro), and in Norway (Nordic Electrofuel AS) to support the development of Innovative and cost-efficient production process for Power-to-Liquid using industrial off-gases (grant of 40 million Euro)

[3] For example, a loan of 120 million Euro was provided to advanced biofuels plant in Spain

with the European Union provides venture debt and equity backed by public funding for SAF projects.

- OPTION 2.3: Eligibility of SAF projects for tax advantaged business status
    - For example, master limited partnerships (MLPs) are a specialized U.S. business organization type that is limited in use to the real estate and natural resources sectors (e.g. oil production). MLPs do not pay federal income taxes in the same way that other corporate structures do.
- OPTION 2.4: Accelerated depreciation/'bonus' depreciation
    - Accelerated or bonus depreciation allows the accounting write-off of capital investment or the potential to write off more than the actual capital investment. This will result in less expected tax to be paid over the life of the project and improve overall project economics.
- OPTION 2.5: Business Investment Tax Credit (ITC) for SAF investments
    - An ITC tax credit allows deduction of construction and/or commissioning costs of a qualifying asset which can reduce income tax payable and flow through to investors. This will result in less expected tax to be paid over the life of the project and improve overall project economics.
- OPTION 2.6: Performance-based tax credit
    - The concept consists of a tax credit for a project meeting certain conditions. The credit could be a sliding scale performance credit (higher credit for better GHG performing projects) and should have a defined policy life (i.e. 10-15 years).
        - The U.S. Sustainable Aviation Fuel Credit – also known as the "SAF blenders tax credit" - provides an incentive starting at $1.25 per gallon of SAF for SAF with a 50% lifecycle greenhouse gas improvement when compared with conventional jet fuel. This credit increases for each percentage point of improvement in emissions up to $1.75 per gallon.
- OPTION 2.7: Bonds / Green Bonds
    - Bonds can be issued by private companies, supranational institutions, and public entities including sub-national and local governments to provide low-interest rate and tax exempt financing used to support fuel production infrastructure build out. Green Bonds are designed specifically to support specific climate-related or environmental projects
        - The U.S. States of Nevada and Oregon issued bonds in support of prospective SAF producers.
        - The European Union Taxonomy Regulation covers SAF production and uptake, which enables to issue European green bond for such activities.
- OPTION 2.8: Reduce administrative burden and accelerate the approval process for industrial plants.

  - Review of the approval rules for establishing of industrial plants for feedstock/inputs production which are needed for SAF (e.g. hydrogen) and for SAF production itself to simplify administrative procedure and reduce the time required to establish industrial capacities.
    - Examples of initiatives include the proposal for the EU Net Zero Industrial Act, which includes SAF among net zero technologies.

- OPTION 2.9: Aggregating and de-risking supply
  - Within the hydrogen accelerator measures, the European Hydrogen Bank is a financing instrument designed to unlock private investments in hydrogen value chains, both domestically and in third countries, by connecting renewable energy supply to EU demand and addressing the initial investment challenges, including for e-fuels for aviation (in November 2023 the first competitive bidding was launched under the Innovation Fund).

Policy Category 3: Targeted incentives and tax relief to assist SAF facility operation

SAF production facilities are likely to face higher operating costs and risks than existing fuel suppliers. This issue can be addressed through policy mechanisms that provide a boost or support to SAF production via targeted financial incentives or relief from taxes via tax credits. These approaches assist with reducing the cost gap between SAF and fossil jet fuel. They are linked to a specific quantity of fuel produced and made available to the market.

- OPTION 3.1: Blending incentives: Blender's Tax Credit (BTC)
  - An incentive targeted at the providers and/or blenders of fuel that provides a credit against the blending entity's taxes. This mitigates the purchase difference between SAF and fossil jet.
    - For example, in the U.S. a long time Blender's Tax Credit (BTC) provides a USD 1.00 per gallon incentive for blenders of certain types of biofuel. In August 2022, a Sustainable Aviation Fuel Credit replaced this BTC for SAF and increased the support to $1.25 per gallon of SAF that has a minimum of 50% lifecycle greenhouse gas improvement when compared with conventional jet fuel with a sliding scale to $1.75 per gallon for SAF with 100% improvement.
- OPTION 3.2: Production incentives: Producer's Tax Credit (PTC)
  - An incentive targeted at the producers of fuels that provides a credit against the producers taxes. This mitigates the cost of production difference between SAF and fossil jet.

- OPTION 3.3: Excise tax credit for SAF
  - For States that tax domestic jet fuel consumption, a reduction or elimination of the tax in proportion to the quantity of SAF consumed serves to incentivize fuel consumers to purchase SAF by contributing to lower SAF cost.
    - For example, in the U.S. an existing domestic commercial and general aviation jet fuel tax funds the Airport and Airways Trust fund on a per gallon basis. This could be eliminated for either unblended (neat) or blended quantities of SAF to incentivize SAF production and use.

        - The proposal for the revised Energy Taxation Directive introduced tax on jet fuel, with the modulation of the rate and preferential treatment in function of the environmental performance of fuel.

- OPTION 3.4: Support for feedstock supply establishment and production

    - SAF production may be limited by availability and cost of the raw material (feedstock) from which it is produced. Targeted support can address the risks and costs to farmers and feedstock suppliers of establishing a new crop and producing it under uncertain conditions. Crop insurance program support for SAF can also be considered in addition to subsidy payments made to farmers aimed at incentivizing production.

        - A U.S. example is the Biomass Crop Assistance Program (BCAP) which offers annual incentive payments and establishment payments to farmers of biomass crops intended for bioenergy production.

- OPTION 3.5: Consumption incentive: reducing the cost gap between SAF and fossil jet fuel

    - SAF uptake by airlines may be limited by cost of the product. Targeted support to the end user, i.e. airlines, can help address the cost issue and support airlines to procure more SAF.

        - The European Union Emissions Trading System (EU ETS) provides 20 million extra allowances for aircraft operators uplifting SAF till 2030 on a 'first come-first served' basis. The aim is that of reducing the price gap between fossil jet A1 and SAF. This support instrument adopts a gradual approach per emissions reduction profile of the different SAF options (reaching up to 100% compensation of the cost differential with fossil jet A1), as well as airport size and location to facilitate the widespread uptake of SAF beyond main airport hubs.

        - Brussels Airport Company, the Brussels National Airport (BRU) operator, received a funding from the Belgian government of €2 million in 2024 to support SAF uptake by airlines. The incentive covers 80% of the price difference between conventional jet fuel and SAF, up to 1000 euros per ton of SAF and a total of 200,000 EUR per airline. Feedstocks must be compliant with EU regulation (consolidated version of REDII) and a minimum SAF blend ratio of 25% has to be met for the fuel that receives incentives

Policy Category 4: Recognition and valorisation of SAF environmental benefits

SAF production and use may create a number of environmental benefits and ecosystem services that can be recognized and valued under existing and new policies. These could include carbon benefits and greenhouse gas emissions reductions; air quality improvements; waste reduction and reductions of the contribution of contrails to climate change. Additional benefits may be identified going forward.

- OPTION 4.1: Recognize SAF benefits under carbon taxation

    - Where a jurisdiction has introduced a carbon tax, carbon price, or carbon levy (that is setting a tax rate on carbon emissions for each fuel type, thereby providing a signal to reduce emissions) SAF could be rated as either zero or in proportion to the life-cycle greenhouse gas emissions benefit of the particular fuel, thereby subject to reduced tax. This differs from a cap and trade system by not stipulating an overall emission reduction target.

        - The Canadian Greenhouse Gas Pollution Pricing Act came into force in 2018 (Section 186, Chapter 12 of the Statutes of Canada – S.C. 2018, c. 12, s. 186). This carbon pricing system sets a fuel charge on fossil fuels and enables a trading system for industry (Output-Based Pricing System). For aviation turbo fuel, a charge of CAD 0.0516/L in 2020 increases linearly to CAD 0.4389/L in 2030. These measures ensure there is a price incentive for industrial emitters to reduce their GHG emissions and encourage innovation.

- OPTION 4.2: Recognize SAF benefits under cap-and-trade systems as they develop

    - Cap-and-trade systems limit total GHG emissions by setting a maximum emissions level and allowing participants with lower emissions to sell surplus emission permits to larger emitters. This system creates supply and demand for emissions permits and establishes a market price for emissions and a value for avoided emissions. If SAF were used in such a system, it would exempt or reduce the obligations of the user of the SAF under the regulation. Examples include:

        - Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA), where an operator using SAF can reduce its offsetting obligations under the scheme.

        - The EU ETS where all aircraft operators regardless of their jurisdiction serving intra-European routes using SAF are exempted from the obligation to surrender the corresponding amount of allowances.

- OPTION 4.3: Recognize non- CO_2SAF benefits: improvements to air quality

    - Some programs and incentives place a value on local air quality. SAF should be able to financially participate in these incentive schemes based on air quality benefits that certain SAFs may be able to provide.

- OPTION 4.4: Recognize non-CO_2 SAF benefits: reduction in contrails

    - As the understanding of the science evolves, reductions in contrail formation resulting from use of SAF may be able to be recognized for their environmental benefits. The first *ICAO Symposium on Non-CO_2 Aviation Emissions* was held in September 2024 and showcased recent developments in this field.

5.2 Creating Demand for SAF

The following policy options are targeted at increasing SAF demand, including creating mandates for SAF use in the transportation fuel supply, providing incentives or subsidies that reduce the cost of SAF for consumers, and voluntary commitments to use SAF.

Policy Category 5: Creation of SAF Mandates
Policies that require SAF to become available as part of the transportation fuels supply can take a number of approaches such as setting volumetric requirements or fuel supply greenhouse gas emission reduction targets. These policies may also obligate different parties such as transportation fuel providers or fuel users.

This approach can result in a tradeable or bankable incentive being created that can help to address the cost differential between conventional kerosene and SAF.

- OPTION 5.1: Mandate renewable energy volume requirements in the fuel supply
  - An obligation on fuel providers to provide increasing SAF fuel volumes added to the existing fuel supply on a multi-year schedule creates an incentive for production of more SAF and other fuels which meet the renewable energy definitions of the program. These definitions can include life-cycle greenhouse gas emissions reduction requirements.
    - Variations of this type of policy for road fuels (not SAF) are represented by the EU's Renewable Energy Directive (RED), the U.S. Renewable Fuels Standard (RFS2), and Canada's Renewable Fuels Regulation.
    - Variations of this policy for SAF include the ReFuelEU Aviation Regulation in the European Union, Norway's SAF Blending Mandate, and the Canadian Province of British Columbia's amended Low Carbon Fuels Regulation.
- OPTION 5.2: Mandate reduction in carbon intensity of the fuel supply
  - An obligation on fuel providers to reduce the carbon intensity (life-cycle greenhouse gas emissions intensity) of the transportation fuel supply on a multi-year schedule creates an incentive for production of more SAF and other fuels with greenhouse gas benefits. Low carbon fuel standards (LCFS) and clean fuels standards can enable targeting of the carbon intensity of the State's fuel supply.
    - Variation of this type of policy for road fuels are represented by the U.S. State of California Low Carbon Fuel Standard (LCFS), the U.S. State of Oregon Clean Fuel Program (CFP), the U.S. State of Washington Clean Fuel Standard (CFS), the Canadian Province of British Columbia's Low Carbon Fuel Standard (BC-LCFS), the Canadian Federal Clean Fuel Regulations (CFR).), and the Renewable Energy Directive (RED) revised in 2023 (where SAF is included in the overall transport target).
    - Taking into effect on 1 January 2024, the Canadian Province of British Columbia's amended BC-LCFS requires life cycle GHG reduction for jet fuel supplied in the province of 2% beginning 2026, increasing to 10% by 2030.
- OPTION 5.3: Mandate reduction in carbon intensity of the fuel uptake by aircraft operators
  - An obligation on aircraft operators to reduce the carbon intensity (life-cycle greenhouse gas emissions intensity) of their operations through the transportation fuel they buy, on a multi-year schedule, which fosters the competition among fuels producers for the use of the best technology available and the most efficient SAF and thus creates an incentive for cleaner fuel to be brought to the area. Each airline will be able to evaluate and choose the sustainable fuel with the best cost-benefit relation.
    - Variation of this type of policy includes the Japanese volume-based mandate approach or the Brazilian Government bill under discussion at Congress

integrating a CO_2 emission reduction mandate using SAF, both only applied to national airlines.

