

Sustainable Aviation Fuel Accounting in the Australian Context

Perspective of Boeing and Virgin Australia

Background and why it matters:

The global aviation industry has committed to achieve net zero CO₂ emissions by 2050. While a variety of abatement measures will be required to realise this objective, it is widely accepted that Sustainable Aviation Fuel (SAF) is critical to accelerating the decarbonisation of the aviation sector. As the adoption of SAF expands from boutique application to large volume global use, It is necessary that a robust SAF accounting framework, based on trusted chain of custody approaches, is implemented to support the scaling up of SAF production and utilisation. Such a framework would allow access to the environmental benefits of SAF even while local production industries are being established in Australia.

This Working Paper explores the opportunities and challenges associated with implementing SAF accounting frameworks in the Australian context and consists of two parts. **Part 1** provides a definition of and a rationale for the importance of SAF accounting. It outlines the three primary chain-of-custody models used globally (Physical Segregation, Mass Balance and Book & Claim) and explains how these intersect with regulatory schemes including the Carbon Offsetting and Reduction Scheme for International Aviation (CORSA). A brief overview of significant international action and guidance, including by the International Air Transport Association (IATA) is also provided. The potential of Book and Claim as a recommended approach to SAF accounting is explored, including the means by which this approach could also drive concurrent scaling of local SAF production.

Part 2 briefly examines SAF accounting within Australia, considering recommendations for preferred accounting approaches and likely implications for implementation. It focusses on how Book and Claim, in particular could be integrated into the Australian context, examining the guiding international frameworks that would inform implementation. It also introduces potential adjustment mechanisms that would be required within the Australian policy context. A subsequent working paper will build upon these foundations and further investigate how SAF accounting could be applied in an Australian context with reference to incorporation into National Greenhouse and Energy Reporting (NGER) and/or other arrangements such as the Safeguard Mechanism.

Summary of the key points of this working paper:

- SAF accounting is the process or method by which the physical delivery of SAF and the associated environmental benefits may be decoupled, tracked, and claimed through a robust chain-of-custody model.
- The 3 main chain-of-custody models are Physical Segregation, Mass Balance, and Book and Claim, each with their associated advantages and disadvantages.
- Book and Claim SAF accounting is recognised by IATA as a vital enabler for low cost, efficient and sustainable uptake and global production of SAF.
- IATA is working with cross-industry stakeholders and will publish a joint guidance document recommending a set of common SAF accounting principles, including for book and claim in 2024.

- SAF accounting is essential for airlines (and their customers) to claim the environmental benefits of SAF they have purchased and used.
- Current challenges associated with book and claiming SAF include a lack of globally harmonised principles for both aircraft operators making scope 1 claims and corporates seeking scope 3 emission claims.

Recommendations of this working paper:

- The Australian Government recognise the importance of SAF accounting as a key lever for unlocking the full potential of SAF for Australian Airlines, producers, supply chain, corporates and consumers.
- The Australian Government recognise the opportunities associated with Book and Claim in the Australian context.
- The Australian Government work closely with Australian airlines, industry including IATA and through ICAO to promote the establishment of a globally harmonised approach to SAF accounting.

Part 1:

SAF accounting: Context

IATA represents approximately 300 member airlines from 120 countries around the world. In October 2021, the members of IATA passed a resolution committing them to achieve net zero emissions by 2050 to align with the objectives of the Paris Agreement. The following year, in 2022, the member states comprising the International Civil Aviation Organisation (ICAO) also adopted a long term global aspiration goal to achieve net zero emissions from international aviation by 2050. These resolutions built upon previous international efforts including ICAO's 2016 adoption of the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) which addresses international emission growth above 85% of the 2019 emissions for aviation activity between obligated countries.

A range of abatement measures will be required to accelerate progress towards the net zero goal, including operational efficiency and infrastructure improvements, fleet renewal and technological improvements including electric and hydrogen aircraft. In the short-medium term, however, under a variety of decarbonisation scenarios explored by the Air Transport Action Group in the Waypoint 2050 report, Sustainable Aviation Fuel remains the most impactful abatement measure. IATA's Net zero roadmap also provides evidence of the relative contribution of SAF as illustrated below:

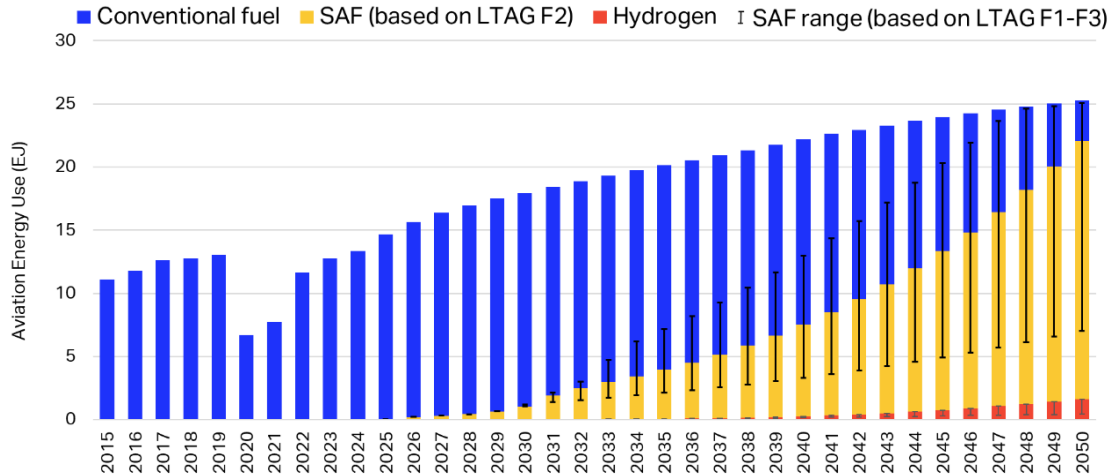


Figure 1: Aviation transition to net zero (IATA)

Sustainable Aviation Fuel (SAF) is a ‘drop-in’ replacement for conventional fossil jet fuel (CFJF). Today, SAF must be blended (up to 50%) with CFJF and certified to ASTM d1655 (or equivalent). At this point, it is entirely interchangeable with CFJF requiring no modification of engines, airframes, or associated fuel delivery infrastructure. As a result, blended SAF can use existing fuel delivery infrastructure, avoiding the need for inefficient bespoke supply chains from the point of origin to an aircraft’s wingtip. In the short-term, SAF is the most expedient means by which aviation may be decarbonised and also provides the opportunity to achieve broader sustainability outcomes, including those associated with driving more circular economies.

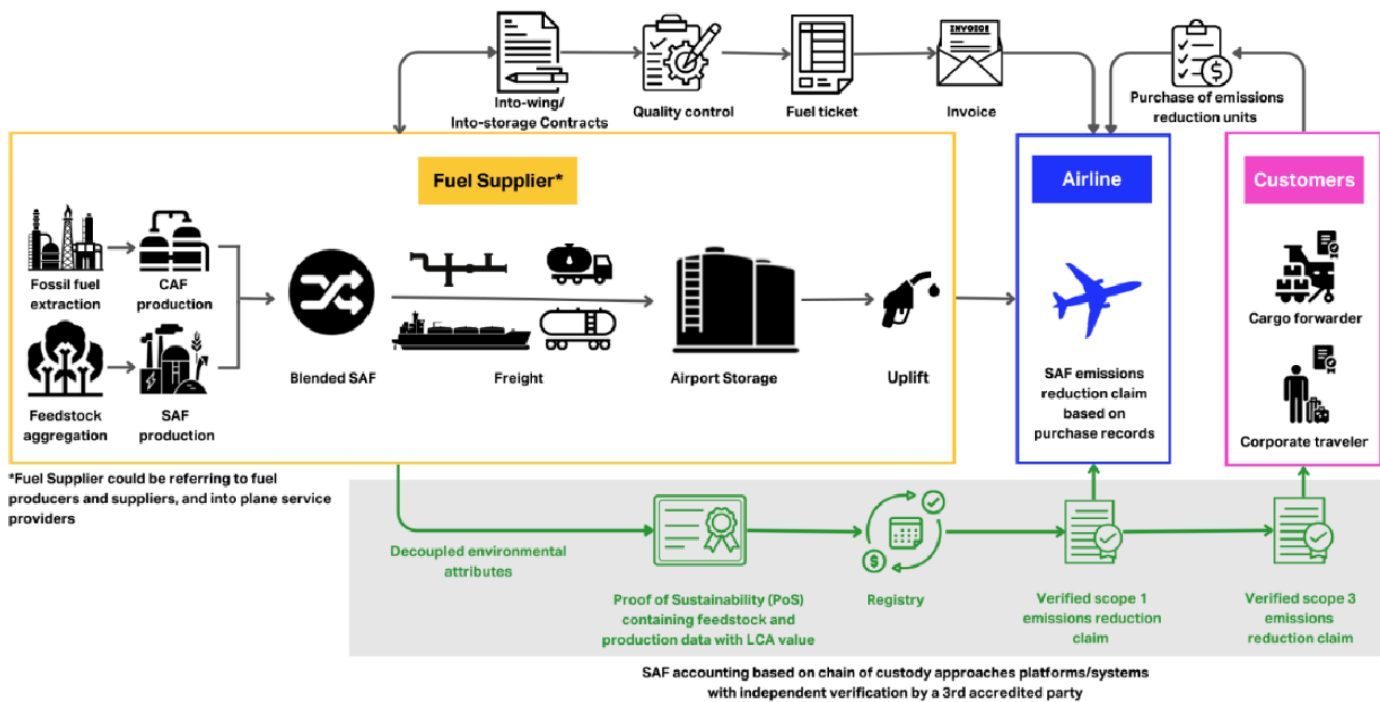
Despite the significant opportunities that SAF represents to decarbonise aviation, economic challenges to uptake remain for both producers and consumers. Currently, SAF is more costly to manufacture than CFJF and is therefore more expensive to purchase. Depending on the technology production pathway, feedstock and production location, SAF can cost 2-5 times more than CFJF. It is hoped that as technologies advance, feedstock volumes increase and economies of scale are achieved, this price differential reduces. Government policies, on either the supply or demand side can also play a significant role in reducing the cost of SAF. For example, SAF sold in markets where there are incentives (supply side incentives) are typically 2-3x CFJF whereas SAF sold in markets where there are mandates (demand side incentives) are typically 4-5x CFJF ([Anne Rigail, IATA World Sustainability Symposium](#)). Policies and market-based approaches that stimulate SAF industry growth and overcome geographic barriers to production, are important in ensuring SAF moves closer to price parity with CFJF.

