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WP4 Policy brief:
Policy support options for promoting Sustainable Aviation Fuels (SAF) in South Africa

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This policy brief summarises the activities undertaken under WP4 of the Waste to wing project funded by the EU programme Switch Africa Green (contract number DCI-ENV/2017/391-384).
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Feb 2020

Executive summary

The urgent need for action on climate change, together with the emergence of the flight shame movement, has brought GHG emissions from aviation under increased scrutiny. Efforts to find a global solution to address international aviation emissions through the Carbon Offset Reduction Scheme for International Aviation (CORSIA) of the International Civil Aviation Authority (ICAO), have been criticized for not being ambitious enough and for relying too heavily on carbon offsets. This has put pressure on countries to develop national policy interventions that address emissions from the aviation sector.

One of the key measures to decarbonise the aviation sector is the development and deployment of Sustainable Aviation Fuels (SAF). SAF is a low-carbon fuel alternative to Conventional Aviation Fuels (CAF). It is generally bio-based or produced from waste, residues and end-of-life products and should meet robust sustainability requirements. Benefits of SAF include CO_2 emission reduction, improved local air quality, improved fuel efficiency, increased energy security, reduction in exposure to the volatility of jet fuel supply and price, and economic development through new investments and job creation, particularly in rural areas. Developing a domestic SAF industry presents South Africa with an opportunity to realise at least five strategic goals, namely to:

- proactively prepare for the international aviation emission mitigation framework under CORSIA that becomes mandatory from 2027 onwards;
- allow SAF to become a mitigation option available to domestic airlines under South Africa's Carbon Tax Bill;
- safeguard South Africa's global connectivity in an increasingly carbon-constrained world;
- enable continued growth of the travel and tourism sector and its contribution to economic development by giving the country an edge over other aviation hubs competing to attract tourists to Africa as well as provide regional leadership for decarbonising the sector;
- use the many comparative advantages the country has to become a competitive SAF producer as an industrialisation opportunity in this new and fast-growing sector, with the associated employment generation and other macro-economic benefits.

Many countries have already adopted or are considering policies or policy instruments to promote SAF primarily as a means to decarbonise their aviation sectors. For example, Norway and Sweden have introduced blending mandates for SAF, the European Union awards a multiplier of 1.2 to SAF in counting towards its overall biofuel target (i.e. one ton of SAF counts as 1.2 tons of fuel towards the mandated targets), whereas in the American state of California, the Low Carbon Fuel

Standard incentivises low carbon fuels by making them eligible to generate emission reduction credits which fuel producers need to comply with the standard.

This policy brief assesses the policies and policy instruments that are currently in place or are being considered to promote SAF around the world and, based on these developments, makes recommendations for a SAF policy framework for South Africa. An overview of the prominent policy instruments that are being considered is provided below (Table E-1). These can be applied individually or can be deployed as a policy package, depending on the different SAF value chains and the incentives needed to make them a reality.

Table E.1: Key policy instruments to promote SAF

Policy instruments	Key features
Support for research and development	Targeted Research and Development (R&D) support can help address specific technological or supply chain challenges in SAF value chains. It can also help localising existing technologies to maximise their domestic impact.
Blending mandates	Blending mandates are one of the most commonly used policy interventions to kick-start SAF markets and boost demand. These obligate fuel suppliers to introduce a certain share of renewable fuel in their products.
Financial incentives	A number of options are available, including input subsidies for incentivising feedstocks production; production facility grants, concessionary loans and output subsidies linked to the quantum of production achieved for fuel producers.
Pricing mechanisms	These instruments can effectively address the variations in the price differential between CAF and SAF that arise from CAF price volatility, thus reducing uncertainty on the aviation fuel market in favour of SAF.
Taxation instruments	A wide variety of taxation instruments can be used to address the price differential between CAF and SAF. Introducing a value-added tax for CAF while maintaining the exemption on SAF, increasing carbon tax rate and putting a passenger tax on flights not using SAF, can all be considered.

Policy recommendations

While many technologies needed for SAF production are proven and new ones are being developed continuously, the scale and speed at which the aviation sector needs to deploy SAF require policy support at the international, regional and national level. For South Africa, a toolkit of policy interventions for promoting SAF at national level could include those listed in Table E-2 below:

Table E-2: Policy recommendations for greater uptake of SAF in South Africa

Timescale	Policy recommendations
Short-term (2020-2025)	• Tap into international cooperation opportunities; • Develop a comprehensive roadmap for long-term development and decarbonisation of the sector with SAF playing a key role as a mitigation option; • Set a modest blending mandate to kick-start the market (2-3% by 2025); • Identify the best strategy for producing SAF in South Africa to locally meet the demand created by the blending mandate and investigate appropriate incentives; • Leverage position on ICAO council to influence the development of the international regulatory framework on SAF for its greater uptake in the region; • Include aviation fuels in the next phase of South Africa's Industry Policy Action Plan's (IPAP) key action programme – policy roadmap for climate-compatible industrial development.
Medium-term (2026-2030)	• Join the first phase of CORSIA (2024-26); • Scale up SAF uptake by either bridging the price gap differential or gradually increasing the blending mandate; • Scale up incentives for SAF produced from feedstocks where South Africa holds a competitive advantage.
Long-term (Beyond 2030)	• Government to define an ambitious vision for the sector; • Set a 2050 target to replace at least 50% of aviation fuel sold in the country with locally produced SAF; • Position South Africa as global SAF hub and key SAF exporter.

Conclusions

Growing pressure on the aviation sector to decarbonise presents an opportunity for South Africa to take regional and global leadership by developing a competitive local SAF industry. This presents policymakers with a strategic opportunity to not only decarbonise its aviation sector but also enable its travel and tourism sectors to meet the changing profile of international, and increasingly also domestic

travellers, while seizing the industrialisation opportunity in this emerging green sector. Taking proactive policy interventions will enable the aviation sector to benefit from early mover advantage and protect its regional dominance as the gateway to Africa in the long run.

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Key Acronyms

CAEP	Committee on Aviation Environmental Protection
CAF	Conventional Aviation Fuel
CNG	Carbon Neutral Growth
CORSIA	Carbon Offset Reduction Scheme for International Aviation
GHG	Greenhouse Gases
ICAO	International Civil Aviation Organization
IPAP	Industry policy Action Plan
IPCC	Intergovernmental Panel on Climate Change
RTK	Revenue Tonne Kilometres
SAF	Sustainable Aviation Fuel
SAP	State Action Plan
UNFCCC	United Nations Framework Convention on Climate Change

1 Introduction

In 2019, words such as 'climate emergency' and 'flight shame' came to symbolize the rallying cries emphasizing the urgent need for action on climate change. Both are also often used in the same breath to highlight the growing contribution of the aviation sector to the climate crisis. In particular, GHG emissions from international aviation, currently not covered under the Paris Agreement, came under increased scrutiny as they create an accountability gap that remains inadequately addressed. While efforts to find a global solution to address international aviation emissions under the aegis of the International Civil Aviation Organization (ICAO) are under negotiation, the evolving policy framework is criticized for not being ambitious enough and relying too heavily on carbon offsets through its market-based mechanism – the Carbon Offset Reduction Scheme for International Aviation (CORSIA).

This has created pressure on countries to develop national initiatives to address emissions arising from the aviation sector. In Sweden, the flight shame (Swedish: *flygskam;* coined in 2017) movement has put the spotlight on the CO_2 impact of air travel and given rise to an enriching policy debate on how to make aviation sector fossil fuel free. In line with Sweden's Climate Act and Climate Policy framework that has set a national target of net zero emissions by 2045 (Swedish Environmental Protection Agency 2019), the Swedish aviation sector is gearing up to make *domestic* flights fossil-free by 2030 and reach the goal of *all* flights being fossil-free by 2045. This translates into 100% Sustainable Aviation Fuels (SAF) usage by 2045. In Germany, the heightened awareness of aviation's climate impact has already seen a year-on-year fall of 12% in the number of people flying between the German cities (Wilkes and Weiss 2019). The German government, industry and union representatives have also recently signed the 'Leipzig Statement for the Future of Aviation' with an 'ambitious goal of CO_2-neutral flying'. A recent survey conducted by the European Investment Bank showed that 94% of Chinese, 75% of Europeans, and 69% of American citizens surveyed were planning less air travel for holidays in 2020 (Wilkes and Weiss 2019). These national and consumer initiatives are in response to increasing domestic demand, particularly in European countries, to give up or at least reduce air travel (Abend 2019).

South Africa has the opportunity to respond to changing consumer preferences and proactively address the potential strain on the travel industry by playing an active role in the development of the SAF sector, nationally and internationally. **Through this policy brief, we assess the recent policy developments tackling aviation emissions around the world and discuss ways for the South African aviation sector to maintain its competitiveness in the age of flight shame, adhere to domestic legislation aimed at GHG mitigation (i.e. the South Africa's Carbon Tax Bill of 2019) and gear itself for the forthcoming international emission reduction targets.** To this end, we provide an overview of the policies that are being

considered to promote Sustainable Aviation Fuels (SAF) in different countries and argue that promoting SAF would be a strategic policy response for South Africa.