- OPTION 5.4: Requirement for end users to support SAF use
    - A requirement on air transport users to pay for SAF use, in line with the user pays principle. It provides transparency to consumers, and ensures a level-playing field as consumers pay based on the amounts consumed (e.g. proportionate to flight lengths and class of travel). It also provides for a long-term financially sustainable approach to generate SAF demand as costs are borne by the aviation system. This may not necessarily be a mandate.
        - An example is Singapore's 1% SAF target from 2026 applying to flights departing Singapore, to be implemented through an introduction of a SAF levy to provide cost certainty to airlines and travelers. The levy will be set at a fixed quantum based on the SAF target and projected SAF price at the point in time. The actual SAF uplift volumes may differ depending on SAF price fluctuations. To support implementation, the procurement of SAF will be centralized, and levies collected will be used to aggregate demand and reap economies of scale. SAF credits will be allocated back to the airlines based on the share of levies collected.

Policy Category 6: Update existing policies to incorporate **SAF**

Many States may have existing alternative fuel incentive policies at a national level that could incorporate SAF as qualified fuels.

- OPTION 6.1: Incorporating SAF into existing national and supra-national policies
    - Many national level policies may be adapted to incorporate SAF. Typically, legacy biofuel policies have focused on road-transport-appropriate fuels and do not include SAF as an option. With the more recent advent of drop-in jet fuel/SAF production technologies, an opportunity exists to update existing policies to support SAF production. An examination of the State's existing policies for opportunities to support SAF can be a good starting point.
        - For example in the U.S., SAF has been recognized for credit in the Renewable Fuel Standard (RFS2) as an opt-in fuel as well as in the EU RED where SAF in counted to the transport target. Alterations to the RFS2 policy to more directly recognize and/or require SAF production have been proposed.
- OPTION 6.2: Incorporating SAF into existing sub-national, regional or local policies
    - Similar to the national or supra-national levels, a State may have existing alternative fuel incentive policies at a sub-national, regional or local level that could incorporate SAF as qualified fuels. An update to these existing policies to support SAF production can provide additional support and may enable a beneficial "stacking" of incentives at multiple levels that contributes to SAF economic viability.
        - For example in the U.S., multiple states have established low carbon fuel standards (LCFS) or clean fuels standards designed to reduce the carbon intensity

of their transportation fuel supply. SAF has been recognized in the States of California, Washington, and Oregon as an opt-in fuel. It has also been proposed to alter various aspects of the programs to further incentivize SAF. SAF production in these states can also receive credits in both the national RFS2 and effectively "stack" both incentives.

    - For example certain EU Member States developed SAF roadmaps and incentive schemes to support SAF production and deployment consistently with the overall EU regulatory framework

Policy Category 7: Demonstrate government leadership

A clear statement of policy direction and ongoing SAF purchasing are examples of government leadership that can generate ways in which to ramp-up SAF production and use.

- OPTION 7.1: Policy statement to establish direction
    - Setting aspirational goals of specific production or use amounts to signal future intent to develop comprehensive SAF policy measures. This can be linked to the implementation of future policies, sending a signal for project planning. Examples could including State level commitments for a quantitative SAF use goal or carbon reduction by a certain time, or signals from industry such as a commitment to achieve net zero by 2050.
        - Examples from the U.S. includes the 2021 U.S. Aviation Climate Action Plan with a goal of net zero U.S. aviation by 2050, and SAF Grand Challenge with a goal of 3 billion gallons of domestic SAF production by 2030 and 35 billion gallons by 2050, and in ReFuelEU Aviation Regulation that sets progressive SAF supply targets from 2025 until 2050.
        - The ICAO 3rd Conference on Aviation and Alternative Fuels (CAAF/3) adopted the ICAO Global Framework for SAF, LCAF and other Aviation Cleaner Energies that sets a global, aspirational target of 5% CO2 emissions reduction by 2030 from SAF and other cleaner energies.
- OPTION 7.2: Government commitment to SAF use, carbon neutral air travel
    - A strong demand signal can be created by requiring national, state, local governments, and military to commit to renewable fuel/SAF procurement to reduce environmental impacts of air travel and operations. Governments often have the ability to commit to long term contracts backed by strong credit rating which lowers project risk. Governments can either directly purchase SAF for use by government aircraft or contract with commercial air carriers to provide SAF to power government purchased travel.
        - Examples include Canada's Low Carbon Fuel Procurement Program which aims to secure a supply of SAF for aircraft operated by the Government of Canada and the Netherlands' procurement of SAF for corporate travel through the KLM Corporate SAF Programme.

5.3 Enabling SAF Markets

Additional activities may be necessary to bring clarity and certainty to enable SAF markets to function optimally.

Policy Category 8: Market enabling activities
Clear standards and methods for supporting the qualification of new SAF production pathways and for certifying the sustainability of feedstock and fuel, as well as calculating, crediting and possibly trading the environmental attributes of SAF which can facilitate national and international markets for SAF.

- OPTION 8.1: Adopt clear and recognized sustainability standards and life cycle GHG emissions methods for certification of feedstock supply and fuel production.
    - Recognition of harmonized standards for life cycle GHG calculation and sustainability certification will support broad SAF markets and ensure environmental integrity.
        - National governments (e.g. U.S. RFS2, Canada CFR); supra-national organisation (e.g. EU RED) , international bodies (e.g. ICAO CORSIA); and, industry/non-governmental organizations (e.g. Roundtable on Sustainable Biomaterials (RSB), International Sustainability and Carbon Certification (ISCC) have all developed sustainability certification and GHG emissions methodologies.
- OPTION 8.2: Support development/recognition of systems for environmental attribute ownership and transfer
    - Standard processes and shared systems may facilitate "book and claim" purchasing of SAF that decouples the physical fuel location and the environmental benefit in order to facilitate and promote more efficient and broader use of SAF volumes and their GHG emission reductions.
        - A number of independent pilot programs are underway or in development. These include RSB, World Economic Forum SAF Certificate (WEF SAFc), Smart Freight Center and Massachusetts Institute of Technology's guidelines (SFC MIT). However, to be effective and to obtain confidence, airline industry and regulators will require a common set of agreed principles, accounting and reporting mechanisms, protections against double counting/claiming, and a robust registry.
- OPTION 8.3: Support SAF stakeholder initiatives
    - Stakeholder consultation groups can take many forms and be either government, industry or NGO led. These groups serve a critical function of aligning the diverse stakeholders that make up the SAF supply chain. They can directly coordinate actions and provide critical information and feedback to policymakers.
        - A number of SAF stakeholder groups have provided critical support to the SAF effort. These include the Commercial Aviation Alternative Fuel Initiative (CAAFI) in the U.S.; the Aviation initiative for renewable energy in Germany (Aireg); the Brazilian Biojetfuel Platform (BBP); the Nordic Initiative for Sustainable Aviation (NISA); and the Canadian Council for Sustainable Aviation

Fuels (C-SAF), the EU Renewable and Low Carbon Fuels Value Chain and Industrial Alliance (RLCF Alliance) among others. For a listing of the many initiatives see ICAO's website.

- Support increased transparency on SAF uptake by airlines through the implementation of common environmental label which provides passengers with reliable information regarding the sustainability of flights provided by aircraft operators to make informed choices when comparing between different options.
  - The RefuelEU Aviation Regulation sets up a voluntary environmental labelling scheme that estimates flights emissions (Flight Emissions Label). Such scheme will increase transparency on the lifecycle emissions of flights, enable passengers' informed decisions on flight options and recognize climate contribution of SAF uptaken by aircraft operators.

- OPTION 8.4: Support fuel producers with qualification of new SAF production pathways.
  - SAF Clearing Houses[4] to support fuel producers in their qualification of new SAF production pathways will help to accelerate and reduce costs of the standardization processes, including technical suitability and production scalability, thus helping SAF producers to access financial support and increasing the availability of SAF in the markets. Increased variety of SAF production pathways increases the opportunities for states across the regions to produce SAF in function of their resource endowment.

The variety in policy options should be highlighted as an important point which allows States looking into implementing regulation to support the production of SAF to tailor it to their needs. Below is a visual representation of the options implemented by various States, as described in appendixes B to G.

[4] Such concept has been developed in the US, the UK and the EU

Impact Area	Policy Category	Policy Option	Appendix B : EU[5]	Appendix C : UK	Appendix D : USA	Appendix E : Japan	Appendix F : Brazil	Appendix H Singapore
Stimulating Growth of SAF Supply	**1 - Public funding for SAF research, development, demonstration and deployment (RDD&D) to accelerate learning**	1.1 - Public funding R&D	■		■	■		
		1.2 - Public funding for demonstration and deployment	■	■	■	■	■	
	2 - Targeted incentives and tax relief to expand SAF supply infrastructure	2.1 - Capital grants	■	■	■	■		
		2.2 - Loan guarantee programs	■		■			
		2.3 - Eligibility of SAF projects for tax advantaged business status			■			
		2.4 - Accelerated depreciation/'bonus' depreciation						
		2.5 - Business Investment Tax Credit (ITC) for SAF investments						
		2.6 - Performance-based tax credit			■			
		2.7 – Bonds / Green Bonds	■			■		
		2.8 – Simplify administrative procedures	■				■	■
		2.9 – De-risking supply	■	■				■
	3 - Targeted incentives and tax relief to assist SAF facility operation	3.1 Blending incentives: Blender's Tax Credit			■			
		3.2 – Production incentives: Producer's Tax Credit			■	■		
		3.3 - Excise tax credit for SAF	■					
		3.4 - Support for feedstock supply establishment and production				■		
		3.5 – Reducing the price gap between SAF and fossil fuel for end user	■					
	4 - Recognition and valorization of SAF environmental benefits	4.1 – Recognize SAF benefits under carbon taxation						
		4.2 - Recognize SAF benefits under cap-and-trade systems	■	■				

[5] This does not take account of measures pursued at the European Union Member States level

		4.3 - Recognize non-CO_2 SAF benefits: improvements to air quality
Creating Demand for SAF	**5- Creation of SAF mandates**	5.1 - Mandate SAF energy volume requirements in the fuel supply
		5.2 - Mandate reduction in carbon intensity of the fuel supply
		5.3 – Mandate reduction in carbon intensity of the fuel uptake
		5.4 – Requirement for end users to support SAF use
	6 - Update existing policies to incorporate SAF	6.1: Incorporating SAF into existing national and supra-national policies
		6.2: Incorporating SAF into existing sub-national, regional or local policies
	7 – Demonstrate government leadership	7.1 Policy statement to establish direction
		7.2: Government commitment to SAF use, carbon neutral air travel
Enabling SAF Markets	**8 - Market enabling activities**	8.1 - Adopt clear and recognized sustainability standards and life cycle GHG emissions methods for certification of feedstock supply and fuel production
		8.2 - Support development/recognition of systems for environmental attribute ownership and transfer
		8.3 - Support SAF stakeholder initiatives
		8.4 – Support the qualification of new SAF production pathways

6. Comparative analysis tools

As a means of providing policy makers with high level analysis tools, CAEP puts forward information in the following section on two tools: 1) Rules of Thumb for understanding big picture trends for costs and processing of feedstock and finished SAF that enable order of magnitude estimations; and 2) a discussion of the concept of SAF cost assessment on the basis of marginal abatement cost of CO_2 which allows a policy maker to assess the effectiveness of a specific intervention relative to other alternatives.

6.1 ICAO SAF Rules of Thumb

As part of work of the CAEP Fuels Task Group, CAEP experts from Washington State University and Hasselt University have been developing a set of heuristics or "Rules of Thumb" for sustainable aviation fuel (SAF) that could be utilized to make order of magnitude estimations related to SAF costs, investment needs and production potential that can be used to inform policymakers and project developers. These SAF Rules of Thumb have been made available on the ICAO SAF Rules of Thumb website.

The Rules of Thumb provide information for three ASTM qualified SAF processing technologies that were assessed: Fischer-Tropsch (FT), alcohol to jet (ATJ) and hydro-processed esters and fatty acids (HEFA). Information is also provided for Pyrolysis, another SAF processing technology for which ASTM qualification is still pending. For each of the technologies, multiple feedstock and two levels of technology maturity were assessed: *n*th plant (production facility with a mature technology) and pioneer plant (first of a kind facility). The Rules of Thumb have been generated by a set of underlying techno-economic analysis (TEA) models developed in support of CAEP. All of the TEA models are based on open-source information about feedstock and fuel conversion technologies. Costs that use proprietary technology may differ significantly. The Rules of Thumb provide the impact of feedstock cost, fuel yield, facility scale (total distillate and SAF), total capital investment (TCI) and minimum selling price (MSP) for both the *n*th plant and pioneer facility scales.