Technical SAF and accounting:

Currently, commercial flights are permitted to fly with a blend of up to 50% SAF. Post blending, the fuel mix (SAF and CFJF) is recertified to ASTMd1655 international standard and is treated as standard ‘jet fuel’, meaning it can be inserted into transport pipelines and airport fuel farms. Once SAF enters the jet fuel supply chain, it is important that robust mechanisms exist to track and claim the environmental benefits associated with the purchase of SAF in a cost effective, environmentally sustainable, and credible manner. This is vital to ensure the benefits can be accurately reported to customers or counted against decarbonisation targets/obligations.

Features of SAF accounting:

SAF accounting is the process by which this may be done accurately and in a manner that ensures the veracity of data required to meet voluntary sustainability targets and reporting or compliance obligations. IATA notes the key role of SAF accounting frameworks to support



progress towards the global aviation industry's goal of net zero emissions by 2050. Importantly, these must be underpinned by robust chain of custody approaches by which inputs, outputs and

Figure 2: Generic SAF accounting process based on robust chain of custody methods

associated information are transferred, monitored and controlled as they move through each step in the relevant supply chain.

IATA provides an overview of the key benefits of a robust accounting system, or interrelated network of systems. These include:

- Assuring immutable tracking of environmental attributes to enable verification.
- Providing full transparency over sustainability claims made over SAF
- Preventing double issuance, usage or claiming
- Allowing the stacking of incentives to maximise opportunities to reduce the barriers to uptake resultant from SAF higher prices.
- Avoiding, under certain methodologies, the unnecessary transport of SAF and feedstocks, minimising associated environmental and economic costs.

An important component of a SAF accounting system is the potential to separate the physical supply of fuel from its environmental attributes. As a result, SAF accounting can provide a means to incentivise the scaling up of technologies, feedstocks, methods and approaches required to drive industry uptake. It can also enable SAF production to occur where it is most efficient and uptake simulated in areas where production may not be possible. It is important,

however, that all SAF accounting approaches adhere to common principles of accuracy and robustness.