This policy brief is structured as follows: Section 2 introduces the readers to the global overview of key developments in the aviation sector. Sector 3 establishes the rationale for promoting SAF in South Africa. Section 4 unpacks the concept of SAF and highlights the scale of shift needed. This is followed in Section 5 by policy support options that are currently available to support the uptake of SAF specifically at the national level. Section 6 provides an overview of policy developments to promote SAF at international, regional, national and sub-national levels. The section also elaborates on the examples of international support extended for SAF development. Section 7 concludes with policy recommendations for greater SAF uptake in South Africa.

2 The need to decarbonise aviation

2.1 The role of aviation in avoiding catastrophic climate change

The 2018 flagship report of the Intergovernmental Panel on Climate Change (IPCC) on the global warming of 1.5^{0}C unequivocally established that climate risks of 2^{0}C global warming are substantially higher than those of 1.5^{0}C global warming for all ecosystems (IPCC 2018). To contain global temperature increases within 1.5^{0}C to stand a fair chance of avoiding catastrophic climate change, it is pertinent to drastically reduce GHG emissions at a hitherto unprecedented rate of 7.8% per annum for the next decade (UNEP 2019). This needs to be achieved across all economic sectors, including aviation. At 2.5% of all CO_2 emissions, and 4% annual growth in emissions, the aviation sector is one of the fastest-growing sources of greenhouse gas (GHG) emissions worldwide (Pavlenko, Searle, and Christensen 2019).

The literature identifies four broad mitigation strategies for realising GHG emission reduction in the aviation sector (Larsson et al. 2019):

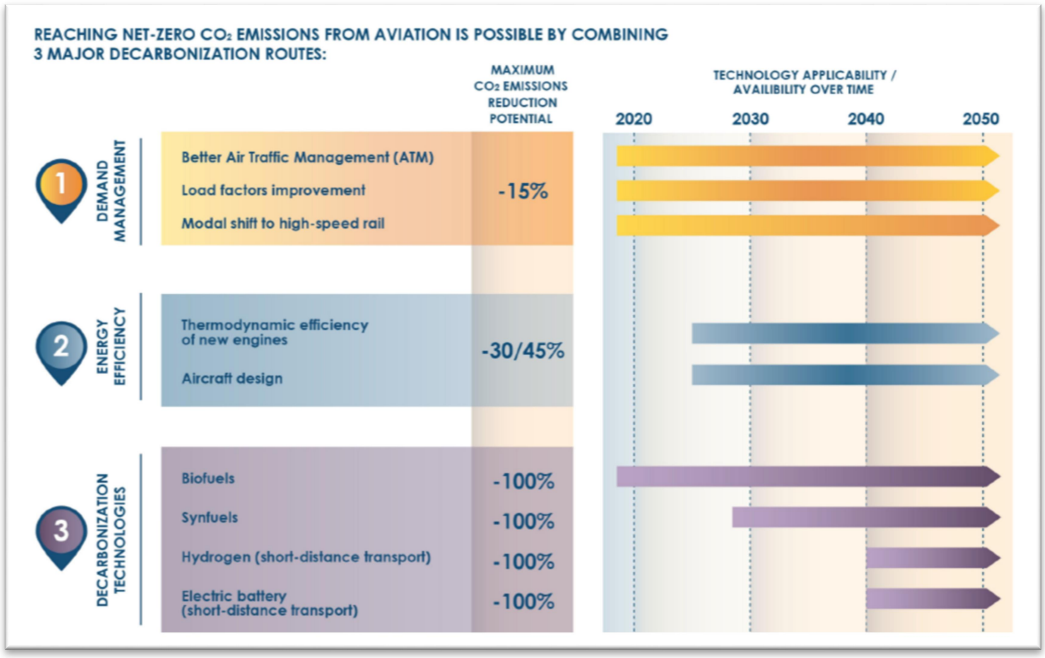
- Technological improvements;
- Use of low carbon fuels;
- Optimized air traffic management; and
- Reduced air travel volumes compared to the business-as-usual scenarios.

While all of these are necessary to achieve the level of decarbonisation needed in line with climate science's 1.5^{0}C pathway, it is only a complete switch from conventional aviation fuel (CAF) to sustainable aviation fuel (SAF) that will deliver the necessary in-sector reductions (Figure 1).

This was evidenced by a recent Energy Transitions Commission study set up to assess the feasibility of realising net-zero emissions from harder-to-abate sectors, which confirmed that 'it will not be possible to keep emissions flat' in the aviation

sector, and in line with the Paris Agreement, realize net-zero carbon emissions by mid-century, 'without a shift to alternative low-carbon fuels or to electric engines' (ETC 2018).

Figure 1 Reaching net-zero CO_2 emissions from Aviation



Source: ETC, 2018

2.2 Setting a global emission reduction target for aviation

All mitigation measures available to the aviation sector, including SAF, apply to both the domestic and international aviation emissions, but the policies and regulations needed to stimulate their adoption fall under different jurisdictions.

Emissions from domestic aviation can be addressed by undertaking mitigation policies at the national level, while emissions from international aviation are regulated by the UN body International Civil Aviation Organisation (ICAO). Considering only a relatively small (albeit growing) number of countries or federal states are actively supporting the uptake of SAF as a mitigation measure for aviation emissions, the developments on the international arena are considered to be key for the development of the global SAF sector.

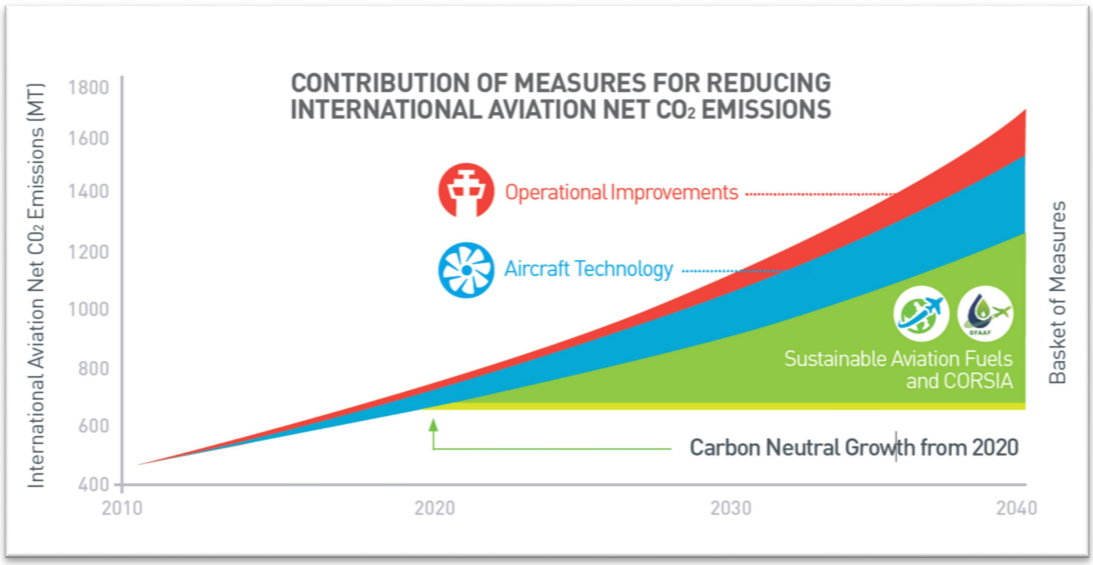
To this end, ICAO has set up two aspirational goals for the international aviation sector: a) 2% annual fuel efficiency improvement through 2050; and, b) Carbon Neutral Growth from 2020 onwards (Cames et al. 2015).[1] In line with the four

[1] For meeting its fair share, by 2050 the emissions from the aviation sector should be reduced by 41% to 96%, compared to its level in 2005 (Cames et al. 2015). While a step in the right direction, it is worth noting that the aviation emission trajectory proposed by ICAO does not

mitigation strategies listed above, ICAO is promoting a basket of measures to reduce CO_2 emissions (Figure 2), consisting of:

- Aircraft related technology and standards
- Improved air traffic management and operational improvements
- Development and deployment of SAF
- Market-based measures (CORSIA)

Figure 2: ICAO's contribution of measures for reducing international aviation net CO_2 emissions



Source: ICAO (2016)

The aviation industry is also increasingly indicating its willingness to tackle its growing climate impact[2]. Already in 2009, the International Air Transport Association (IATA) adopted three targets and a four pillars strategy (IATA 2019) for addressing the climate impact of the sector (The four pillars identified by IATA to meet these targets were: improved technology, including the deployment of sustainable low-carbon fuels; more efficient aircraft operations; infrastructure improvements; and a single global market-based measure to fill the remaining emissions gap. With the adoption of CORSIA at the 39th ICAO Assembly in 2016, a global market-based measure for aviation was set in motion.