The Rules of Thumb are intended to provide big picture trends for costs and processing technology/feedstock comparisons and may be utilized to make order of magnitude estimations. However, they *do not provide* precise cost or price information. As such, investment or policy decisions should be based on a dedicated analysis that captures specific details related to the investment or policy.

All of the information in the Rules of Thumb has been calculated using U.S. costs and financial assumptions. The values will change based on regional variables. No incentives were included in the minimum selling price (MSP) values calculated. Summary Tables 1 and 2 provide the most likely costs and facility scales based on the TEA models, existing literature values and expert opinion.

Summary Table 1 - Technology, feedstock type and price, yield, total annual distillate scale, annual SAF production for both n[th] and pioneer facilities.

Processing Technology	Feedstock	Yield (ton distillate/ton feedstock)	Feedstock Price	Total Capacity (million L/year)		SAF production (million L/year)	
				n[th]	**pioneer**	**n[th]**	**pioneer**
FT*	MSW	0.31	$30/ton	500	100	200	40
FT*	forest residues	0.18	$125/ton	400	100	160	40
FT*	agricultural residues	0.14	$110/ton	300	100	120	40
ATJ	ethanol	0.60	$0.41/L	1000	100	700	70
ATJ	isobutanol-low	0.75	$0.89/L	1000	100	700	70
ATJ	isobutanol-high	0.75	$1.20/L	1000	100	700	70
HEFA	FOGs	0.83	$580/ton	1000	-	550	-
HEFA	soybean oil***	0.83	$809/ton	1000	-	550	-
FT	CO2 from Direct Air Capture (DAC) , H2	0.24	$300/t, $6/kg	1000	-	200	-
FT	waste CO_2, H_2	0.24	$300/t, $6/kg	1000	-	200	-
Pyrolysis**	forest residues	0.23	$125/ton	400	100	180	40
Pyrolysis**	agricultural residues	0.21	$110/ton	400	100	180	40

**feedstock price is for pre-processed feedstock*

***pyrolysis ASTM qualification is pending.*

****2013-2019 average price of soybean and canola oils*

Summary Table 2: Total capital investment (TCI), capital cost, and minimum selling price (MSP) for nth and pioneer facilities for each pathway.

Processing Technology	Feedstock	TCI (million $)		Capital Cost ($/L total distillate)		MSP ($/L)	
		n^{th}	pioneer	n^{th}	pioneer	n^{th}	pioneer
FT*	MSW	1428	813	2.9	8.1	0.9	2.1
FT*	forest residues	1618	1088	4.0	10.9	1.7	3.3
FT*	agricultural residues	1509	1267	5.0	12.7	2.0	3.8
ATJ	ethanol**	328	117	0.3	1.2	0.9	1.1
ATJ	ethanol, agricultural residues	581	170	0.6	1.7	2.2	2.5
ATJ	isobutanol-low**	332	94	0.3	0.9	1.3	1.5
ATJ	isobutanol-high**	410	110	0.4	1.1	1.7	1.9
HEFA	FOGs	448	-	0.4	-	0.8	-
HEFA	vegetable oil	456	-	0.5	-	1.0	-
FT	DAC CO_2, H_2	3366	-	3.4	-	4.4	-
FT	waste CO_2, H_2	3209	-	3.2	-	3.5	-
Pyrolysis* **	forest residues	1038	594	2.6	5.9	1.3	2.1
Pyrolysis* **	agricultural residues	1084	619	2.7	6.2	1.3	2.2

**feedstock price is for pre-processed feedstock,*
***alcohol feedstock is corn-based,*
****pyrolysis ASTM qualification is pending.*

Graphical representations of these numbers, additional graphics and underlying data spreadsheet behind the Rules of Thumb are available at the ICAO SAF Rules of Thumb website.

6.2 How to determine the marginal abatement cost of CO_2 mitigation from using SAF?

The aviation sector is seeking ways to reduce or abate emissions. Some options such as replacing older fleet or improving operational performance (e.g. winglets, lighter onboard materials) have a clear economic benefit. Less fuel consumption means a reduced operating cost, while also delivering an environmental benefit. Historically, airlines have not required a policy intervention to make such changes; however, the environmental performance improvement has been limited to around 2% per annum.

More substantial CO_2 reduction can come from a reduced life-cycle fuel. Current knowledge suggests that SAF has the greatest potential to deliver significant industry wide CO_2 reductions. This confidence is supported by a clear understanding of feedstock potential under necessary sustainability constraints and the technology readiness of SAF being high. Additionally, SAF is a drop-in fuel, meaning no adaptation to airframes, engines, or fuel storage or delivery infrastructure is required. This makes a cost assessment of SAF on a CO_2 basis relatively simple. Understanding this can be valuable for a policy maker to assess the effectiveness of a specific intervention relative to other alternatives.

This illustrative example explains the process for determining the *per tonne of CO_2* cost from using SAF under a set of assumptions.

Example:

Airline XYZ requires 10 tonnes of jet fuel per annum and decides to use SAF to reduce its emissions. The airline makes a decision to use 8 tonnes of conventional kerosene and 2 tonnes of SAF.

Assumptions:

Cost of 1 tonne of conventional kerosene = $600

Cost of 1 tonne of SAF = $1100

Jet fuel combustion CO_2 emissions factor = 3.16

CO_2 emissions reduction factor of this SAF = 80%

Firstly, the amount of CO_2 reduced must be determined which is a function of the amount of SAF used, the jet fuel combustion factor and the SAF emissions reduction factor.

Net CO_2 emissions reduction = 2 tonnes * 3.16 * 80% = 5.06 tonnes CO_2

The cost per tonne of CO_2 reduced is found by calculating the cost difference between SAF and conventional kerosene divided by the amount of CO_2 reduced.

Cost per tonne of CO_2 reduced = 2 tonnes * (1100-600) / 5.06 = $197.78 / tonne

This example indicates the carbon price at which it becomes interesting for operators to purchase SAF instead of paying an offsetting penalty.Given the above, how does the cost of SAF compare to aviation use of hydrogen or electric? Hydrogen and electric power are non-drop in fuel alternatives. This means changes are necessary for either aircraft, engines, or airports including fuel systems and storage facilities. This makes a CO_2 based cost effectiveness assessment of different abatement options complex.

To determine the per tonne of CO_2 cost reduction from hydrogen it is necessary to have reliable data on:

- The cost of product for hydrogen.
- The cost of a new or modified aircraft (hydrogen compatible).
- The operating economics of a hydrogen aircraft (for example, expected block hours, maintenance cycles, certification costs).
- The cost of new or modified fuel storage and fuel delivery infrastructure.

These complexities mean that comparing the effectiveness of policy interventions for hydrogen and electric will be more complex for the medium term. However, the SAF CO_2 abatement cost method can serve as a useful benchmark as better information for non-drop-in fuel alternatives develops and for comparing against different out-of-sector solutions such as offsets, carbon capture usage or storage, utilization and storage or direct air capture.

7. How Do Policies Impact SAF Project Economics?

Simple illustrative examples can be useful to examine and understand how a policy might influence the profitability of a SAF project. Examples can particularly help to expose the differences in impact between a policy that applies towards the start of the project and a policy that provides smaller support over the life over the project.

The below five examples demonstrate the sensitivity of a hypothetical project to small changes in the input assumptions. Specifically, they highlight how policy can be applied to influence a project's financial viability. It is important to note that these examples purely examine a project from the perspective of the project owner. While a 'real life' project will have significantly more line items and additional complexity, these examples provide an illustration of how policy decisions could impact the project's economic merit.

The analysis metric used is Net Present Value (NPV). NPV is a central tool in discounted cash flow (DCF) analysis and is a standard method for using the time value of money to appraise long-term projects. Equally, it would be possible to determine what amount of revenue would be required (e.g. minimum selling price of the SAF) to achieve a positive NPV.

Example 1:

Example 1 is a base case scenario. This is an example where purchasing land, equipment and constructing a SAF refining plant costs $260 million. Both operating costs and revenues ramp up, then remain consistent from year 3. In a real world scenario these are not likely to be linear but this does not impact the example. A discount rate of 9% is used. This is the rate that must be achieved to deliver a NPV of $0. This example delivers a forecast NPV of -$83.28 million or an internal rate of return (IRR) on the funds employed of 3.82%. This does not meet the hurdle rate (of 9%) hence a rational firm would not undertake this project.

EXAMPLE: 1	*Simplified cost-benefit example - base case project CBA*										
Project analysis (Million USD)											
Year	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Capital costs											
Project construction	-250										187.5
Improvements						-25					17.5
Equiptment	-10					-10					5
Total	-260	0	0	0	0	-35	0	0	0	0	210
Operating costs											
Aggregate annual costs		-5	-15	-20	-20	-20	-20	-20	-20	-20	-20
Revenues											
Annual aggragate revenues		15	25	40	40	40	40	40	40	40	40
Net Cash Flow	-260	10	10	20	20	-15	20	20	20	20	230
Discount rate	9%										
NPV	**-$83.28**										
IRR	**3.82%**										

Example 2

Example 2 replicates example 1, except in this case a project grant of $100 million is received. This could be a government grant. A grant is often contingent on satisfying certain criteria, however in this case it is assumed that this criterion is met and the funds are received without attached conditions.

While the aggregate of the grant is only 2.5 years of projected revenue, it represents 40% of the total assumed construction cost. The advantage of receiving these funds at project inception is significant, particularly with high discount rates.

This change to the project delivers a $16.72 million positive NPV at an IRR of 10.43%. A rational firm would undertake this project.

EXAMPLE: 2					*Simplified cost-benefit example - project grant*						
Project analysis (Million USD)											
Year	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Capital costs											
Project construction	-250										187.5
Project grant	100										0
Improvements						-25					17.5
Equiptment	-10					-10					5
Total	-160	0	0	0	0	-35	0	0	0	0	210
Operating costs											
Aggregate annual costs		-5	-15	-20	-20	-20	-20	-20	-20	-20	-20
Revenues											
Annual aggragate revenues		15	25	40	40	40	40	40	40	40	40
Net Cash Flow	-160	10	10	20	20	-15	20	20	20	20	230
Discount rate	9%										
NPV	**$16.72**										
IRR	**10.43%**										

Example 3:

Example 3 replicates Example 1, except in this case the firm acquires an interest free loan for 10 years of 100 million. This could be provided from a government program and when the project is more mature this debt could easily be refinanced and repaid. Further, conceptually the idea of an interest free loan could be substituted with non-dilutive equity.

While the project NPV remains negative at -$25.52 million it is substantially improved on example 1. Further, the IRR of 6.37% may be feasible for some investors.

EXAMPLE: 3					*Simplified cost-benefit example - interest free loan*						
Project analysis (Million USD)											
Year	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Capital costs											
Project construction	-250										187.5
Interest free loan	100										-100
Improvements						-25					17.5
Equiptment	-10					-10					5
Total	-160	0	0	0	0	-35	0	0	0	0	110
Operating costs											
Aggregate annual costs		-5	-15	-20	-20	-20	-20	-20	-20	-20	-20
Revenues											
Annual aggragate revenues		15	25	40	40	40	40	40	40	40	40
Net Cash Flow	-160	10	10	20	20	-15	20	20	20	20	130
Discount rate	9%										
NPV	**-$25.52**										
IRR	**6.37%**										

Example 4:

Example 4 replicates example 1, however in this case the SAF supplier receives a subsidy. While in this case the subsidy is not sufficient to generate a positive project NPV, it demonstrates that the annual subsidy improves the forecast IRR from 3.82% in example 1 to 5.23% in example 4.

EXAMPLE: 4	Simplified cost-benefit example - revenue subsidy										
Project analysis (Million USD)											
Year	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Capital costs											
Project construction	-250										187.5
Improvements						-25					17.5
Equiptment	-10					-10					5
Total	-260	0	0	0	0	-35	0	0	0	0	210
Operating costs											
Aggregate annual costs		-5	-15	-20	-20	-20	-20	-20	-20	-20	-20
Revenues											
Subsidy		1.5	2.5	4	4	4	4	4	4	4	4
Annual aggragate revenues		15	25	40	40	40	40	40	40	40	40
Net Cash Flow	-260	11.5	12.5	24	24	-11	24	24	24	24	234
Discount rate	9%										
NPV	**-$61.16**										
IRR	**5.23%**										

Example 5:

Example 5 incorporates some of the policy features of the other examples. It includes a revenue subsidy of 10% of revenues, a project grant of $50 million and an interest free loan of $100 million repayable in 10 years.