12 provisions to guide this process:

- **Immutable tracking** - ensuring that data associated with a physical/environmental attribute of SAF cannot be altered;
- **Transparency** – providing sufficient data to give confidence in the physical/environmental attribute of the SAF;
- **Verification** – ensuring that the claims related to the physical/environmental attribute of the SAF can be audited;
- **No double counting** - ensuring that the environmental attribute can only be claimed once under the same scope;
- **No double issuance** – ensuring that an environmental attribute cannot be issued more than once from the same batch of SAF;
- **No double dosage** – the environmental attribute from one batch of SAF cannot be used in multiple jurisdictions;
- **Inter-operability** – interoperability between registries to ensure that the environmental attributes of SAF cannot be claimed in multiple registries through the creation of unique IDs;
- **Agnostic** – Recognising that SAF can be made from various approved pathways and feedstocks;
- **Stacking** – Allowing the environmental attributes to be used to comply with multiple obligations;
- **Splitting/Divisibility** – Allowing the environmental attributes associated with a batch of SAF to be split and sold separately to different customers;
- **Permeance** – Once claimed, an environmental attribute may not be claimed again; and
- **Vintage Period** – Ensuring that environmental attributes have an expiry date.¹

Three Primary Chain of Custody Approaches:

Three common chain-of-custody approaches being considered today are Physical Segregation, Mass Balance and Book and Claim, the key features of which are summarised in figure 3 below (World Economic Forum, First Movers Coalition, SAF offtake manual, 2023).

¹ IATA industry book and claim guidance, 2023




	 Physical segregation	 Mass balance	 Book and claim
Description	A physical segregation approach requires "separation" of different product streams (e.g. certified material from non-certified material) throughout the supply chain. This chain of custody approach delivers consignments that physically contain 100% of the specific product stream, but they can be from a variety of sources. It does not necessarily provide traceability back to the source of the feedstock (e.g. a specific farm or plantation) but could. Physical segregation can either be by location (e.g. separate storage or distribution channels) or by time (e.g. batch-wise processing or delivery)	A mass balance approach allows products with different characteristics to be physically mixed but kept administratively separate (think HEFA SAF from used cooking oil, where the oil has been collected from various restaurants). At each step in the supply chain, companies do not sell or produce more products with specified characteristics than they sourced. Mass balance is required in the EU under REDII. ⁹	A book and claim approach enables the decoupling of the physical fuel from environmental attributes associated with the fuel. For the volume of SAF that is claimed to be used, it can be claimed that sufficient material with those characteristics has been added to the system (considering relevant conversion factors). A more complex approach might involve applying value to scope 1 and 3 emissions, encouraging non-physical fuel users to participate in these transactions.
Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) considerations	CORSIA recognizes eligible fuels.	Mass balance is accepted under CORSIA with the "control point" being the blend location, typically the airport.	CORSIA already includes some elements of book and claim chain of custody after SAF blending.
Comparison	Physical segregation is cost prohibitive due to green premium associated with SAF compounded by dual physical infrastructure.	Mass balance means more control points compared to book and claim and more limited supply options for SAF producers resulting in some SAF (or feedstocks) being shipped around the world to demand geographies.	Book and claim offers maximum flexibility for tracking the environmental benefits from SAF with an opportunity to accelerate uptake by injecting SAF into the aviation fuelling system at the most logical logistical locations (especially 2025-2035 while supply scales) in a manner suited to incorporate corporate demand.

Figure 3: Three primary chain of custody models

Physical segregation requires 'physical separation' of different product streams throughout the supply chain. This chain of custody approach delivers consignments that physically contain 100% of the specific product stream, but they can be from a variety of sources. It does not necessarily provide traceability back to the source of the feedstock (e.g. a specific farm or plantation) but could. Physical separation can either be by location (e.g. separate storage or distribution channels) or by time (e.g. batch-wise processing or delivery). This method is the most cost-prohibitive at this stage of SAF industry development in Australia, due to the need for dual physical infrastructure.

The CORSIA framework, through its Standard and Recommended Practices (SARPs) recognises that conventional fossil jet fuel and on specification blended SAF are not typically (and do not need to be) segregated at airports but co-mingled. As such, CORSIA eligible fuels can be mingled in fuel pipelines and storage systems. CORSIA allows a mix of mass balance and book and claim, with mass balance being required until the control (blend) point and from blending release satisfying technical certification ASTM d1655 (or equivalent) the fuel is treated as conventional jet fuel and sustainability attributes can be book and claimed.