Figure 3). Its three targets were:

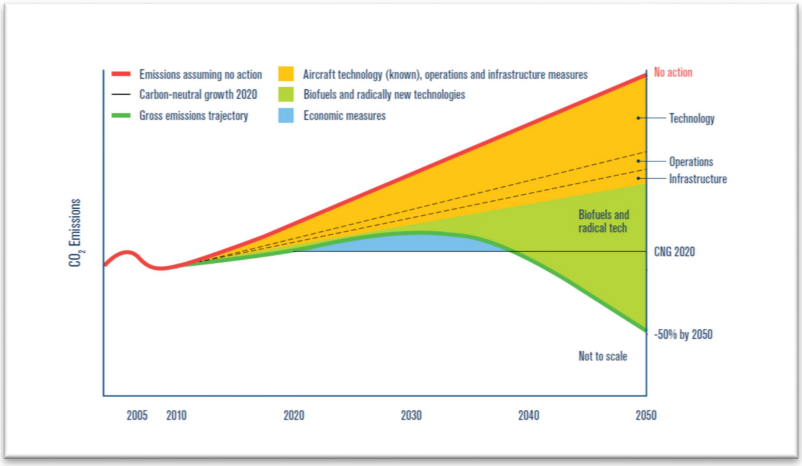
- An average annual improvement of 1.5% in fuel efficiency from 2009 to 2020;
- A cap on net aviation CO_2 emissions at 2020 levels by undertaking a Carbon-Neutral Growth (CNG) strategy;
- To halve the net CO_2 emissions by 2050, compared to 2005 levels.

represent the adequate contribution from aviation towards limiting global warming to even 2°C, let alone 1.5°C.

[2] It should be noted that aviation industry's level of ambition is regarded as insufficient.

The four pillars identified by IATA to meet these targets were: improved technology, including the deployment of sustainable low-carbon fuels; more efficient aircraft operations; infrastructure improvements; and a single global market-based measure to fill the remaining emissions gap. With the adoption of CORSIA at the 39th ICAO Assembly in 2016, a global market-based measure for aviation was set in motion.

Figure 3: Schematic representation of IATA's CO_2 emissions reduction roadmap



Source: IATA (IATA 2013)

More recently, as a response to the findings of the IPCC 1.5°C report and the growing public pressure on the aviation sector to get its act together, the International Airlines Group (IAG) has announced the adoption of 'Flightpath net zero' (Figure 4) – becoming the first airline group worldwide that has committed itself to net-zero CO_2 emissions by 2050 (IAG 2019).

Figure 4: AIG Flightpath Net Zero

Source: IAG (2019)

In addition to being in line with the UN's objective to limit global warming to 1.5^{0}C, the IAG also committed US$ 400 million over 20 years to the development of SAF.

3 Rationale for promoting SAF in South Africa

To continue operating in a carbon-constrained future, the aviation sector will need to embrace measures to drastically reduce its climate impact. Such measures will transform the entire supply-chain and support novel business models that facilitate decarbonisation of the aviation sector. Recent global developments highlighted above indicate that the aviation sector is warming up to the idea of deep decarbonisation. Nevertheless, the advantages of being an early adopter and taking the mantle of a global leader remain up for grabs.

For South Africa, five strategic goals can be achieved by extending policy support for greater uptake of SAF:

1) With the coming into force of CORSIA from 2027 at the latest, countries will need to contribute towards realising the CNG target for international aviation and adopting the commensurate ICAO regulations. Lack of a domestic policy could mean that South Africa will be buying offsets or SAF from elsewhere for staying within CNG2020, adding to the already heavy currency risk exposure of domestic airlines. Developing a domestic SAF market will alleviate this concern.
2) In the recently legislated Carbon Tax Bill, as and when SAF is included in Schedule 1, it will be recognised as a mitigation option for airlines for domestic aviation. However, to become more than a theoretical option, a policy framework with incentives is needed to develop domestic SAF production.
3) Due to its geographic location, aviation will remain crucial for maintaining South Africa's connectivity with the world. Limited, inefficient and unreliable alternatives for long-haul travel, coupled with increasing pressure on the aviation sector to decarbonise will necessitate that South Africa takes proactive measures for decarbonisation of the sector in the short-to-medium term.
4) The travel and tourism sector contributed ZAR 425.8 billion to the country's economy in 2018 – 8.6% of all economic activity in South Africa and 1.5 million jobs (9.2% of total employment) (WTTC 2019). 44% of tourism came from international travellers. The travel and tourism sector aims to double tourism numbers by 2030 (IOL 2019). Given the increased sensitivity of international travellers towards the climate impact of flying for holidays to far-off locations and the growing resonance of the flight shame movement in the younger generation, it may become difficult to achieve these numbers. There is a risk that the spreading flight shame movement can reduce the

attractiveness of South Africa as a tourism destination and have a direct negative impact on the performance and competitiveness of its aviation and tourism sectors. As the regional powerhouse and most significant aviation hub for Southern and Central Africa, South Africa has the opportunity to provide leadership for decarbonising the sector. This will strengthen its position as a climate leader in the African continent as well.

5) Proactive SAF policies can leverage the many comparative advantages South Africa has for the production of SAF (resource base, technical expertise, regional aviation hub etc.) to develop a new industry with all the associated benefits of job creation, import substitution, attracting investment, and possibly creating a new export sector.

Africa, and particularly Sub-Saharan Africa, is seen as one of the major expansion areas for the production of biofuel feedstock. Feedstock potential assessments suggest that if SAF (or alternative aviation fuel) is targeted at 50% of the total jet fuel demand from international aviation, sub-Saharan Africa can contribute 30% to 90% of future SAF demand in the form of aviation biofuel compliant with Roundtable for Sustainable Biomaterials (RSB) criteria (Bole-Rentel et al. 2019). For South Africa, in 2016, aviation fuel demand was approximately 2 600 million litres. Assuming a 3% annual growth rate, without significant improvements in operations and fuel efficiency, domestic demand for aviation fuel could reach 7 000 million litres by 2050. The current technical potential of RSB-compliant SAF from energy crops in South Africa is between 80-180% current jet fuel demand and 60-115% long-term demand (2050) in the country. If agricultural residues are also tapped to produce SAF then 260% of the country's current jet fuel demand and more than 140% of its long-term demand can be met (Bole-Rentel et al. 2019). In addition to this, re-directing sugar from loss-making exports, fermentation of waste gasses and using invasive alien plants as feedstock in 2nd generation processes extend this potential much further. All this indicates that South Africa has the potential to fully meet its domestic SAF demand, as well as turn this into a lucrative export product.

To sum up, in proactively developing a SAF industry, South Africa can realise several strategic goals. Establishing a policy and regulatory framework and associated institutional structure to promote the uptake of SAF will ensure a competitive edge for South Africa in what is a harder-to-abate sector. The commercial-scale SAF production also has significant employment generation potential, especially in rural areas, creating new drivers for economic growth and industrialisation.

The majority of the literature dealing with SAF tends to focus on the technical aspects. Policy studies dealing with SAF are very few and far in between. **This study fills this gap by providing an overview of state of the art policies that are in place or in the process of deployment to promote SAF. Based on this assessment, we provide recommendations for SAF policy development in South Africa.**

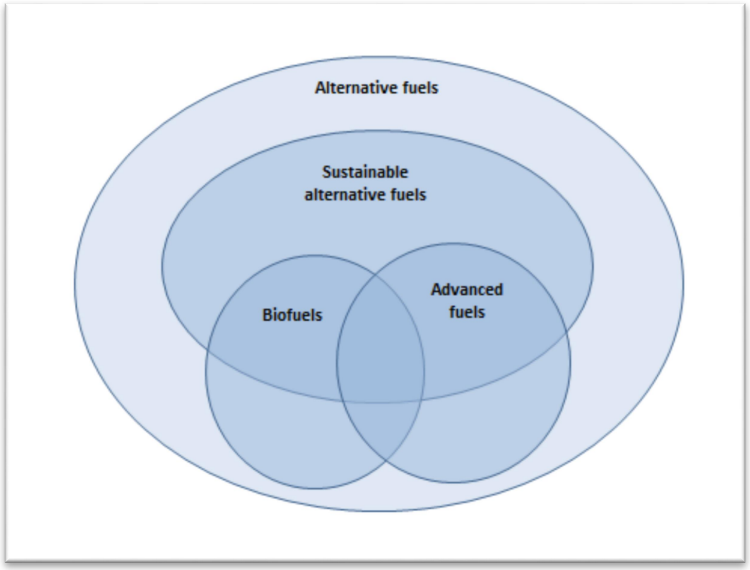
4 Unpacking Sustainable Aviation Fuels

4.1 SAF vs CAF

Sustainable Aviation Fuels or SAF are low-carbon fuel alternatives to CAF. While many alternative fuels use the language of sustainability, 'alternative fuel' and 'sustainable fuel' cannot always be used as synonyms (Figure 5). Some – especially those based on edible or even non-edible crops – risk having negative social and environmental impacts. They could affect food security when arable land is used for biofuel feedstock production, cause environmental degradation from deforestation and unsustainable soil and water use, resulting in increased emissions, and many more. For this reason, all future aviation fuel production should be truly sustainable and secured by robust sustainability certification.