This example clearly demonstrates how combining some policy mechanisms can make an otherwise unattractive project successful. Example 5 generates a forecast NPV of $46.59 million at an IRR of 15.1%. Even at a discount rate of 9% this project is comfortably acceptable. This shows how when connected stakeholders such as the project owner and operator, the government, product demand e.g. an airline and debt financiers work collaboratively, policy mechanisms can combine to build a strong business case.

EXAMPLE: 5	Simplified cost-benefit example - project grant										
Project analysis (Million USD)											
Year	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Capital costs											
Project construction	-250										187.5
Project grant	50										0
Interest free loan	100										-100
Improvements						-25					17.5
Equiptment	-10					-10					5
Total	-110	0	0	0	0	-35	0	0	0	0	110
Operating costs											
Aggregate annual costs		-5	-15	-20	-20	-20	-20	-20	-20	-20	-20
Revenues											
Subsidy		1.5	2.5	4	4	4	4	4	4	4	4
Annual aggragate revenues		15	25	40	40	40	40	40	40	40	40
Net Cash Flow	-110	11.5	12.5	24	24	-11	24	24	24	24	134
Discount rate	9%										
NPV	**$46.59**										
IRR	**15%**										

It should be assumed that subsidies either reduce or 'fade out' over time. If this is articulated by policy makers it does not need to impact project feasibility. It is assumed that both the technology learning curve and project economies of scale will reduce the unit cost of production over time, thus reducing the reliance on subsidies. Interest free loans or project grants simply tackle the high discount rate conundrum at the start of a capital intense project in an embryonic industry.

8. How Do Policies Impact SAF Minimum Selling Price?

To examine and understand how policy might influence the sales price of SAF for a SAF producer, it can be useful to look at an illustrative example. This analysis from the U.S. context helps to demonstrate how the benefit of the stacking of multiple policy mechanisms can be an effective way to move SAF minimum selling price (MSP) toward price parity with conventional kerosene. Minimum selling price (MSP) is the fuel selling price that aligns with the target real discount rate and an NPV of zero. The five examples in this section illustrate the possible impact of policies on MSP with a target real discount rate of 10%. The calculations are for an example facility and do not model a specific facility or include any proprietary information. As such, the MSP should not be taken as absolute. The impact of policies on each conversion technology and feedstock combination will be different as a result of widely varying capital and operating costs. The included examples demonstrate the impact of incentive policies on a hypothetical Fischer-Tropsch facility that uses woody biomass as feedstock with costs, economic variables and incentives from the U.S. The following examples demonstrate that stacking of incentives can be an effective way to move SAF MSP toward price parity with conventional kerosene. All analysis is for mature, nth plant economics unless otherwise stated.

In the U.S. there are multiple policy incentives used to promote investment in renewable fuels. The Renewable Fuel Standard (RFS2) is a federal program that issues Renewable Identification Numbers (RINs) for each gallon of fuel produced (note the analysis below pro-rates this value for liters). Multiple RIN types exist, and each has a percent CO_2e reduction threshold and a monetary value which is paid to the fuel producer as taxable income. For the examples here, all RINs considered are for cellulosic biofuels also known as D3 RINs.

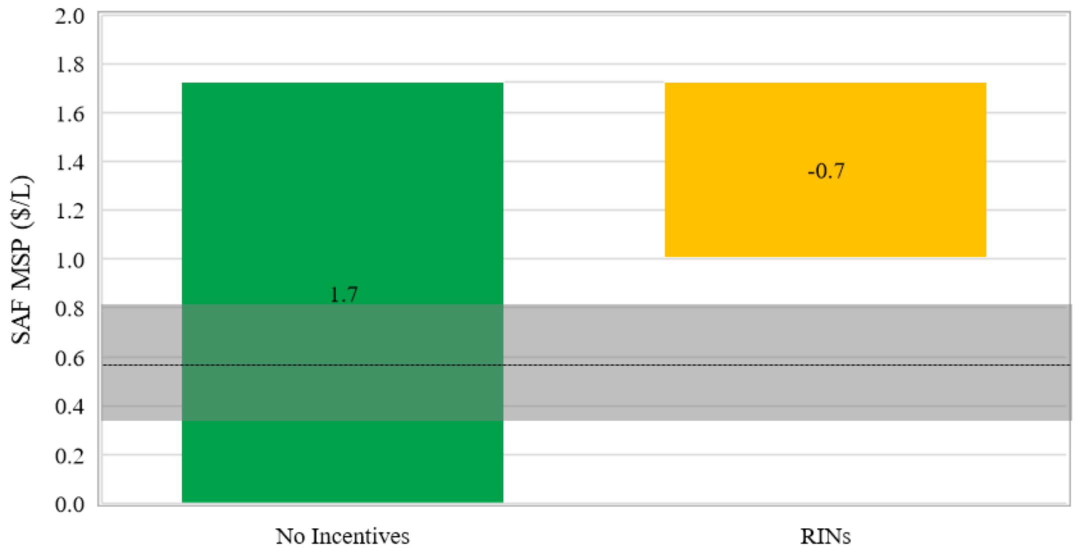
Blenders Tax Credits are a second type of federal incentive that is paid to the blender as a reduction of taxes to zero and then as untaxable income. In the U.S. this type of incentive has existed for most fuel types, but has just been extended explicitly to SAF. The examples with this incentive include assumed values for 10-years and for scenarios in which the producer and blender are the same entity.

State or regional incentives currently drive fuel to a compressed part of the U.S. California’s Low Carbon Fuel Standard (LCFS), an incentive that scales based on carbon intensity score is included in some of the examples.

Capital grants, an incentive with the intended purpose of helping finance new technology is included in an example. The reduction in capital costs lowers MSP, while also reducing the risk to investors.

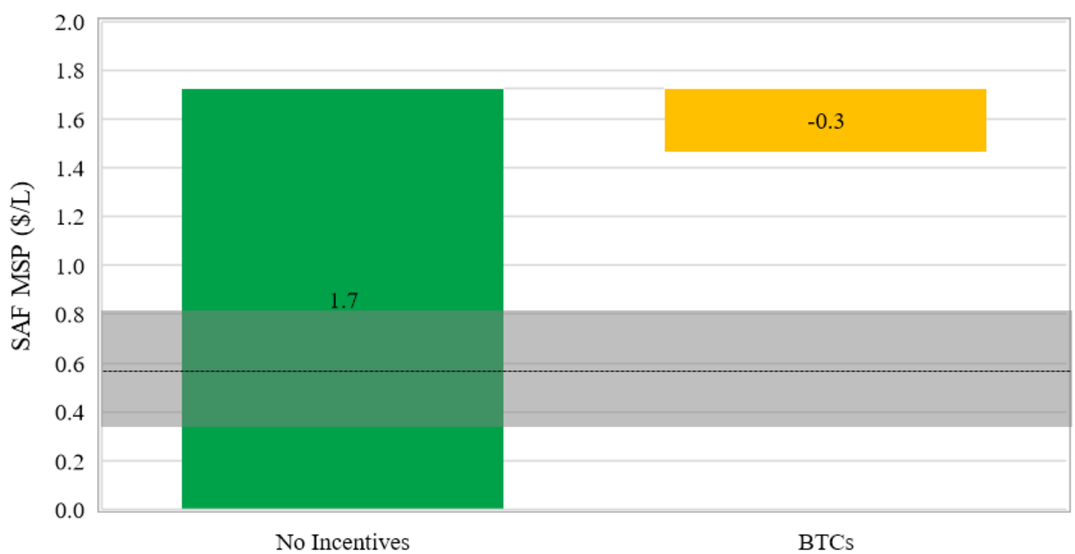
Example 1:

Example 1 illustrates the possible reduction in SAF MSP for the example facility with the addition of RFS RINs. The values of RINs vary, an average value was applied for the years 2014 through 2020. The estimated MSP will vary with the current market value of RINs. The grey band on each chart is the range of annual average wholesale conventional kerosene prices from 2011-2020 and the dotted line is the average value (EIA 2021). The RFS incentive package is not enough to reduce the MSP into the range of conventional kerosene.



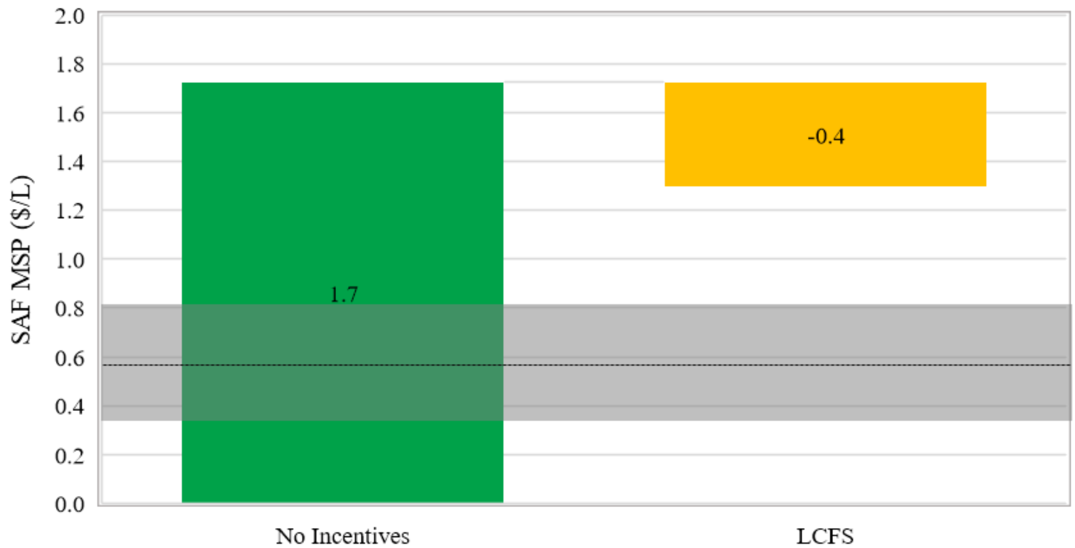
Example 2:

Example 2 replicates example 1, but instead of looking at the impact of RINs, the MSP reduction from blender tax credits is quantified. Once again, this incentive is not enough to bring the SAF MSP into the conventional kerosene range.



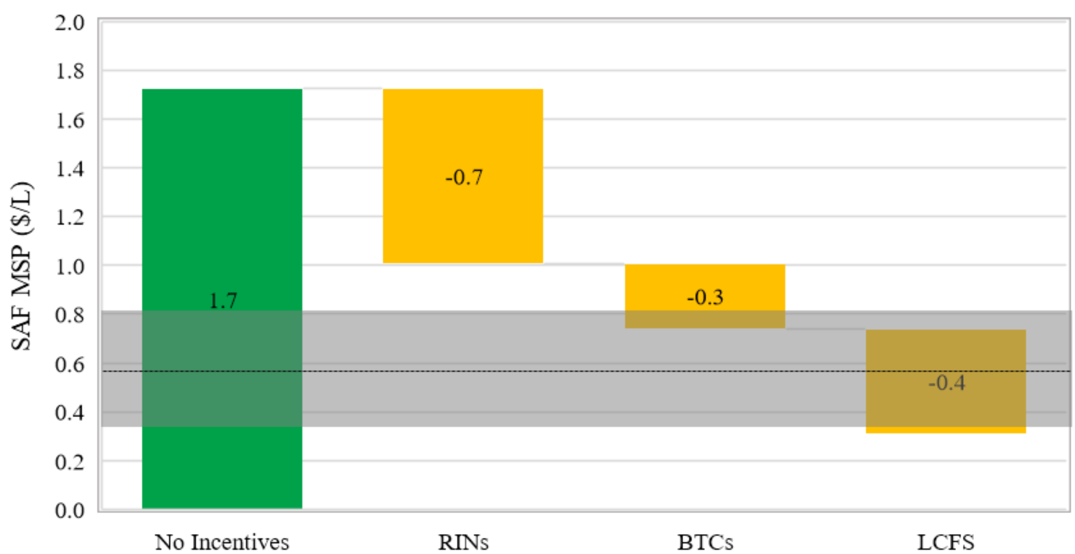
Example 3:

Example 3 mimics examples 1 and 2, but instead of RINs or BTC, the change in MSP from the addition of California's LCFS is estimated. The SAF MSP from the LCFS does not reduce enough to drop the SAF MSP within the price parity range with conventional kerosene.