SAF accounting under CORSIA

A mix of mass balance and book and claim:

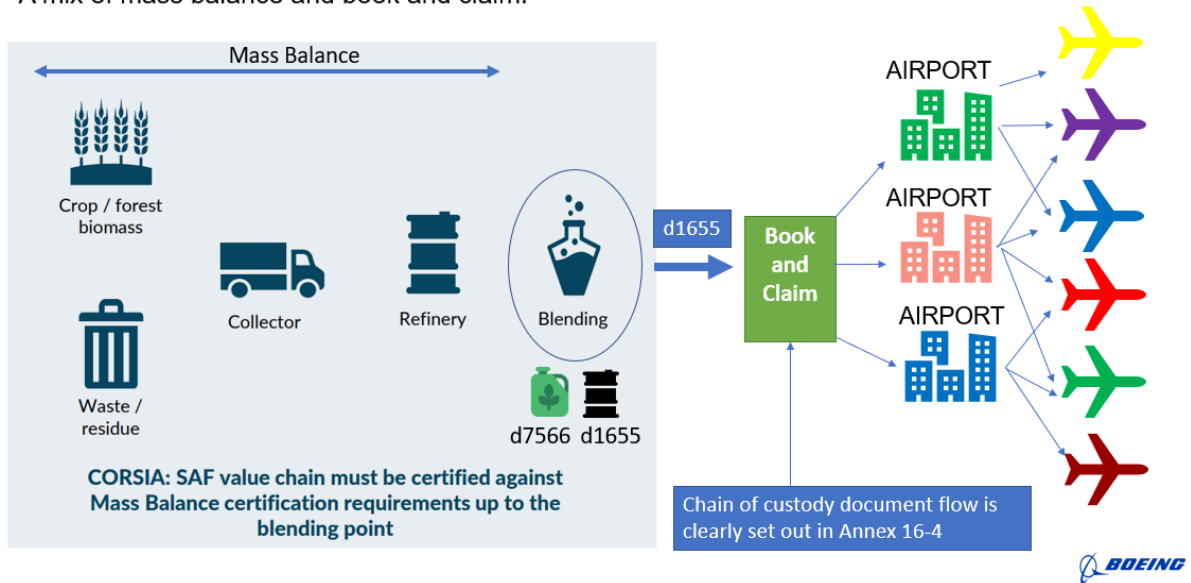


Figure 4: SAF chain of custody under CORSIA

Mass balance allows for products with different characteristics to be physically mixed, but kept administratively separate. At each step in the supply chain, companies do not sell or produce more products with specified characteristics than they sourced. Mass balance is utilised in the European Union under Renewable Energy Directive (RED) II.

Book and Claim SAF accounting enables trade in the physical product to be completely decoupled from the trade in information (or certificates). As such, this approach offers greater flexibility in tracking the environmental benefits from SAF and for scaling up investment and innovation in SAF production in the most logical locations. For the volume of SAF that is claimed to be used, it can be claimed that sufficient material with those characteristics has been added to the system (taking into account relevant conversion factors). A more complex system might involve applying value to scope 1 and scope 3 emissions, encouraging non-physical fuel users to participate in these transactions. The ICAO Global Framework for SAF, LCAF and other Aviation Cleaner Energies, adopted at the 2023 ICAO Conference on Alternative and Aviation Fuels (CAAF/3), recognizes that accounting methodologies provide confidence for usage and uptake.

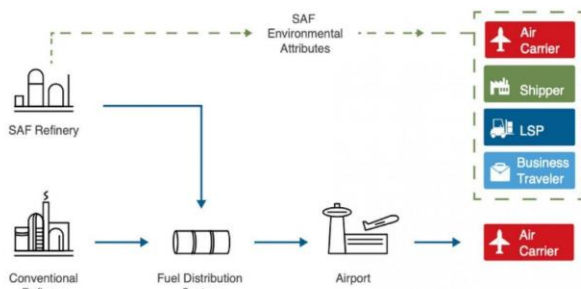
Chain of custody approaches



- Chain of custody refers to the method by which a connection is made between information that relates to the production of raw materials and any claims that are made relating to the final product.

Figure 5: Chain of custody approaches

Source: Boeing, GSPP



Chain-of-custody model allowing “de-coupling” of environmental benefits from physical transfer of SAF via book and claim registry

- Allow companies to contribute to goals of Paris Agreement;
- Provide return on investment on innovative climate solutions;
- Allow for efficient capital deployment;
- Provide real emissions reductions.