The key benefits of SAF are CO_2 reduction, improved local air quality, and improved fuel efficiency. Additional benefits of SAF include increased energy security, reduced exposure to the volatility of jet fuel supply and price, and economic development through new investments and job creation, particularly in non-urban areas. Sustainability of alternative fuels is best ensured through a regulatory demand. In order for them to count towards any national decarbonisation objectives or access any form of policy support, they must be certified by an independent sustainability scheme, such as the Roundtable on Sustainable Biomaterials (RSB)[3].

Figure 5: Typography of various alternative fuels



[3] For more information on the RSB, please see https://rsb.org/

4.2 The scale of shift needed

At the second Conference on Aviation and Alternative Fuels (CAAF/2), ICAO proposed a volumetric target for alternative aviation fuels of 285 million tons per annum, which is expected to be approximately 50% of the total fuel demand of international aviation in 2050 (ICAO 2017a).[4] While ICAO's 2050 goal has not yet been approved, states did agree that "a significant proportion of Conventional Aviation Fuels (CAF) to be substituted with SAF by 2050, for international civil aviation to reduce carbon emissions significantly…" (ICAO 2017b). Domestic aviation is also likely to become an important source of demand for SAF, with an increasing number of countries considering blending mandates for such fuel. By comparison, global biofuel production grew 7% year-on-year in 2018 to reach 89 million tonnes of oil equivalent (Mtoe). Average production growth of only 4% per year is anticipated over the next five years whereas a sustained growth of 10% is needed to be on track with IEA's Sustainable Development Scenario in 2030 (280 Mtoe) (IEA 2019).

The total aviation biofuel production of 15 million litres in 2018 accounted for even less than 0.1% of total aviation fuel consumption. To reach a significant proportion of CAF from such a small share requires ambitious ramping up based on a multi-pronged strategy that includes technological development, setting standards, and supporting SAF through various policy interventions such as financial de-risking measures, guaranteed offtake of SAF and the development of biofuels quotas. In South Africa, replacing at least 50% of CAF with SAF would translate to 1.1 billion litres of SAF per year at current jet fuel consumption levels.

5 Policy support options

SAF is recognised as the key measure for reducing the CO_2 impact of the aviation sector. Its technical viability and performance have been demonstrated globally. However, SAF remains significantly more expensive than CAF and the ability of airlines to carry the price premium themselves is limited. Achieving commercial viability for SAF will, therefore, require significant policy support in the short-to-medium term. For the aviation sector to fully decarbonise by 2050, the scale and speed at which SAF must be deployed over the next decade need to be substantially ramped up and encouraged by supportive policy.

A range of policy instruments are available that can support the uptake of SAF at the national level. These policy options overlap with each other and can also be used in conjunction.

- **Support for Research and Development:** Establishing research initiatives involving relevant governmental entities, industry bodies, universities, centres of excellence and civil society would be instrumental in gaining a

[4] Without the necessary sustainability safeguards in place, alternative fuels used towards this target cannot necessarily be considered SAF.

comprehensive overview of the technical challenges facing the sector. These initiatives can focus on localising the existing technologies, developing new technologies and supply-chains and evaluating available funding sources.

- **Blending mandates:** Blending mandates promote market development for SAF by nudging fuel suppliers. They are one of the most commonly used policy interventions to develop SAF production capacity (IRENA 2017). A blending mandate obliges fuel suppliers to provide a certain share of renewable fuel in a specific product or overall portfolio (ICAO 2017c). In 2013, Indonesia became the first country to set up a 2% target by 2016 and 3% by 2020 for alternative fuels in the aviation sector (Bosch et al. 2017). Since then, a number of other countries have adopted or proposed blending mandates, most notably Sweden and France. However, where blending mandates are not linked with strict sustainability criteria they have 'overwhelmingly been met with inexpensive, readily available food-based biofuels linked to land-use change' (Searle et al. 2019).

- **Financial incentives:** For delivering SAF at scale and speed, a level playing field needs to be created – between SAF and CAF, and aviation and other sectors. Some of the policy options available for reducing the cost differential between SAF and CAF are:

    - **Production Facility Grants and Investment subsidies:** Setting up a new dedicated SAF facility entails high upfront capital investment which can be facilitated by reducing investment risk through capital grants or once-off subsidy for facility construction (Searle et al. 2019). This can be specifically aimed at SAF producers at the demonstration, pilot and initial commercial stages, as has been the case in the US, where various government agencies have provided grants and loan guarantees to support renewable fuel facilities. For instance, under the Defence Production Act in the US, a partnership of various government agencies has come together to accelerate the development of domestic competitively-priced drop-in diesel and SAF through supporting different elements of supply-chain for commercial-scale facilities (Airlines for America 2019). These can also possibly be extended to airports that decide to implement the supply of SAFs and help to keep capital expenditure costs in check. Extending loan guarantees also helps in alleviating credit constraints.

    - **Production subsidies:** Subsidies can play an important role in the initial stages of market development to bridge the price gap between SAF and CAF as the sector moves along its learning curve towards lower production costs. Both input and output subsidies can operate in conjunction.

- *Input subsidy:* By subsidising feedstock production the government can bring down the input costs of SAF production. This can be particularly crucial for developing supply-chain in the initial stage of market development.
- *Output subsidy:* The fuel producers can be incentivised to produce SAF by linking some form of subsidy to the quantum of production achieved. This can also be based on the amount of GHG emissions reduced.

- **Pricing mechanisms:** By providing long term pricing stability through price support mechanisms or tendering process, the government can signal policy certainty across the supply chain. Such approaches have been used in tendering photovoltaic subsidies in Germany, sustainable wind farms in Europe and also in South Africa through the Renewable Energy Independent Power Producers Procurement Programme (REIPPPP). They all ensure that the price volatility on account of changes in the price of conventional fuel is addressed through government intervention that ensures a certain profit margin. This in turn provides a higher confidence of the required return guarantee for the investor.
- **Taxation instruments:** A variety of taxation options are available to policymakers to incentivise different aspects of the SAF value chain, or dis-incentivise CAF. Taxing CAF, to begin with, could be one option as it reduces the competitiveness of CAF. While the 1944 Convention on International Civil Aviation presently prohibits almost any kind of taxation of jet fuel onboard an aircraft when it lands in another country (Simple Flying 2019), Europe is nonetheless considering a kerosene tax for the aviation sector (Euractiv, 2019a). A less contentious taxation instrument could be GHG emission taxes, which would disproportionately affect CAF, thus making it less competitive. Extending Producers Tax Credits for SAF meeting certain pre-defined standards can be an attractive option to blend SAF in the supply chain. In the US, Congress had established a 'biodiesel and renewable diesel tax credit' to provide a $1/gallon tax credit to those mixing certain biofuels in the biofuel production supply chain. This tax credit expired in 2017 (Airlines for America 2019). Introducing/increasing passenger tax for flights that do not use SAF or blended fuel can also serve as a disincentive for airlines for using CAF. This may be over and above the aviation tax that some countries, namely Germany, France and Norway are planning to introduce.

The above measures are already used by a growing number of countries and regional groupings to support the development of SAF supply chains. An overview of those is presented in the next section.

6 Policy developments for promoting SAF: International, Regional and National overview

This section provides an overview of international, regional and national developments that are currently underway for promoting SAF. These interventions are at different stages of policy formulation and focus on different aspects of the supply chain.

6.1 International policy developments

A. 2050 ICAO Vision on SAF

SAF is seen as one of the key measures for achieving ICAO's climate objectives and realising the global aspirational goal of levelling carbon emissions from 2020, as established in 2010 at the 37th ICAO Assembly and reaffirmed most recently through the eighteenth resolution of the 40th ICAO Assembly. In 2017, at the Second Conference on Aviation and Alternative Fuels (CAAF/2), ICAO proposed a long-term, 2050 vision on Aviation Alternative Fuels[5] for transitioning international aviation from CAF to SAF (Table 1).

Table 1: 2017 proposed ICAO Vision on SAF/Aviation Alternative Fuels

	Short-term goal (2025)	Mid-term waypoint (2040)	ICAO VISION 2050
SAF use in International aviation (Mt/year)	5	128	285
SAF share in international aviation fuel demand	2%	32%	50%
% CO_2 reduction from SAF use in international aviation	0.9%	12%	33%

Source: ICAO (2017a)

However, ICAO member states rejected the 2050 SAF Vision as the targets seemed to have been 'selected based on poor analysis, and grossly overestimated the environmental benefits and potential emissions reductions' (ICSA 2017). The International Coalition for Sustainable Aviation (ICSA) – an umbrella civil society body working towards reducing pollution from air travel – argued that sustainability and emissions reductions aspects of the SAF should be the basis on which the long term vision is defined.