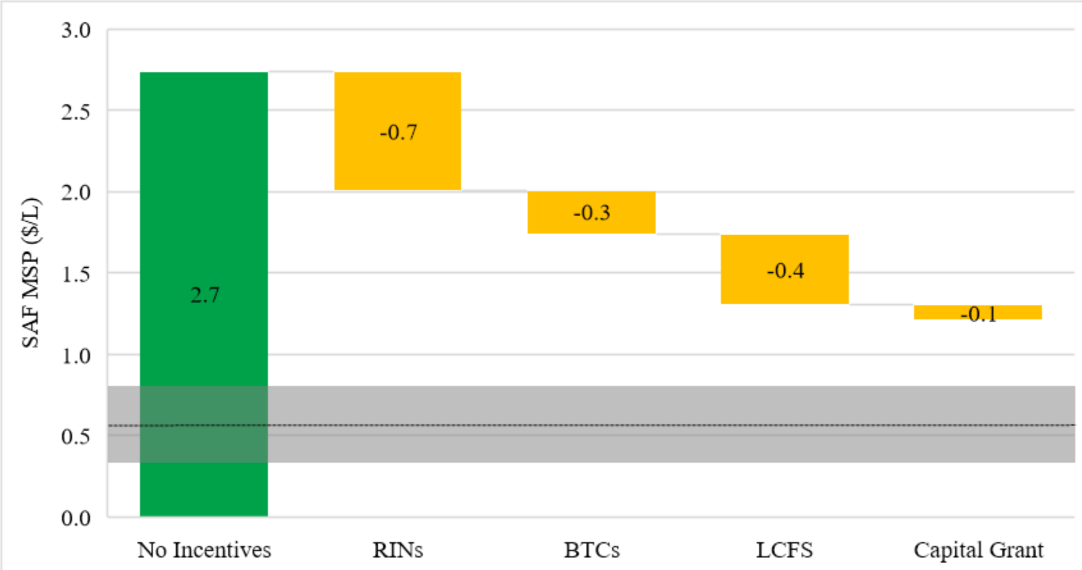
Example 4:

Example 4 is a combination of examples 1 through 3, with all of the incentives stacked together. For the estimated incentive values, the combination of either BTCs or LCFS with RINs brings the MSP to the top of the conventional kerosene price range. However, it is unlikely that investments will be made unless the MSP drops below the average line. The MSP drops below this level with the combination of all three incentives.



Example 5:

Example 5 starts with a baseline (no incentives) MSP for a pioneer plant. The pioneer plant assumption increases the capital cost per liter of fuel and decreases the total plant fuel output. For the technology assessed in this example, this MSP is more relevant to the current state of technology development. The incentives from examples 1 through 3 are added as well as a capital grant of 75 million USD. The combination of all of the four incentives is not enough to drop the pioneer MSP into the conventional kerosene range. The impact of the capital grant is small, the scale of the capital investment needed for a pioneer Fischer-Tropsch, woody biomass plant is too great for 75 million USD to overcome.



The incentives discussed are for illustrative purposes only and it is understood that the values of these incentives will vary with location and time. The findings do show that multiple incentives (or one very large incentive) are required to achieve price parity for nth plant facilities. However, pioneer technology will require additional funding beyond what was discussed to meet this goal.

9. Resources

A list of useful web resources and references is appended here:

Air Transport Action Group – Waypoint 2050

Air Transport Action Group – Fueling Net Zero: How the aviation industry can deploy sufficient sustainable aviation fuel to meet climate ambitions

Alternative Fuels Data Center – U.S. Federal and State Laws and Incentives

Atlantic Council - Sustainable Aviation Fuel Policy in the United States: A Pragmatic Way Forward

California Air Resources Board - Low Carbon Fuel Standard

Canada - Clean Fuel Regulations

European Union - Renewable Energy Directive

European Union - ReFuelEU Aviation regulation

European Union – Emission Trading Scheme Directive

European Union – Innovation Fund

ICAO - Sustainable Aviation Fuels

ICAO - Sustainable Aviation Fuels Guide

ICAO - SAF Rules of Thumb

Frontiers in Energy Research Special Topic on SAF

Singapore Sustainable Air Hub Blueprint

United Kingdom – SAF mandate

United Kingdom – Advanced Fuels Fund

United Kingdom – SAF Clearing House

United States - Renewable Fuel Standard Program

United States - SAF Grand Challenge

United States - SAF Grand Challenge Roadmap, Flight Plan for Sustainable Aviation Fuel

World Economic Forum - Clean Skies for Tomorrow: Joint policy proposal to accelerate the deployment of sustainable aviation fuels in Europe

World Economic Forum – Clean Skies for Tomorrow Sustainable Aviation Fuel Policy Toolkit

10. Glossary of Terms

Aireg	Aviation Initiative for Renewable Energy in Germany
ATJ	Alcohol-to-Jet
BBP	Brazilian Biofuels Platform
BCAP	Biomass Crop Assistance Program
BTC	Blenders Tax Credit
CAEP	Committee on Aviation Environmental Protection
CAAFI	Commercial Aviation Alternative Fuels Initiative
CARB	California Air Resource Board
CEF	CORSIA Eligible Fuel
CORSIA	Carbon Offsetting and Reduction Scheme for International Aviation
CO2	Carbon Dioxide
DOE	U.S. Department of Energy
DSHC	Direct Sugar to Hydrocarbons
EU	European Union
EU RED	European Union Renewable Energy Directive
EU ETS	European Union Emission Trading Scheme
FAA	Federal Aviation Administration
FT	Fischer-Tropsch
FTG	Fuels Task Group
GHG	Greenhouse Gas
HEFA	Hydroprocessed Esters and Fatty Acids
IATA	International Air Transport Association
ICAO	International Civil Aviation Organization
IEA	International Energy Agency
IPCC	Intergovernmental Panel on Climate Change
IRENA	International Renewable Energy Agency
IRR	Internal Rate of Return
ISCC	International Sustainability & Carbon Certification
ITC	Investment Tax Credit
LCA	Life Cycle Assessment
LCAF	Lower Carbon Aviation Fuels
LCFS	Low Carbon Fuel Standard
LUC	Land Use Change

MLP	Master limited partnership
MSW	Municipal Solid Waste
MSP	Minimum Selling Price
NISA	Nordic Initiative for Sustainable Aviation
NPV	Net Present Value
PTC	Production Tax Credit
RDD&D	Research, Development, Demonstration and Deployment
RFS / RFS2	Renewable Fuel Standard
RINs	Renewable Identification Numbers
RSB	Roundtable on Sustainable Biomaterials
SAF	Sustainable Aviation Fuels
SCS	Sustainability Certification Schemes
SPK	Synthetic Paraffinic Kerosene
SIP	Synthetic Iso-paraffin SPK Synthesized Paraffinic Kerosene
TEA	Techno-economic analysis
USDA	U.S. Department of Agriculture
WEF	World Economic Forum

Appendix A – Table of SAF Policy Options

Impact Area	Policy Category	Policy Option	Description
Stimulating Growth of SAF Supply	**1 - Public funding for SAF research, development, demonstration and deployment (RDD&D) to accelerate learning**	1.1 - Public funding for R&D	Research grants and public funding to address barriers to SAF production and use can help early stage SAF production innovations. It also supports SAF economics by accelerating the learning curve for feedstock yields or production optimisation. Support can occur from establishing specific programs or supporting existing private research activities or through universities or similar institutions.
		1.2 - Public funding for demonstration and deployment	Research grants and public funding to demonstrate and de-risk new feedstock and conversion technologies can provide support to both feedstock and fuel technology providers to scale up and integrate their production. This support accelerates the learning process around technology and supply chain scale up. Support can occur from establishing specific programs that support existing private sector producers.
	2 - Targeted incentives and tax relief to expand SAF supply infrastructure	2.1 - Capital grants	A government grant given to an entity to build or buy SAF-specific infrastructure. This can support a range of production facilities, transportation, re-fuelling or blending infrastructure. Capital grants reduce the financial needs and financial risks of the targeted investment.
		2.2 - Loan guarantee programs	A loan backed by a government or public institution helps the project financial case, and also reduces overall project risk, making acquiring additional equity of debt easier and lowers cost of capital.
		2.3 - Eligibility of SAF projects for tax advantaged business status	For example master limited partnerships (MLPs) are a specialized U.S. business organization type that is limited in use to the real estate and natural resources sectors (e.g. oil production). MLPs do not pay federal income taxes in the same way that other corporate structures do.
		2.4 - Accelerated depreciation/'bonus' depreciation	Accelerated or bonus depreciation allows the accounting write-off of capital investment or the potential to write off more than the actual capital investment. This will result in less expected tax to be paid over the life of the project and improve overall project economics.
		2.5 - Business Investment Tax Credit (ITC) for SAF investments	An ITC tax credit allows deduction of construction and/or commissioning costs of a qualifying asset which can reduce income tax payable and flow through to investors. This will result in less expected tax to be paid over the life of the project and improve overall project economics.
		2.6 - Performance-based tax credit	The concept offers a tax credit for a project meeting certain conditions. The credit could be a sliding scale performance credit (higher credit for better GHG performing projects) and should have a defined policy life (i.e. 10-15 years).
		2.7 – Bonds / Green Bonds	Bonds can be issued by private companies, supranational institutions, and public entities including sub-national and local governments to provide low-interest rate and tax exempt financing used to support fuel production infrastructure build out. Green Bonds are designed specifically to support specific climate-related or environmental projects.
		2.8 – Simplify administrative procedures	Review of the approval rules for establishing of industrial plants for feedstock/inputs production as well as for SAF production to simplify administrative procedure and reduce the time required to establish industrial capacities
		2.9 – De-risking supply	For example, the European Hydrogen Bank is a financing instrument designed to unlock private investments in hydrogen value chains, both domestically and in third countries, by connecting renewable energy supply to EU demand and addressing the initial investment challenges.
	3 - Targeted incentives and tax relief to assist SAF facility operation	3.1 Blending incentives: Blender's Tax Credit	An incentive targeted at the providers or blenders of fuel that provides a credit against taxes. This mitigates the blenders cost of production or purchase difference between SAF and fossil jet.
		3.2 – Production incentives: Producer's Tax Credit	An incentive targeted at the producers of fuels that provides a credit against taxes. This mitigates the cost of production difference between SAF and fossil jet.