In the CAAF/2 Declaration, states instead agreed on the wording that replaced aspirational goals with the text that endorsed the "2050 ICAO Vision for SAF as a living inspirational path" and called on states, industry and other stakeholders to work for "a significant proportion of CAF to be substituted with SAF by 2050, for

[5] ICAO's Working paper CAAF/2-WP/13 presented a proposed ICAO Vision on Aviation Alternative Fuels. To maintain consistency throughout this document we refer to Aviation Alternative Fuels as SAF in this section.

international civil aviation to reduce carbon emissions significantly …" (ICAO 2017b).

The declaration called on states, industry and other stakeholders to substitute a substantial proportion of CAF with SAF. In particular, it encouraged states to develop policies that promote the use of SAF and provide examples of successful policy implementation results. The declaration further acknowledged that 'inter-institutional and inter-sectoral coordination is needed for developing policies, research, and financing of SAF to avoid inconsistent actions'. As per the 2050 ICAO Vision, the Third Conference on Aviation and Alternative Fuels (CAAF/3) should be convened no later than 2025 with a view to 'updating the 2050 Vision to include a quantified proportion of CAF to be substituted with SAF, and carbon reductions achieved by SAF'. The declaration also clarifies that the progress in all elements of ICAO's 'basket of measures' is needed to be achieved 'with an increasing percentage of emissions reductions accruing from non-market-based measures over time'.

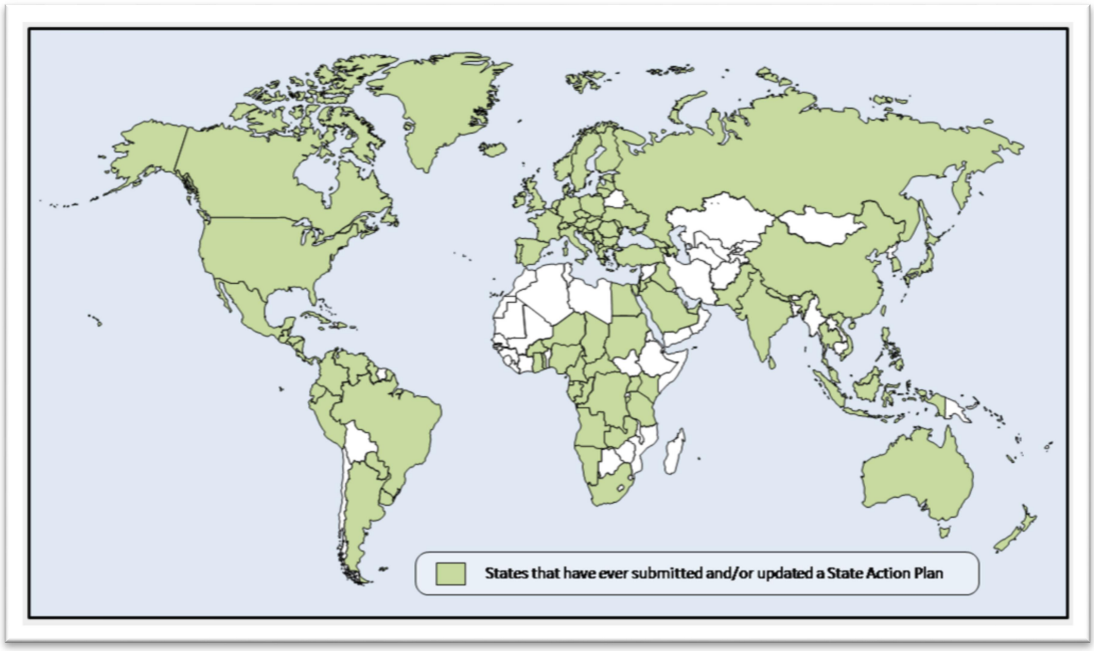
In December 2019, at the 12th meeting of the ICAO's Committee on Aviation Environmental Protection (CAEP-12), the Long Term Goal discussions called for greater ambition from the sector. Based on the inputs from the parties, draft framework and terms of reference for Long Term Aspirational Goals have been agreed, which the Secretariat will now bring it to the attention of ICAO. These developments suggest that states realise that far more ambition is needed to decarbonise the sector and that although at an early stage, states are seriously considering policy interventions to increase SAF uptake.

B. State Action Plans

The 37th session of the ICAO Assembly also encouraged its member states to voluntarily submit their State Action Plans (SAP) for reducing CO_2 emissions from international aviation. The SAPs are long-term plans that should provide an overview of a state's strategy until 2050 and are to be updated every three years. So far, 118 states, representing 94.32% of global Revenue Tonne Kilometres (RTK) have submitted their SAPs to ICAO (Figure 6). Amongst others, the SAPs contain:

- *Baseline fuel consumption, CO_2 emissions and traffic:* Should provide annual historic fuel consumption and traffic from international aviation (from 2010 or earlier); projected future fuel consumption and traffic to 2020 and if possible to 2050; differentiation between international and domestic emissions needs to be provided and future estimates should be verified.
- *List of selected measures and their expected results:* The basket of measures provided by the ICAO are to be reviewed for their feasibility and emissions reduction potential in the given country context.
- *Assistance needs*

Figure 6: State Action Plans submitted to ICAO



Source: ICAO (2020)

Most of the SAPs provide information about the actions that countries have undertaken to reduce GHG emissions from the aviation sector. These include a list of actions undertaken by airlines and airports, operational improvements and air traffic management. Measures related to the development of SAF are also enumerated but are generally not supported by an overarching policy framework yet. A brief analysis of the SAPs submitted by key G20 countries (Appendix A) indicates that most countries are still awaiting more clarity, particularly around commercial viability in this regard. South Africa's SAP identifies usage of SAF as a complimentary measure for reducing CO_2 emissions in the sector but does not provide any technical details, plans or strategy on how it can increase its uptake. It however recognises finance and technical support as key element for the implementation of SAF projects.

C. CORSIA

The ICAO Assembly resolution A38-18 included a decision to develop a Global Market-Based Measure (GMBM) scheme for international aviation. This was followed up by the ICAO Assembly Resolution A39-3 in 2017, which decided to implement a GMBM in the form of the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) as part of ICAO's 'basket of measures'. CORSIA is aimed at addressing any annual increase in total CO_2 emissions arising from international civil aviation above 2020 levels. This needs to be done taking into account special circumstances and respective capabilities of the countries. As currently envisaged, CORSIA consists of three phases: pilot phase (2021-23), the first phase (2024-26) and the

second phase (2027-35) (ICAO 2016). Under CORSIA, starting from 1st January 2019, aircraft carriers are required to report their CO_2 emissions on an annual basis. There are five implementation elements for CORSIA. These are, States for Chapter 3 State Pairs, CO_2 Estimation and Reporting Tool, CORSIA Eligible Fuels, CORSIA Eligible Emissions Units, and CORSIA Central Registry. SAF is integrated into CORSIA through CORSIA Eligible Fuels. This means that emission reductions achieved through the use of SAF will count towards achieving airlines emission reduction obligations under CORSIA.

After some back-and-forth, ICAO has developed a set of sustainability criteria for CORSIA Eligible Fuels. In terms of GHG emission reduction, CORSIA requires eligible fuels to achieve a net GHG reduction of at least 10% life cycle emissions compared to the baseline. For carbon stock, the guiding principle is that 'CORSIA eligible fuel should not be made from biomass obtained from land with high carbon stock'. Primary forest, wetlands, or peatlands are identified as lands with high carbon stock. Any fuel that is derived from the conversion of such lands after 1st January 2008 and/or contributes to the degradation of the carbon stock in such land would not be classified as CORSIA eligible fuel. In cases where land-use change takes place after 1st January 2008, IPCC land categories will be used and Direct Land Use Change shall be calculated. In instances where the GHG emissions from Direct Land Use Change exceed the default Induced Land Use Change, the former will replace the latter.

6.2 Regional policy developments

D. European Union

Aviation in EU-ETS

Between 1990 and 2016, emissions from EU aviation almost doubled. This was in contrast with other sectors (other than transport) which witnessed reduced emissions. While emerging economies are expected to drive aviation sector's growth in the future, regulating emissions from EU remains important due to its geographic centrality, high per capita usage and its climate leadership which can influence other regions to take commensurate measures to regulate emissions. In the past, the EU tried to regulate emissions from the aviation sector by including aviation in the EU Emissions Trading Scheme (EU-ETS) from 2012. However, after resistance from the United States, major developing countries and industry, the EU decided not to include international aviation in the EU-ETS. While flights within Europe have been included in the EU-ETS, other international flights still need to be regulated. ICAO remains the global platform most suited to address international aviation emissions by regulating CO_2 emissions using its basket of measures, including SAF, undertaking CO_2 efficiency standards for new aircraft and CORSIA. Currently, carbon price within the EU-ETS is 20 € /t CO_2, which is too low to stimulate SAF uptake on its own.