		3.3 - Excise tax credit for SAF	For States that tax domestic jet fuel consumption, a reduction or elimination of the tax in proportion to quantity of SAF consumed serves to incentivize fuel consumers to purchase SAF by contributing to lower SAF cost.
		3.4 - Support for feedstock supply establishment and production	Targeted support can address the risks and costs to farmers and feedstock suppliers of establishing a new crop and producing it under uncertain conditions. Crop insurance program support for SAF can also be considered in addition to subsidy payments made to farmers aimed at incentivizing production.
		3.5 – Reducing the price gap between SAF and fossil fuel for end user	Targeted support to the end user can help address the cost issue and support airlines to procure more SAF by covering a certain amount of the price different between SAF and fossil jet fuel
	4 - Recognition and valorization of SAF environmental benefits	4.1 – Recognize SAF benefits under carbon taxation	Where a jurisdiction has introduced a carbon tax, carbon price, or carbon levy (that is setting a tax rate on carbon emissions for each fuel type, thereby providing a signal to reduce emissions) SAF could be rated as either zero or in proportion to the life-cycle greenhouse gas emissions benefit of the particular fuel, thereby subject to reduced tax. This differs from a cap and trade system by not stipulating an overall emission reduction target.
		4.2 - Recognize SAF benefits under cap-and-trade systems	Cap-and-trade systems limit total GHG emissions by setting a maximum emissions level and allowing participants with lower emissions to sell surplus emission permits to larger emitters. This system creates supply and demand for emissions permits and establishes a market price for emissions and a value for avoided emissions. If SAF were used in such a system, it would exempt the user of the SAF of obligations under the regulation.
		4.3 - Recognize non-CO_2 SAF benefits: improvements to air quality	Some programs and incentives place a value on local air quality. SAF should be able to financially participate in these incentive schemes based on air quality benefits that certain SAFs may be able to provide.
Creating Demand for SAF	**5- Creation of SAF mandates**	5.1 - Mandate SAF energy volume requirements in the fuel supply	An obligation on fuel providers to provide increasing SAF fuel volumes added to the existing fuel supply on a multi-year schedule creates an incentive for production of more SAF and other fuels which meet the renewable energy definitions of the program. These definitions can include life-cycle greenhouse gas emissions requirements.
		5.2 - Mandate reduction in carbon intensity of the fuel supply	An obligation on fuel providers to reduce the carbon intensity (life-cycle greenhouse gas emissions intensity) of the transportation fuel supply on a multi-year schedule creates an incentive for production of more SAF and other fuels with greenhouse gas benefits. Low carbon fuel standards (LCFS) and clean fuels standards can enable targeting of the carbon intensity of the State's fuel supply.
		5.3 – Mandate reduction in carbon intensity of the fuel uptake	An obligation on aircraft operators to reduce the carbon intensity (life-cycle greenhouse gas emissions intensity) of their operations through the transportation fuel they buy, on a multi-year schedule, which fosters the competition among fuels producers for the use of the best technology available and the most efficient SAF and cleaner fuels.
		5.4 – Requirement for end users to support SAF use	A requirement on air transport users to pay for SAF use, in line with the user pays principle. It provides transparency to consumers, and ensures a level-playing field as consumers pay based on the amounts consumed (e.g. proportionate to flight lengths and class of travel). It also provides for a long-term financially sustainable approach to generate SAF demand as costs are borne by the aviation system. This may not necessarily be a mandate
	6 - Update existing policies to incorporate SAF	6.1: Incorporating SAF into existing national policies	Many national level policies may be adapted to incorporate SAF. Typically, legacy biofuel policies have focused on road-transport-appropriate fuels and do not include SAF as an option. With the more recent advent of drop-in jet fuel/SAF production technologies, an opportunity exists to update existing policies to support SAF production.
		6.2: Incorporating SAF into existing sub-national, regional or local policies	Existing alternative fuel incentive policies at a sub-national, regional or local level may be abler to to incorporate SAF as qualified fuels. An update to these existing policies to support SAF production can provide additional support and may enable a beneficial "stacking" of incentives at multiple levels that contributes to SAF economic viability.
	7 – Demonstrate government leadership	7.1 Policy statement to establish direction	Setting aspirational goals of specific production or use amounts to signal future intent to develop comprehensive SAF policy measures. This can be linked to the implementation of future policies, sending a signal for project planning. Examples could include State level commitments for a quantitative SAF use goal or carbon reduction by a certain time, or signals from industry such as a commitment to achieve net zero by 2050.

		7.2: Government commitment to SAF use, carbon neutral air travel	A strong demand signal can be created by requiring national, state, local governments, and military to commit to renewable fuel/SAF procurement to reduce environmental impacts of air travel and operations. Governments often have the ability to commit to long term contracts backed by strong credit rating which lowers project risk. Governments can either directly purchase SAF for use by government aircraft or contract with commercial air carriers to provide SAF to power government purchased travel.
Enabling SAF Markets	**8 - Market enabling activities**	8.1 - Adopt clear and recognized sustainability standards and life cycle GHG emissions methods for certification of feedstock supply and fuel production	Use of clear standards and harmonized methods for life cycle GHG emissions calculation and sustainability certification will support broad SAF markets and ensure environmental integrity.
Enabling SAF Markets	**8 - Market enabling activities**	8.2 - Support development/recognition of systems for environmental attribute ownership and transfer	Standard processes and shared systems for calculating, crediting and trading the environmental attributes of SAF may facilitate "book and claim" purchasing of SAF that decouples the physical fuel location and the environmental benefit in order to facilitate and promote more efficient and broader use of SAF volumes and their GHG emission reductions.
Enabling SAF Markets	**8 - Market enabling activities**	8.3 - Support SAF stakeholder initiatives	Stakeholder consultation groups can take many forms and be either government, industry or NGO led. These groups serve a critical function of aligning the diverse stakeholders that make up the SAF supply chain. They can directly coordinate actions and provide critical information and feedback to policymakers. The implementation of common environmental label to allow passengers to make informed choices regarding the sustainability of flights can directly support stakeholders' actions and SAF procurement by airlines
Enabling SAF Markets	**8 - Market enabling activities**	8.4 – Support the qualification of new SAF production pathways	SAF Clearing House concepts will help to accelerate and reduce costs of the standardization processes, including technical suitability and production scalability, thus helping SAF producers to access financial support and increasing the availability of SAF on the market.

Appendix B – Policy Approach Example: European Union

The EU has undertaken various regulatory, financial and other support initiatives to support SAF development and deployment, which provide a comprehensive approach towards SAF production, supply and uptake through:

- long-term market certainty for SAF supply and uptake under ReFuelEU Aviation Regulation (further detailed in the first part of this appendix);
- carbon capping and pricing under the EU ETS, including SAF allowances (further detailed in the second part of this appendix);
- fuel tax under the proposal for the revision of Energy Taxation Directive;
- flight emissions label laying down harmonized rules for the estimation of flight emissions uptake;
- inclusion in the EU taxonomy of SAF production and uptake to improve access to green finance;
- R&D and deployment financing support under Horizon Europe, Innovation Fund, InvestEU programmes;
- accelerating qualification of new technologies and approval of new production plants through creation of EU SAF Clearing House and inclusion of SAF in the Net Zero Industry Act proposal;
- cross-sectoral cooperation in Renewable and Low-Carbon Fuels Value Chain Industrial Alliance;
- EU supporting capacity building in third countries.

Overview of ReFuelEU Aviation Regulation

ReFuelEU Aviation Regulation (EU) 2023/2405, adopted on 18 October 2023, with an objective to reduce aviation environmental impact while preserving level playing field on the aviation market.

The Regulation imposes following obligations on aviation fuel suppliers, aircraft operators and Union airports managing bodies:

- aviation fuel suppliers to supply an increasing minimum share of SAF at Union airports, starting from 2% by 2025 up to 70% by 2050 – including a dedicated minimum share for synthetic aviation fuels starting from 1.2% by 2030 to 35% by 2050;
- aircraft operators to uplift at least 90% of the aviation fuel needed to operate their flights from Union airports, avoiding tankering practices which could be exacerbated through the introduction of the mandate;
- Union airports managing bodies to facilitate access to SAF at Union airports.

Aircraft operators and airports with low passenger or cargo traffic levels and airports located in outermost regions are in principle out of the scope of the Regulation. in line with the proportionality principle. However, aircraft operators and airports may opt-in to the scope of the regulation. Aircraft operator may also opt-in to have their non-commercial flights in the scope of the Regulation.

During a transition period of ten years (i.e. from 2025 to the end of 2034) aviation fuel suppliers have the possibility to meet their SAF minimum shares not in every Union airports but rather as an aggregate at all Union airports to which they supply aviation fuel. After that period, aviation fuel suppliers are required to supply the minimum shares of SAF to each Union airport falling under the scope of the Regulation. The

Regulation does not set SAF production targets; both imported and EU-sourced SAF can count to the SAF minimum shares provided they both meet the sustainability criteria. The Regulation relies on the SAF sustainability criteria and traceability through the Union Database as established under the Renewable Energy Directive. Under the Regulation, SAF includes drop-in fuels that are biofuels, recycled carbon fuels and synthetic fuels produced from renewable energy. However, aviation fuel suppliers can demonstrate compliance with the supply obligations through the supply of low-carbon non-fossil fuels (notably produced from electricity of nuclear origin) as well as renewable and low-carbon non-fossil hydrogen.

The obligation on aircraft operators to uplift aviation fuel applies to both EU and non-EU operators in the scope of the Regulation for all departing flights from Union airports. As such, the Regulation does not mandate SAF uptake on aircraft operators. The European Union Aviation Safety Agency (EASA) will facilitate the reporting of aircraft operators on their aviation fuel uptake.

Such volume-based obligation aims to de-risk investments by providing long-term predictability and market certainty on SAF amounts required on the market. It is expected to ramp up production of SAF by overcoming a 'chicken and egg dilemma' between SAF supply and demand and to reduce the cost of SAF over the time thanks to the economies of scale and production efficiencies.

Some alternative policy options were considered in the impact assessment at the time of the preparation of the proposal for ReFuelEU Aviation Regulation but were not retained in the legislative proposal[6].

These included considerations regarding the following options that were not retained:

a) Definition of the target setting vs as a reduction of the fuel's CO_2 intensity

This would impose on aviation fuel suppliers a minimum reduction of the CO_2 intensity (meaning the lifecycle CO_2 emissions per unit of energy) of the overall jet fuel supplied rather than imposing the supply of a certain quantity of SAF. The aim is to take a technology-neutral approach by using the CO_2 intensity reduction-based obligation which does not impose the scale up of certain technologies to defined levels, but lets the market react based on the CO_2 performance of each technology. SAF can count towards meeting the target to the extent of the CO_2 intensity reduction they achieve.

b) Obligation on the demand side (intra and extra-EU scope)

This policy option consisted of imposing an obligation on aircraft operators to use a minimum share of SAF (expressed in volume terms) as part of their total jet fuel use on intra-EU flights and flights from any EU airport to an extra-EU airport. An aircraft operators is not strictly required to use SAF on each flight as long as it can demonstrate that it has used the minimum share of SAF on average over the course of each reporting period of one year. As some aircraft operators may not have physical access to SAF at the airports where they focus their operations, a transaction system allows them to purchase SAF and claim their use even if they do not use it physically, provided that it is used elsewhere in the EU aviation system. Such a system would have worked under the EU ETS Monitoring Reporting and Verification IT structure and would represent a limited number of transactions by aircraft operators on a yearly basis, hence negligible administrative costs. An existing European organisation (e.g. Eurocontrol) is required to compile the information contained in the EU ETS and CORSIA emission reports regarding SAF use, and reports to the Commission on the compliance of individual airlines with their SAF use obligation.

c) Obligation on the demand side (intra-EU scope)

[6] Further details could be found in sections 7 & 8 of the Study supporting the impact assessment of the ReFuelEU Aviation initiative prepared for the to support the European Commission's Impact Assessment of the ReFuelEU Aviation initiative – https://op.europa.eu/fr/publication-detail/-/publication/46892bd0-0b95-11ec-adb1-01aa75ed71a1

This mandate option consisted of covering only intra-EU flights. This means that an obligation is imposed on aircraft operators to use a minimum share of SAF (expressed in volume terms), as part of their total aviation fuel consumption on intra-EU flights only. Aircraft operators operating such flights would need to use a larger portion of SAF to compensate for excluding extra EU scope flights. If not, this option would result in lower emissions reductions achievement than all other options. Monitoring, reporting and verification of SAF use by aircraft operators is ensured through the dedicated mechanisms under the EU ETS Monitoring and Reporting Regulation, meaning that airlines operating intra-EU flights report SAF use within their individual emissions reports.

Overview of the EU Emission Trading Scheme for Aviation

The Directive on EU Emission Trading System applied to aviation[7] has also been revised in the context of the Fit-For-55 integrated package of initiatives. In accordance with the European Climate Law, every sector is required to contribute to reaching climate neutrality by 2050. The aviation industry has been included in the EU Emissions Trading System (EU ETS) since 2012 and continues to contribute to the reductions in emissions across EU. In the 2023 revision, the Linear Reduction Factor (LRF, i.e., the annual reduction of cap on emissions) nearly doubles from the previous 2.2% to 4.3% in 2024 and 4.4% in 2028. The EU ETS currently covers emissions from all flights within the European Economic Area, as well as departing flights to the UK and Switzerland. **Aviation is one of the hard-to-abate sectors, expected to experience substantial growth**. Consequently, its incorporation within the EU ETS is necessary to **help the aviation industry implement measures necessary to achieve the climate neutrality objectives**.

The EU ETS supports the use of SAF by zero-rating them, thus not requiring the surrender of emission allowances for their use. Furthermore, an additional support system has been introduced in the 2023 revision for uplifting eligible sustainable aviation fuels on routes covered by the ETS. For this purpose, **around €1.6 billion are reserved from the EU ETS revenue.** These resources will be given on a **first-come, first-served basis** to airlines **to cover the price difference compared to fossil kerosene**. This support mechanism will help kick-starting the SAF market in Europe. The EU ETS requires the European Commission to report on the functioning of this support mechanism by January 2028, and in case it sees appropriate, to propose the extension of this support up until 2035. It would be a development that is welcome if there would be a need for additional support, as it would imply the increased uplift of SAF.