Aviation in EU RED II

The revised Renewable Energy Directive (RED) (2009/28/EC) of the European Union, known as RED II was adopted in 2018. It sets the overall EU target for consumption from Renewable Energy Sources (RES) by 2030 to 32%, with a minimum of 14% renewable energy consumed in transportation. Within the 14% target for the transport sector, advanced biofuels (as defined in Part A of Annex IX of RED II) must be supplied at the minimum of 0.2% in 2022, 1% in 2025 and at least 3.5% by 2035. Already some of the EU countries are gearing up to introduce much more ambitious targets for advanced biofuels. Advanced biofuels would be double-counted towards both the 3.5% target and the 14% target. Biofuel produced from animal fats and used cooking oil is to be capped at 1.7% in 2030 and will be double-counted towards the 14% target. Although the 14% target does not include the fuels used in the aviation (and maritime) sector, these sectors can opt to contribute to the target. In such a case, the usage of non-food renewable fuels in these sectors would be counted 1.2 times their energy content. The multiplier of 1.2 does go some way to reducing the price gap between SAF and CAF, but not far enough. Industry body IATA has expressed its disappointment for the lack of ambition (Airlines 2018). The actual effectiveness of RED II for uptake of SAF still needs to be determined.

The EU Member states need to adopt RED II provisions as part of their respective national legislation by 30 June 2021. RED II provides the EU member states flexibility in terms of implementation choices under the transport mandate. This includes flexibility in choosing the most suitable policy intervention of supporting RES in transport, exempting or distinguishing different fuel suppliers and energy carriers from the 14% target, and depending on the local availability of feedstocks, and setting different cap levels for feedstocks identified in Part B of Annex IX. The commission will review the 32% RES target and the 14% sub-sector target for the transport sector by 2023 – and can propose to increase the target but not decrease it. The feedstocks as defined in Annex IX also need to be updated every two years but existing feedstocks cannot be removed.

In late 2019, finance ministers of nine European countries responsible for more than half of EU's aviation emissions called on the European Commission Ursula von der Leyen to propose new measures on aviation pricing, "e.g. in the form of aviation taxation or similar policies" (Euractiv 2019b).

6.3 Key national and sub-national policy developments

Sweden

By highlighting the urgency of climate change, the Swedish climate activist, Greta Thunberg, successfully brought the impact of aviation into the limelight. The impact is prominently visible in Sweden where a new word *Flygskam* was defined to draw a linkage between the collective impacts of individual choices to fly on

climate. Translated as flight shame, *flygskam* might become the most recognised Swedish word outside Sweden. This was followed by *Flygfritt* 2019 (Swedish for No-fly), a social media campaign which was able to attract pledges from 14,500 people to not fly during that year. The campaign aims to reach 100,000 pledges during 2020. This self-reflection has raised existential questions for the Swedish Aviation industry. As per a 2019 survey conducted by WWF Sweden, '23 % of Swedes have abstained from travelling by air in the past year to reduce their climate impact, up 6 percentage points from a year earlier' (Hoikkala and Magnusson 2019).

In response to this bottom-up pressure, the Swedish government instituted an investigation commission on the use of biojet fuel in Sweden. The commission proposed a reduction obligation (Flightpath 2019) that sets a requirement for fuel producers to reduce their emissions by greater uptake of bio-jet fuel. To do so, a biofuel blending mandate for each year from 2021 to 2030 (Table 3) has been proposed, with a long-term goal of 100% SAF use in Sweden by 2045. The SAF blending mandate is equivalent to the GHG reduction target of 0.8% in 2021 and 27% in 2030. The ratio corresponds to SAF volumes of 13,500 and 424,000 m^3 used in 2021 and 2030 respectively. The 2045 goal is in line with Sweden's Climate Act and Climate Policy Framework (Swedish Environmental Protection Agency 2019) that sets a target of net zero emissions by 2045. A 'reduction obligation fee' of 6 Swedish Kronas/kg[6] of CO_2 equivalent has been proposed in case fuel suppliers fail to meet the reduction obligation.

Table 2: Reduction levels, presumed LCA emissions and estimated blending ratios

Year	*GHG reduction level for aviation*	*Presumed LCA-emissions bio-jet fuel (gCO_2/MJ)*	*Equivalent estimated volume ratios of SAF (in %age terms)*
2021	*0,8*	*16,0*	*1*
2022	*1,7*	*14,2*	*2*
2023	*2,6*	*12,5*	*3*
2024	*3,5*	*10,7*	*4*
2025	*4,5*	*8,9*	*5*
2026	*7,2*	*8,9*	*8*
2027	*10,8*	*8,9*	*12*
2028	*15,3*	*8,9*	*17*
2029	*20,7*	*8,9*	*23*
2030	*27*	*8,9*	*30*

Source: From Swedish proposal summary[7]

[6] 1 Swedish Krona = Roughly 9.1 Rands
[7] Available online at https://www.biofuelsflightpath.eu/images/Swedish_proposal_summary.pdf

Norway

Norway has the highest airline trips per capita in Europe. The Norwegian government has announced a blending mandate (Greenair 2018a) requiring the jet fuel suppliers to blend a minimum of 0.5% SAF to be sold from 2020 onwards. Biofuels from problematic feedstocks such as palm oil are not eligible for meeting this requirement. It is estimated that the mandate will result in 14,000 tonnes of CO_2e reduction in the first year. By 2030, the Norwegian government aims to have 30% SAF in the aviation sector. The mandate is aimed to generate market demand for SAF in Norway. The extra fuel cost may be passed over to the passengers. The government moreover intends to increase air passenger tax on long-haul flights. Norwegian airport operator Avinor has also set a target to electrify all domestic and short-haul flights lasting up to one-and-a-half hours by 2040. SAS has also set a 2030 goal of powering all its domestic flights by biofuels – which account for 17% of its total fuel consumption.

France

The French government plans to introduce a levy of € 1.50 – € 18 on passenger flights from 2020 onwards (Farand 2019) depending on the flying class and the destination. It is reported that the government expects to raise €182 million through the tax to fund green transport infrastructure. The tax would apply to all departing flights.

Early this year, France has launched a roadmap to develop a SAF industry. The roadmap envisages that fossil fuel kerosene would be replaced with SAF at 2% from 2025, 5% in 2030 and 50% in 2050 (Greenair, 2020). The long term target is in the context of the National Low Carbon Strategy to reach carbon neutrality by 2050. The initiative sets out the following recommendations for realising energy transition in aviation:

- Mobilise the necessary volume of raw materials for the aviation sector
- Ensure that sustainable resources, especially those sourced from the circular economy, are used to produce advanced SAF
- Ensure the industry is economically viable for all players in the value chain through appropriate incentive schemes
- Use existing airport logistics distribution networks
- Support and promote production diversification (Biofuels International, 2020)

Germany

Germany established the Aviation Initiative for Renewable Energy in Germany (AIREG) in 2011. The goal of AIREG is to drive the research, production and usage of SAF in Germany. It has a target of replacing 10% of the kerosene fuelled nationwide with SAF by 2025 (AIREG 2020).

The German aviation tax came into effect in 2011 and applies to all passenger flights departing from Germany. It ranges from €7.38 to €41.49 per passenger and is determined on the flight distance. There has been a growing debate in Germany on how to tackle emissions from aviation. It has been reported (Wehrmann 2019b) that the governing alliance in the country is considering ending the tax exemption for kerosene to tackle aviation emissions. This could reduce the price differential between SAF and CAF if SAF remained exempt.

In terms of developing partnerships in support of SAF, the German government introduced the Leipzig Statement for the Future of Aviation. Signed by both industry and government officials, the Leipzig statement emphasizes the use of hydrogen as a fuel and stresses the relevance of 'alternative sustainable fuels – in particular, synthetic Power to Liquid fuels' (Nationale Luftfahrtkonferenz 2019). In support of this, Germany intends to soon finalise a green hydrogen strategy which is seen as a key pillar of its national decarbonisation strategy.

Finally, in line with increased calls for demand management, the Green MP Dieter Janecek made a call (Wehrmann 2019a) to allow each citizen a maximum of three flights per year, proposing that any additional flights need to be bought from the allowance of fellow citizens. While he remains a lone voice in politics, his proposal reflects the civil society's calls for aviation to start actively manage demand, at least until the climate impact of flying is reduced.

Netherlands

On the policy front, the Dutch government submitted the national flight tax bill (Ministry of Finance 2019) to its House of Representatives. While the exact rate of the tax will be set in 2021, it is expected to be in the vicinity of €7 per departing passenger, if the EU does not manage to set up a European-wide tax.

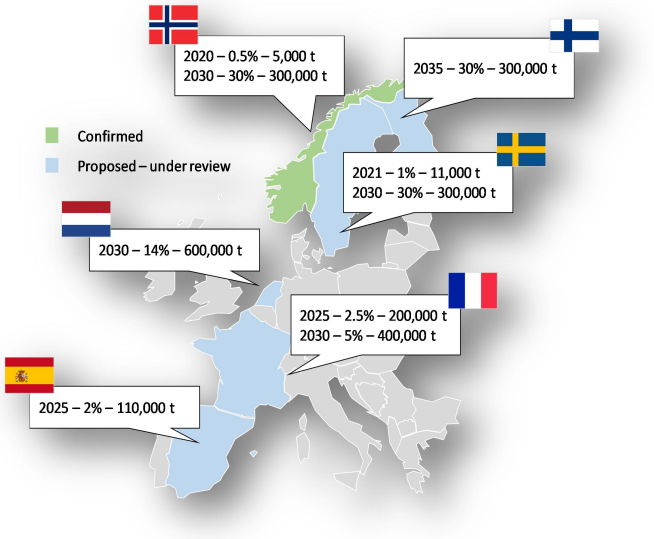
Responding to consumer pressure, the Dutch airline KLM recently launched a public campaign encouraging people to 'fly responsibly' and consider the environmental impact of their flights (Wilson 2019). The Dutch civil aviation sector has presented the Dutch government with its 'Smart and Sustainable' plan to reduce its gross carbon emissions originating in the Netherlands by 35% by 2030. It identified seven action areas (Greenair 2018b) including greater utilization of SAF in the relatively short term. By 2030, the plan envisages that 14% of all fuel produced will be sustainable. This will be done by scaling up of sustainable fuel from new sustainable raw materials and technologies (Air Transport Netherlands, 2018).

Spain

Spain is proposing to establish a national supply of SAF under EU RED II. The initial objective is for 2% of the total supply of aviation fuel (approx 150,000 tonnes) to be met through SAF in 2025 (Velarde 2019). It is referred to as 'the balanced compromise'.

In general, European countries have taken the lead in supporting SAF at the national level. Figure 7 below summarizes the SAF development in European countries.

Figure 7: SAF development in European countries



Source: Based on ongoing research at SkyNRG, last updated December 2019.

Indonesia

Beginning with 1% in 2009 (Sanjaya 2019), the Indonesian government's biofuel mandate has now reached 20% effective since September 2018. The government has pushed to increase overall biofuel mandate as a means to reduce fuel imports and boost the demand for locally produced raw material such as crude palm oil. In the aviation sector, this translates into a mandate to use 2% of bio-jet fuel for aviation by 2018, 3% by 2020 and 5% by 2025. Ensuring the sustainability of its biofuels is key to ensuring that it is eligible to be considered as SAF.

Mexico

In 2011, Mexican government developed a comprehensive fuel program for identifying existing and missing elements of SAF supply in the country. The objective of the program was to supply 15% of aviation fuel demand with SAF by 2020. In 2016, the Mexican Government through its Sectorial Energy Sustainability Fund (SENER-CONACYT) approved financing of a R&D program for SAF in Mexico. The program is collaboration between federal government, private sector, as well as research centres and other institutions. It includes development of raw material and construction of two demonstration plants with different technologies (ICAO 2017d). Mexico is considering setting up new laws and regulations to promote private investment for establishing the SAF industry in the next decade.

The national targets for SAF uptake in place as of February 2020 are summarized below (Table 3).

Table 3: National targets for SAF uptake

Country	Target	Main means of achievement	Other key provisions
Sweden	1% by 2021; 30% by 2030; 100% by 2040	Blending mandate	In line with Sweden's Climate Act and Climate Policy Framework, the government is considering a long-term goal of 100% SAF use in Sweden by 2045.
Norway	0.5% by 2020; 30% by 2030	Blending mandate	It is estimated that the mandate will result in 14,000 tonnes of CO_2e reduction in the first year. By 2030, the Norwegian government aims to have 30% SAF in the aviation sector. The mandate is aimed at generating market demand for SAF in Norway.
France	2% by 2025; 5% by 2030; 50 by 2050%.	Roadmap launched. Unclear if this is mandate or a target.	Introduce a levy of € 1.50 – € 18 on passenger flights from 2020 onwards
Germany	10% by 2025	Fuel substitution	
Indonesia	2% by 2018; 3% by 2020; 5% by 2025	Comes into effect through a broader biofuel mandate	
Netherlands	14% by 2030	Scaling up of sustainable fuel from new sustainable raw materials and technologies	The 'Smart and Sustainable' plan is a private sector initiative, submitted by the Dutch civil aviation sector to the government. The plan is currently under discussion
Spain	2% by 2025	Secure national supply under EU RED II	Currently a proposal
Mexico	15% by 2020	Collaborations	Mexico has taken a program approach in establishing collaboration between federal government, private sector and research centres.

California's Low Carbon Fuel Standard (LCFS)

A sub-national policy intervention, California's LCFS came into force in 2011 (Boutwell 2018) as one of the programs designed to reduce GHG emissions in support of California's Global Warming Solutions Act of 2006 (CARB, 2014). The California Air Resources Board (CARB) is the entity responsible for its administration. The ability of LCFS to gradually make its opponents – including oil companies that disagreed on policy issues – beneficiaries has been identified as an important reason for its success (Sperling and Murphy 2018).

The original goal of LCFS was to reduce fuel carbon intensity by 10% below the 2010 baseline by 2020. Further amendments were made (Green Car Congress 2018) to the LCFS to double the carbon intensity reduction target to 20% and extend it to 2030 (California Air Resources Board 2019). The providers of transportation fuel can meet the LCFS through a system of credits and debits – fuels with carbon intensity lower than the standard generate credits, whereas fuels with carbon intensity higher than the standard generate deficits. To comply with the standard, a fuel producer must either generate enough credits failing which it must acquire credits. SAF is also eligible to generate LCFS credits and participate in the program going forward. The LCFS has recently attracted investments of $350 million to develop SAF refineries with a capacity of 150 million gallons per year (Lane 2018)

6.4 International support for SAF development

Increasingly, international donors are keen to support the development and scaling up of different pathways for SAF supply. Prominent among these is the European Union's Horizon 2020 call which has been funding projects to use a diverse range of organic waste feedstocks for SAF production. A recent example of this support is the FlexJET project (flexJET 2019) which has been provided funding to deliver a blueprint for production and distribution of high-quality SAF using processing waste feedstocks near the source and at a pre-commercial scale. Such projects are aimed at promoting low-emission alternative energy sources for transport, including aviation.

Another example is of the ICAO-European Union Assistance project (ICAO 2019) aimed at capacity building for CO_2 mitigation from international aviation in 14 States in Africa and the Caribbean. As part of the project, four feasibility studies were undertaken in four developing countries, namely – Dominican Republic, Trinidad & Tobago, Burkina Faso and Kenya – on the use of SAF. The main objective of the study was to provide a comprehensive assessment of the potential for scaling production and use of SAFs in the case countries. The four studies identified challenges and opportunities in establishing a potential SAF Supply Chain; defined potential capacity in terms of feedstock availability and SAF production; defined demand by factoring in cost-benefit analysis; evaluated the environmental and local development impact, and identified key factors for facilitating implementation in

the four countries. Based on these findings, the report recommended policy roadmap strategies for the uptake of SAF in the four countries (Appendix B).

7 Policy recommendations for greater SAF uptake in South Africa

At the international level, ICAO plays a crucial role in addressing CO_2 emissions from aviation. Through CORSIA, it seeks to stabilize the levels of CO_2 emissions from international aviation from 2020 onwards. While a portion of this would be achieved through offsets achieved elsewhere in the global economy, development and deployment of SAF will be crucial in realising in sector reductions. Beginning in 2027, the second phase of CORSIA would make it mandatory for states to meet their CORSIA requirements. It is in South Africa's interest to be better prepared for the upcoming international regulations under CORSIA. One way to do so is by promoting SAF domestically.

While the technologies needed for SAF production are proven, for aviation to limit its climate impact and be in line with the latest findings of IPCC, SAF production needs to be ramped up drastically. The scale and speed at which it needs to be deployed can only be realised if supported by strong policy interventions with a long-term vision of transitioning international aviation away from CAF to SAF. Such interventions need to be deployed across the entire value chain of SAF, from Research and Development to financing, production and finally uptake by airlines. At the same time, necessary checks and balances are also needed to ensure a balance between realising social and environmental objectives, particularly in South Africa.

As discussed in section 3, for South Africa, putting in place a policy and regulatory framework for development of SAF value chains provides an opportunity to achieve various strategic goals – be prepared for upcoming international aviation regulations under the aegis of CORSIA, ensuring compliance in due course of time with domestic mitigation requirements under the carbon tax, guaranteeing connectivity with the wider world through a low-emission mode of transport, enabling economic growth and green jobs in travel and tourism sector and, taking on and providing regional leadership for decarbonising the sector. To this end, a toolkit of policy interventions is suggested below for promoting SAF in South Africa.

In the short-term (2020-2025), gathering all the necessary information and addressing any knowledge gaps to make informed policy choices should be prioritised. Studying and learning from ongoing policy initiatives in other countries and tapping available international cooperation opportunities, such as EU Horizon 2020 can be instrumental for staying abreast of the latest developments for SAF promotion and enhancing capacity building for defining a domestic policy and regulatory framework.