- Only renewable fuels of non-biological origin (RFNBO), hydrogen from renewable sources, advanced biofuels and other fuels that are eligible under ReFuelEU Aviation Regulation that are not stemming from fossil fuels are eligible for SAF support under the EU ETS.
- Only SAF used on flights covered by EU ETS compliance obligation are eligible for free SAF allowances.
- At airports where it is impossible to assign fuels to individual flights, the proportion of SAF bought at that airport will be eligible which corresponds to the proportion of emissions from ETS covered flights from that airport. Not applying this rule would result in a competitive distortion in favour of airlines that have a low share of ETS covered flights.
- There is no book and claim possible under the ETS Directive. The principle is that fuel use must be reported for flights that are covered by the EU ETS and at the place of its uplift.

[7] Directive (EU) 2023/958 of the European Parliament and of the Council of 10 May 2023 amending Directive 2003/87/EC as regards aviation’s contribution to the Union’s economy-wide emission reduction target and the appropriate implementation of a global market-based measure

With respect to the level of support, the 20 million extra SAF allowances will be allocated, in a non-discriminatory manner. They will cover 70 % of the remaining price differential between the use of fossil jet fuel and hydrogen from renewable energy sources and advanced biofuels, 95 % of the remaining price differential between the use of fossil jet fuel and renewable fuels of non-biological origin, 100 % of the remaining price differential at airports situated on islands smaller than 10 000 km2 and with no road or rail link with the mainland, at airports which are insufficiently large to be defined as Union airports and at airports located in an outermost region. In other cases, 50% of the price differential will be covered.

EU ETS includes an obligation for monitoring, reporting and verification (MRV) of non-CO2 aviation effects that would feed an annual report from the European Commission. By 1 January 2028, building on the results of the MRV, mitigation measures for non-CO2 aviation effects may be proposed.

Moreover, around €400 million from the EU ETS revenue are put aside for the **Innovation Fund**, which is expanded including to support projects for the reduction of overall climate impact or electrification of aviation. Additionally, the Innovation Fund continues to support the development of renewable energy, hydrogen, and alternative fuels.

Appendix C - Policy Approach Example: UK SAF Policy Programme

The UK Government is committed to the aviation sector reaching net zero by 2050, SAF is a core policy measure in achieving this with Government commitments to help ensure it plays a significant part in the carbon abatement required for aviation.

Definition of SAF

"SAF" are low carbon alternatives to conventional, fossil derived, aviation fuel – 'drop in equivalents' that present similar characteristics to conventional jet fuel. Generally, SAF can be produced from three types of feedstock:

- Biomass: this includes biogenic waste, e.g. used cooking oil.
- Non-biogenic waste: e.g. unrecyclable plastics or waste fossil gases from industry.
- CO_2 + green hydrogen: zero-carbon electricity is used to produce hydrogen through water electrolysis; hydrogen then reacts with CO2 captured from the air or waste industrial exhaust streams to produce a synthetic fuel. This process is known as power-to-liquid (PtL).

Key UK SAF policies

- **Create secure and growing UK SAF demand** by implementing a SAF mandate which will come into force in 2025[8]. The mandate will set an obligation on fuel suppliers to reduce the greenhouse gas emissions of aviation fuel by suppling SAF into the UK aviation fuel mix. It will incentivise SAF supply through the award of tradeable certificates with a cash value.
- **Kickstart a domestic SAF industry** by continuing to support the development of SAF through advanced fuels funding competitions. The UK is supporting 13 first-of-a-kind SAF projects to attract external investment and reach commercial scale through the Advanced Fuels Fund[9] providing £135 million. Once operational, these projects are expected to collectively produce over 700 kilo tonnes of SAF and reduce CO2 emissions by 2.7 million each year. This funding will help to achieve the commitment of having at least five commercial-scale plants under construction in the UK by 2025.
- To further support the development of a UK SAF industry, the Government launched a UK Clearing House[10] in November 2023. The Clearing House is a national hub capable of facilitating testing, expert advice and funding for new sustainable aviation fuels looking to enter testing at all qualification stages and pathways. It helps to reduce costs to businesses and accelerates the approval of new SAF entering the market whilst supporting investor confidence in UK SAF projects. Alongside this, up to £3million of DfT grant funding is available to support testing costs for fuels that pass an assessment against our criteria, based on factors including sustainability, technical suitability and commercial potential.
- The UK is also driving forward technological innovation and industry collaboration to support the rapid uptake and use of SAF. With support of up to £1 million from the UK government, Virgin Atlantic flew the first transatlantic flight on a commercial aircraft using 100% SAF in November 2023.

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[8] https://www.gov.uk/government/speeches/sustainable-aviation-fuel-initiatives
[9] https://www.gov.uk/government/publications/advanced-fuels-fund-competition-winners/advanced-fuels-fund-aff-competition-winners
[10] https://www.safclearinghouse.uk/

- **Work in partnership with industry and investors to build long term supply**. Following the King's Speech in July 2024[11], the UK Government will be laying legislation to introduce a revenue certainty mechanism to support SAF production in the UK. An eight-week consultation on revenue certainty options to support investment in a UK SAF production industry closed on 20 June 2024. A government response will be published in due course.

UK SAF Mandate

Following consultation in 2021 and 2023, the UK Government has published the final details of the UK SAF mandate in a government response.

Key principles of the UK SAF mandate:

Creating UK demand for SAF

- The mandate will create demand and provide certainty about the size of the market going forwards. The Government has confirmed it will start in 2025. The mandate will set an obligation on fuel suppliers to reduce the greenhouse gas emissions of aviation fuel by supplying SAF into the UK aviation fuel mix. The mandate will apply to jet fuel suppliers.

- The mandate will operate as a tradeable certificate scheme, where the supply of SAF is rewarded in proportion to its GHG emissions reductions. These certificates can be used to discharge a supplier's obligation or can be sold to other suppliers. The final government response details how the provision of certificates is calculated.

  In 2025, the overall SAF trajectory will be set at an equivalent of 2% of the total fossil jet fuel supplied, increasing annually to 10% in 2030 and 22% in 2040.

- More advanced fuels – namely PtL - will be incentivised through a sub-target in recognition of PtL fuels having a higher GHG emissions savings potential, lower competition for biogenic feedstocks and low risk of wider environmental issues like land use change. The PtL obligation will be introduced in 2028 set at 0.2% of total jet fuel demand, increasing to 0.5% in 2030 and 3.5% in 2040.

- The UK has confirmed that a buy-out mechanism will be included in the SAF Mandate. This provides a way for suppliers to discharge their mandate obligation in cases where they are unable to secure a supply of SAF, preventing excessive costs from being passed on to consumers. It will also provide a sufficiently high incentive to supply SAF into the UK market and will support investor confidence in UK SAF projects. The obligation buy-out price will be set at the equivalent of £4.70 and £5.00 per litre for the main and PtL obligations, respectively.

Encouraging fuels with the best GHG savings and sustainability credentials

- The UK has been clear that the SAF mandate must deliver fuels with the highest sustainability credentials. The Government is therefore imposing strict sustainability criteria that SAF must meet in order to be eligible under the mandate. The full sustainability criteria that suppliers will need to evidence is set out in the final government response.

- Under the Mandate, SAF must be made from sustainable wastes or residues (such as used cooking oil or forestry residues), recycled carbon fuels (e.g. unrecyclable plastics), or be Power to Liquid fuels made using low carbon (renewable or nuclear) electricity. SAF produced from food, feed or energy crops will not be allowed.

[11] https://www.gov.uk/government/speeches/the-kings-speech-2024

- SAF must achieve at least a 40% reduction in carbon intensity compared to fossil kerosene. This level reflects both the need to expand the scope of eligible SAF to include recycled carbon fuels, and the nascent state of the UK SAF industry. This minimum requirement is expected to rise in future years of the mandate.
- SAF from HEFA will be capped to allow space in the market for other SAF that makes use of novel feedstocks. The HEFA cap, as a proportion of the overall trajectory, will be set at a maximum amount of 100% in 2025 and 2026, decreasing to 71% in 2030 and 35% in 2040.

For more in-depth information on topics considered for the UK SAF mandate, see the original consultation document and the government response.

Appendix D - Policy Approach Example: United States SAF Grand Challenge

The United States 2021 Aviation Climate Action Plan was announced on November 9, 2021. It provides an example of an overarching policy framework to achieve the U.S. Aviation Climate Goal of "*Net-Zero GHG Emissions from the U.S. Aviation Sector by 2050*." Within this framework the Action Plan states that SAF will be critical to the long-term decarbonization of aviation. It commits the U.S. government to work with industry to rapidly scale up SAF production through a range of policy instruments, including the "SAF Grand Challenge" – a broad U.S. government framework for expanding SAF with the goal of meeting the fuel needs of U.S. aviation by 2050.

SAF Grand Challenge

The SAF Grand Challenge is a multi-agency initiative led by the U.S. Department of Transportation (DOT), Department of Energy (DOE), and Department of Agriculture (USDA) to implement a government wide effort to reduce cost, enhance sustainability, and expand production and use of SAF. It was announced at a White House Roundtable on Sustainable aviation on September 9, 2021.

The approach emphasizes the role of U.S. executive branch authorities and programs to support research, development, demonstration, and deployment of SAF. In addition to actions taken by executive branch agencies, the plan recognizes the need for well-designed economic incentives that can be legislated by the U.S. Congress, including blender's tax credits and investment tax credits, to help bridge the cost gap between SAF and petroleum jet fuel.

Goals

Scaling up U.S. SAF production to at least 3 billion gallons of SAF per year by 2030 and, by 2050, sufficient SAF to meet 100% of aviation fuel demand, which is currently projected to be around 35 billion gallons per year.

Definition of SAF

- "drop-in" liquid hydrocarbon fuels with the same performance and safety as conventional jet fuels produced from petroleum
- fully fungible with the existing fuel supply and can be used in today's infrastructure, engines, and aircraft
- can be created from either renewable biomass materials or waste materials including gaseous carbon
- reduce life cycle GHG emissions by at least 50% relative to conventional jet fuel

use of some SAF pathways will also reduce emissions that degrade air quality and could reduce the contribution of contrails to climate change

Intent

Through the SAF Grand Challenge, DOE, DOT, and USDA, will work with the U.S. Environmental Protection Agency (EPA) and other agency partners to enable an ambitious government-wide commitment to: 1) leverage existing government activities in research, development, demonstration, and deployment, support; 2) accelerate new research, development, demonstration, and deployment support; and, 3) implement a supporting policy framework. To meet the Goals of the Grand challenge these actions are intended to support the following objectives:

- **Expand SAF supply and end use** through support for regional feedstock and fuel production development and demonstration; outreach, extension, and workforce development; new infrastructure and commercialization support through federal programs; implementation of supporting policies that are enacted for SAF; enabling approvals of diverse SAF pathways; and, continued outreach and coordination with military and industry end users.

- **Reduce the cost of SAF** through critical activities that drive down cost of production across the supply chain; expand the feedstock and conversion technology portfolio; leverage and repurpose existing production infrastructure; reduce risk to industry; and provide incentives for production.
- **Enhance sustainability of SAF** by maximizing the environmental co-benefits of production; demonstrating sustainable production systems; developing low land-use change feedstock crops; reducing the carbon intensity of SAF supply chains; ensuring robust standards that guarantee environmental integrity through rigorous life cycle analysis; and, enabling approvals of higher blend levels of SAF.

SAF Grand Challenge Roadmap

An interagency team led by the DOE, DOT and USDA worked with the EPA and other government agencies, stakeholders from national labs, universities, nongovernmental organizations, and the aviation, agricultural, and energy industries to develop the SAF Grand Challenge Roadmap, Flight Plan for Sustainable Aviation Fuel. The roadmap was released on September 23, 2022.

The roadmap lays out six action areas spanning all activities with the potential to impact the SAF Grand Challenge objectives. The action areas are:

1. Feedstock Innovation
2. Conversion Technology Innovation
3. Building Supply Chains
4. Policy and Valuation Analysis
5. Enabling End Use
6. Communicating Progress and Building Support.

Within each action area there are workstreams (total of 26) and activities (total of 139) that have been identified. Participating agencies will implement these workstreams and activities with funding support and in partnership with stakeholders.

New Incentives for SAF

In August 2022, the U.S. Congress provided additional support for SAF with the passage of the Inflation Reduction Act (IRA) legislation which included three provisions that provide support for expanded SAF production.

The first provision, the Sustainable Aviation Fuel Credit – also known as the "SAF blenders tax credit" - provides an incentive starting at $1.25 per gallon of SAF that has a minimum of 50% lifecycle greenhouse gas improvement when compared with conventional jet fuel. This credit increases for each percentage point of improvement in emissions reduction up to $1.75 per gallon. The credit is in place for two years from 2023 through 2024.