The government should develop a comprehensive roadmap for the long-term development and decarbonisation of the aviation sector, with SAF playing a key role as a mitigation option. In terms of a specific policy instrument for SAF promotion, setting a modest blending mandate by of 2-3% by 2025 – the minimum needed to support a commercial scale facility – can have a catalytic impact in the short-term to incentivize industry players to explore potential supply-chains for SAF production. Blending mandates are budget neutral and at modest levels will have a negligible impact on the jet fuel price. They will catalyse investment in the first SAF facility in South Africa. However, it is important to note that a blending mandate on its own is not sufficient to ensure that it is met by locally produced SAF; therefore an additional incentive for a local production chain, preferably one that meets multiple government objectives might be needed to ensure this is the case.

Without pre-determining the most suitable specific instrument, such an additional incentive could be included in the next iteration of the Industry Policy Action Plan (IPAP). The IPAP 2018/19 – 2020/21 already identifies green industries as part of its Sectoral Focus Areas and recognises that business needs to move away from investment in carbon-intensive technologies and towards the development of next-generation solutions (DTI 2018). By including SAF production, especially for aviation, in the next phases of IPAP's key action programme – particularly through its policy roadmap for climate-compatible industrial development, the Department of Trade and Industry could facilitate SAF development in South Africa.

In addition, South Africa's re-election as a member in the ICAO council provides a strategic opportunity to shape the evolution of the sector away from CAF. Leveraging its membership to influence the development of an international regulatory framework on SAF as well as facilitating greater uptake of SAF in the region can be the strategic choices for realising this evolution. South Africa should also take the decision to join CORSIA on a priority basis. This will provide enough time for all relevant stakeholders to familiarise themselves with CORSIA's requirements and processes before it becomes mandatory for all member states in 2027. This proactive decision will create a structural demand for SAF in South Africa, incentivising the supply of SAF in the country and the region and also bring added advantages of spreading greater awareness about the importance of decarbonising the aviation sector and preparing the industry for the coming changes in the sector. Joining CORSIA would also expand demand for SAF in South Africa to international airlines, incentivising the supply of SAF in the country and the region.

In the medium-term (2026-2030), SAF uptake should be scaled up by reducing the price gap differential between SAF and CAF and by gradually increasing the blending mandate. Another prominent policy intervention could be the initiation of a Jet Fuel Tax. At the same time, SAF can be promoted by establishing a price floor for the SAF producers. Airlines can be incentivised by setting a carbon price on CO_2

emissions from the airlines. However, policy support would be needed to promote locally promote SAF. Policy interventions such as feedstock assistance for producing non-food energy crops, production facility grants and loan guarantees to incentivise early SAF producers and setting up an input subsidy towards stimulating the upstream value chain to tap synergies with the waste economy, clearing of invasive alien species, and hydrogen economy could be useful for promoting SAF across the value-chain. In particular, scaling up incentives for SAF produced from feedstocks where South Africa holds a competitive advantage will be important.

For the long-term (beyond 2030), the government should define an ambitious vision for the sector which sets out a plan for the development of SAF in the country with an overarching 2050 target to replace at least 50% of aviation fuel sold in the country with locally produced SAF. Realising this vision will position South Africa as an important player in the global SAF hub and key SAF exporter.

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APPENDIX A: Selected measures and SAF specific information from aviation sector amongst key G20 countries

Country, Year, selected measures for mitigation in aviation sector	SAF specific information
Australia, 2017 1) Fleet upgrades, 2) Airports embracing renewable energy, 3) Airservices Australia creating regional partnerships: These include The Asia and South Pacific Initiative to Reduce Emissions (ASPIRE), The Indian Ocean Strategic Partnership to Reduce Emissions (INSPIRE), and 4) International engagement on climate change through UNFCCC & ICAO.	Acknowledgment of the importance of SAF for in-sector emissions reduction: "SAF are likely to become increasingly important as they are currently viewed as a possible long-term solution to keeping CO_2 emissions at 2020 levels."
Brazil, 2016 Identifies five key actions for mitigation in the aviation sector: 1) Operational improvements, 2) air traffic management, 3) aircraft technological development, 4) development of biofuels for aviation and 5) airports. Offers a general framework regarding the GHG of both domestic and international Brazilian aviation. The Brazilian government intends to monitor these indicators and update the data presented periodically.	Within the aviation biofuels section the document provides information about i) Minas Gerais Platform of Biojet Fuels and Renewables; ii) Actions of the Company GOL Linhas Aéreas Inteligentes; and iii) Actions of the company TAM. These are some very specific details but do not provide a policy target.
Canada, 2016 The 2014 update report provides a summary of measures undertaken to reduce GHG emissions from the aviation sector. These include: 1) Fleet Renewals and Upgrades, 2) More efficient air operations, 3) Improved capabilities in Air Traffic Management. And a summary of measures for achieving long-term aspiration goals, namely: aviation environmental R&D, alternative fuels, airport ground operations and infrastructure use, regulatory measures, and international coordination.	Section 6.2 provides an overview of government action on alternative fuels. The focus is very much on RD&D activities and calls for pursuing opportunities to collaborate with key trading partners, particularly the US.
China, 2016 Refers to principles of Common But Differentiated Responsibilities (CBDR) and Respective Capabilities under the UNFCCC as prerequisite and foundation for action on international aviation emissions. In 2011, Civil Aviation Administration of China (CAAC) released "Guidelines to speed up promotion of Energy Conservation and Emissions Reduction Regime in Civil Aviation Industry". Under these guidelines, CAAC undertook three phase approach (2011-12, 2013-15 and 2016-20) which resulted in a	The technical feasibility of aviation biofuel was proven in China in 2011 when Air China conducted the first biofuel demo flight. The SAP states that "this event will encourage and trigger more active involvement of China's enterprises into the R&D as well as commercialization of

reduction of 11%, 15% and 22% respectively in fuel consumption per RTK with 2005 as baseline. Efforts have been undertaken to develop a system for Data Collecting, Monitoring and Evaluating.	aviation biofuel."
India, 2015 Refers to principles and provisions of UNFCCC and Kyoto Protocol, including support. The SAP provides: a) overview of measures adopted by Airlines, and b) overview of measures adopted by Airports. Does not provide any policy recommendation.	States that, "Emphasis will be made on use of biofuel in civil aviation as and when such fuels are made available and commercially viable."
Japan, 2015 Most of the measures identified are aimed at improving fuel efficiency. States that Japan will work out details based on the results of the "Alternative Fuels Task Force (AFTF) consisting of alternative aviation fuel experts … under ICAO CAEP." The document does not provide a policy framework or a cohesive strategy for reducing GHG emissions or promoting the usage of SAF/AAF.	Govt of Japan will study framework for introducing alternative fuels towards the 2020 Olympics, including development of supply chains and relevant guidelines and how to procure AF and approaches for supplying AF produced in Japan.
South Africa, 2016 The South African Action Plan focuses on measures aimed at improving Air Traffic Management and infrastructure use. In addition it lists some complimentary measures that will be updated in the next edition of the Action Plan. These complimentary measures are: a) alternative fuels, and b) airport improvements. On the use of alternative fuels, the goal of producing 500 million litres of biofuel per annum by end of 2023 using a variety of feedstocks has been reiterated. The first African flight using sustainable biofuel was run by South African Airways between Johannesburg and Cape Town in 2016.	Assistance in terms of finance and technical support for increased update of SAF has been identified.

Sources: Country State Action Plans submitted to ICAO; ICAO (2020)

APPENDIX B: Recommended roadmap strategy based on four feasibility studies

	Dominican Republic	Trinidad & Tobago	Burkina Faso	Kenya
Short term	***(2017-18):*** Enhance cooperation & capacity building; Establish information sharing mechanisms; study international cooperation opportunities, with Brazil, Trinidad & Tobago and the USA.	***(2018-23):*** Develop national strategy for carbon pricing and mitigation; support gas to liquid industry; Reinforce government support to gain a comparative advantage in the future production and commercialization of renewable Biomass-to-Liquid SAF; Undertake measures to reduce GHG from Ground Support Equipment.	***(2018-23):*** Secure buy-in from national stakeholders; Establish central coordinating mechanism;	***(2018-19):*** Identify feedstock with best potential; Identify responsibilities and roles of relevant stakeholders; Establish oversight and coordination framework; Develop cooperation and capacity building initiatives; Undertake trials.
Medium term	***(2018-20):*** Adapt regulations & standards; Increase R&D on feedstock capacity; Disseminate information for spreading public awareness; Conduct macroeconomic analysis of implementation.	***(2023-28):*** Adapt waste handling and disposal policies for increasing SAF production; Develop and launch capacity building workshops and training programs on waste separation and recycling.	***(2023-28):*** Provide finance for smallholders; Explore carbon finance.	***(2020-23):*** Ensure complimentary policy and regulatory framework; Awareness raising; Undertake techno-economic and sustainability analysis.
Long term	***(2020 onwards):*** Promote implementation of value chain; Establish incentives to stabilise demand; Revisit technological development.	***(2028 onwards):*** Conduct feasibility study, including economic analysis for SAF production; Evaluate supplementing existing waste biomass with imports from neighbouring countries.	***(2028 onwards):*** Investigate potential for multi-feedstock processing plant.	***(2023-27):*** Ensure new petroleum infrastructure is supportive of SAF; Determine implementation plan based on analysis.