The second provision, the Clean Fuel Production Credit, will begin in 2025 and extend through 2027. Applicable to all transportation fuel it provides an enhanced value for SAF relative to ground transportation and will also provide a credit up to $1.75 per gallon for SAF.

In combination with existing incentives at the federal and U.S. state level (e.g. the Renewable Fuel Standard and low carbon/clean fuel standards in California, Oregon and Washington), these 5 years of combined incentives are intended to improve the economics of SAF production and stimulate additional SAF supply.

The third provision in the IRA legislation supporting SAF is the Alternative Fuel and Low Emission Aviation Technology Program which establishes a competitive grant program for domestic projects "that produce, transport, blend, or store sustainable aviation fuel (SAF), or develop, demonstrate, or apply low-emission aviation technologies." It assigns to the Department of Transportation approximately $250 million dollars for grants to projects relating to the production, transportation, blending, or storage of sustainable aviation fuel. The grant program is called FAST (Fuelling Aviation's Sustainable Transition) and first grant awards are expected to be made in 2024.

Summary of U.S. Actions on SAF

- Continue to support critical U.S. government programs on research, development, demonstration, and deployment of feedstock systems, conversion, testing, analysis, and coordination on SAF directly with industry and through the Commercial Aviation Alternative Fuels Initiative (CAAFI).
- Develop a multi-agency SAF Grand Challenge Roadmap to identify agency roles and an implementation plan
- Leverage existing USG activities in research, development, demonstration, deployment, commercialization support, and policy
- Accelerate additional research, development, demonstration, and deployment (RDD&D) needed for innovative solutions and technologies
- Catalyze bulk purchases of SAF by military and other end users
- Implement a supporting policy framework, including recently enacted SAF support mechanisms passed in the Inflation Reduction Act, as well as any future legislation intended to cut costs and rapidly scale domestic production of SAF

Appendix E - Policy Approach Example: Japan

Public-Private Council

The Public-Private Council holds specialized discussions on issues such as the production and supply of internationally competitive domestically produced SAF, the establishment of a supply chain for SAF, and the registration and certification of domestically produced SAF as CORSIA eligible fuel. In addition, working groups have been established under the council to further discuss in depth the production and supply of domestically produced SAF, securing a stable supply of SAF feedstock, and CORSIA eligible fuel registration and certification of domestically produced SAF.

To accelerate the domestic development and deployment of SAF, through the discussion with Japanese airlines, the Japanese government established the target of replacing 10% of the fuel consumed by Japanese airlines with SAF by 2030.

Through the intensive discussion among fuel suppliers and Japanese airlines, the Japanese government has reached consensus on the volume of SAF supply in 2030. Based on the public announcement, SAF supply in Japan is expected to be about 1.92 billion liters in 2030, while the SAF demand is expected to be about 1.71 billion liters.

To further stimulate the domestic SAF production, the Japanese government undertakes to set both regulations and support schemes as a hybrid approach.

Regulation

- For fuel supplier
  - Supply Target: at least 10% of the aviation fuel consumed in Japan
- For airline
  - Use of SAF: 10% use of SAF for Japanese airlines

Support

- Capital Expenditures, CAPEX
  - Subsidy for initial investments for facilities and feedstock supply chain
- Operating Expenses, OPEX
  - Tax Exemption or Reduction for importing feedstock
- Technology Research & Development
  - Research & Development for SAF production and feedstocks＊
  - *Second generation ethanol, algae and waste

In Japan, the policy of 340 million/5years of support for SAF's manufacturing branch and suppler chain maintenance was also proposed.

Incentive Design

To promote the production and use of SAF, the Japanese government plans to provide strong incentives for SAF production. Japan is expected to develop a tax credit measure for the production phase. Tax credit (corporate tax) would be proportional to the amount volume of the production (planned by JPY 30 per liter).

As for the CAPEX expenditures, the Japanese government is considering subsidies utilizing Green Transition Bonds started from 2024.

Aviation Green Lane (AGL)

Japan jointly proposed Aviation Green Lane (AGL) with Singapore and U.S at CAAF/3. Japan believes AGL will take an important role to decarbonize a “lane” connecting designated airport pairs among participating states. AGL is a still conceptual framework, but it will involve various aviation stakeholders such as airlines, ATM service providers and airport authorities that are eager to incorporate effective decarbonization measures to reduce GHG emission from its operation.

Appendix F - Policy Approach Example: Brazil

Brazil has a long and rich tradition of producing biofuels, particularly ethanol. The use of biofuels as an automotive fuel can be traced back to the 1970's, when the government implemented a series of measures to reduce dependence on foreign oil and promote the use of domestically produced fuel.

Over the years, the industry has grown, and today Brazil is one of the largest biofuels producers in the world and is widely recognized as a model for sustainable and efficient biofuel production. Therefore, it is natural that there has been a growing interest in the production of Sustainable Aviation Fuels - SAF in Brazil.

Public Policy for SAF

Considering the need for a public policy to foster and regulate the SAF market in Brazil, the Ministry of Mines and Energy instituted the Technical Committee – Fuel for the Future (Comitê Técnico - Combustivel do Futuro) in April, 2021. It was created to study and evaluate the technology of advanced fuels for the various transport modals and their viability. The Committee's main objective was to identify challenges and opportunities for the development of cleaner and more sustainable energy sources, especially from biomass.

For the aviation sector, the ProBioQAV Subcommittee was created in July 2021, with the task of proposing a legal framework and policy guidelines for SAF.

After several months of discussions, with the participation of stakeholders from universities, research centers, the industry (OEMs, airlines, airports, fuel producers, feedstock producers) and government institutions, a comprehensive public policy to foster SAF in Brazil was proposed. The proposal was based on the following pillars:

1. Mandate: Foster the SAF industry.
2. Goals of Decarbonization and CORSIA: Promote true decarbonization, aligned with ICAO principles.
3. Project Financing and R&D: Establish guidelines and allow incentives and the structuring of funds and financing lines for R&D and the industry.
4. Taxation: Define tax rules and classifications for SAF.
5. Quality and Certification: Establish compliance specifications and a monitoring/audit program based on international standards.
6. Governance: Define responsibilities of Government stakeholders to debureaucratize and optimize processes.

Main points of the PROBIOQAV Subcommittee conclusions:

The work done at the Technical Committee became a Bill, which was presented by the Government to the Brazilian Congress in 2023 and is in discussion, with a prospect to be approved into Law in early 2024.

The main points of the Bill are:

- Mandate: Instead of a blending mandate, or tax incentives, the Brazilian alternative is based on a mandate of CO_2 emissions reduction (in %) by the use of SAF applied to Brazilian airlines (thus not on SAF distribution). By giving the power of choice for the main consumers, this kind of mandate fosters the competition for the use of the best technology available and the most efficient SAF. Each airline will be able to evaluate and choose the sustainable fuel with the best cost-benefit relation.

Ano	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037
Percentual Mínimo de Redução das Emissões	1%	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%

- It does not favour any route as the ultimate objective is decarbonization: All technological routes can play this role, as long as they are approved by ASTM International and the Brazilian National Agency for Petroleum, Natural Gas and Biofuels - ANP.
- Preestablished beginning and end of the emissions reduction mandate (2027 to 2037): It provides conditions for the production sector to be structured in the country, guaranteeing technological development and economies of scale. It also complies with the Economic Freedom Law in the sense of not imposing market reserves on a sector without an end date.
- Encourages competition in the production sector: Maximizes the use of technological opportunities and feedstock availability for the production of SAF in Brazil.
- Definition of a base year that does not penalize the growth of air operators: The baseline of emissions reduction obligations will be established each year, assuming that all domestic operations, in that corresponding year, have used fossil fuel. Then, the amount of SAF used by each airline and their efficiency will be calculated to provide the achieved reduction in emissions.
- Logistics: Brazil is a continental country. Distributing SAF throughout the whole territory with a volumetric blending mandate would be a difficult task and would reduce its sustainability, due to the need to transport it to every airport. Therefore, the current proposal effectively eliminates that problem, by allowing SAF to be used in the hubs mainly near the production sites. It will also foster the creation/use of a Book & Claim system (to be studied in more details under the policy).
- Definition of Sustainable Aviation Fuels - SAF: alternative fuel to aeronautical fuel of fossil origin, produced from feedstocks and processes that meet sustainability standards; which can be used pure or through mixing with fuel of fossil origin, according to the technical specifications of applicable standards; and that promote environmental benefits when considering their complete life cycle.
- Methodological alignment between RenovaBio and CORSIA: ANP must strive for methodological alignment with ICAO in relation to the eligibility and certification requirements for the SAF within the scope of the National Biofuels Policy.
- Governance: As a joint effort of several public institutions, led by the Ministry of Mines and Energy, the regulatory agenda will continue to be treated in an integrated manner, considering ASTM fuel certification by the National Oil, Gas and Biofuels Agency (ANP) and the air sector regulation by the National Civil Aviation Agency (ANAC), including the international sustainability standards defined by ICAO.

Appendix G - Policy Approach Example: India

On 25 November 2023, India's Ministry of Petroleum and Natural Gas announced that India's National Biofuels Coordination Committee had set initial indicative blending percentage targets to promote SAF usage in the country.

Based on the comments received from the stakeholders, such as the Ministry of Civil Aviation, Niti Aayog, OMCs, etc., rising SAF capacities from new plants, and projected Aviation Turbine Fuel (ATF) sales, the following initial indicative blending percentages of SAF in ATF were approved:

- 1% SAF blending target in 2027 (Initially for International flights)
- 2% SAF blending target in 2028 (Initially for International flights)
- 5% SAF blending target in 2030 (Initially for International flights)

Appendix H - Policy Approach Example: Singapore

The Singapore Sustainable Air Hub Blueprint was launched on 19 February 2024[12]. The Blueprint, developed by the Civil Aviation Authority of Singapore (CAAS) in consultation with industry and other stakeholders, sets out Singapore's action plan for the decarbonisation of its aviation sector. The decarbonisation of the aviation sector will rely on numerous initiatives. In particular, the use of SAF is expected to be the most critical aviation decarbonisation lever, potentially contributing to around 65% of the carbon emission reduction needed to achieve net zero by 2050.

To kickstart SAF adoption in Singapore, flights departing Singapore will be required to use SAF from 2026. We will aim for a 1% SAF target for a start to encourage investment in SAF production and develop an ecosystem for more resilient and affordable supply. Our goal is to raise the SAF target beyond 1% in 2026 to 3 – 5% by 2030, subject to global developments and the wider availability and adoption of SAF.

CAAS will introduce a SAF levy for the purchase of SAF to achieve the uplift target. As the market for the supply of SAF is still nascent and the price of SAF can be volatile, we will adopt a fixed cost envelope approach to provide cost certainty to airlines and travellers. The levy will be set at a fixed quantum based on the SAF target and projected SAF price at that point in time. For example, the quantum of the SAF levy in 2026 will be set based on the volume of SAF needed to achieve a 1% SAF target and the projected SAF price in 2026. The amount collected through the SAF levy will be used to purchase SAF, based on the actual price of SAF at the time of purchase. The SAF levy will not change, even if the actual SAF price differs from what is projected. Instead, the actual uplift volume of SAF will be adjusted based on the pre-determined SAF levy and prevailing SAF price. The levy will vary based on factors such as distance travelled and class of travel. As an indication, we estimate that the levy to support a 1% SAF uplift in 2026 for an economy class passenger on a direct flight from Singapore to Bangkok, Tokyo and London to be S$3, S$6 and S$16 respectively. Passengers in premium classes will pay higher levies.

To support the implementation of the national SAF target and further manage the cost of using SAF, the procurement of SAF will be centralised. The levies collected will be used to aggregate demand and reap economies of scale. Besides SAF demand from the national target, there are also opportunities to aggregate voluntary SAF demand from businesses and organisations looking to purchase SAF to reduce their air travel carbon footprint. Businesses and organisations will be invited to use the central procurement mechanism to reap economies of scale. The central procurement function can also take on the management and allocation of SAF credits generated from SAF use through central purchases. For SAF procured under the national targets, SAF credits will be allocated back to the airlines based on the share of levies collected. Credits generated from SAF procured voluntarily by businesses and organisations will be allocated based on the amount of SAF bought.

— END —

[12] https://www.caas.gov.sg/who-we-are/newsroom/Detail/launch-of-singapore-sustainable-air-hub-blueprint