Figure 6: Chain of custody processes

The benefits and challenges of Book & Claim:

Decoupling the physical and administrative aspects of SAF can be an effective means to enable and scale SAF production by stimulating SAF uptake in locations where production is not otherwise feasible and may also minimise the costs and environmental impacts associated with additional logistics, including transport and storage. Further, it can provide policy certainty and a clear market signal to encourage increased SAF production.

Under a physical segregation chain-of-custody approach, SAF would need to be segregated for the entire length of the supply chain from point of origin right through to the wingtip, incurring significant expense (and emissions) in the process. Given the current cost premium currently associated with SAF relative to CFJF, and that SAF from day 1 has been designed as a drop-in fuel, it is an unnecessary and inefficient solution. Book & Claim provides the most efficient

means for accounting while SAF is scaling. SAF is expected to remain more bespoke in production than CFJF and Book and Claim can provide a mechanism by which production location does not limit uptake and potential revenue. Using this approach, SAF could be produced in markets with little or no current demand for SAF, and the environmental attributes sold in markets where there is little or no surplus supply of SAF. Book and Claim SAF accounting can avoid the need for SAF to travel long distances, particularly when demand or market incentives may attract the fuel to be used in particular geographies. Unnecessarily moving SAF is economically and environmentally suboptimal and inefficient. Further, Book and Claim can assist with addressing the growing demands from corporations for solutions to address scope 3 emissions associated with business travel.

Some of the key challenges are highlighted in the 12 provisos to guide a book and claim process. Perhaps the most important is to ensure a global system can guarantee no double counting of environmental claims. Several factors being worked on will address this, but it is irrefutable that a robust, transparent globally linked registry system will be necessary.

Whilst there is a global understanding of the potential role of SAF accounting, further work is required to facilitate a global Book and Claim framework. It is recommended that Australia monitor and support the global efforts to establish a set of common SAF accounting principles during 2024.

Part 2:

Global SAF accounting in an Australian regulatory context:

Significant opportunity exists to establish a robust SAF accounting system within Australia to enable the realisation of the potential economic and environmental benefits associated with an accelerated SAF industry. Whilst there is a strong international evidence base and clear guidance from bodies including IATA on SAF accounting, it is necessary to examine the policy nuances that may be required here. IATA is working with stakeholders across the industry value chain and will publish a joint guidance document about common principles required for SAF accounting initiatives. This will be a complimentary reference to the work ICAO is seeking to undertake, broadening state level awareness of how SAF accounting can prime markets in all regions of the world. Further opportunity is also presented through the Australia-United States Climate, Critical Minerals and Clean Energy Transformation Compact (signed in 2023), which includes commitments to:

- establish information sharing exchanges on economy-wide emissions accounting schemes for products like hydrogen and sustainable aviation fuel (SAF)
- the sustainable development of high integrity SAF production to support emissions reduction in the aviation sector

Applying a SAF accounting method in the Australian context will require both an adherence to such international guidance and standards, and the embedding of SAF accounting methods in existing emission reduction accounting and reporting schemes.

As an internationally tradeable commodity, SAF production and use can be optimised to ensure that SAF is available to the global market at the lowest possible price. With optimum policy levers in place, geographic regions such as Australia, which have significant SAF production potential, could play a significant role in supplying SAF environmental attributes to a global market. Specifically, potential domestic producers could leverage Australia's abundance of high quality, internationally recognised sustainable feedstocks to manufacture SAF which could be delivered locally, and the environmental attributes sold into an international market. A Book and

Claim framework provides the most effective means to leverage this potential, decoupling the physical and administrative elements of SAF. This does, however, require that consumers, and regulatory bodies have confidence that claims made through the use of SAF can be substantiated. There is a strong need for transparency and confidence in respect to the link between the physical and environmental attributes of SAF, and a usable mechanism by which claims can be verified. It is also critical that the principles of a robust SAF accounting system (as outlined by IATA) be adhered to in an Australian context, including those that prevent issues such as double counting or issuance.

A SAF accounting system should be integrated as a complementary measure into a harmonized governmental approach to enabling SAF uptake and production. Enabling policy would require detailed rules for how Book and Claim units or certificates can be claimed and a robust registry system to ensure adherence to these rules, maintaining transparency and accuracy. Further consideration will need to be given to how these accounting and reporting claims are integrated into broader climate disclosure requirements and practices. Implemented effectively, a robust Book and Claim accounting framework enable access to the environmental attributes of SAF as a local production industry continues to develop. Units could be purchased from or delivered into the international market and then ideally, claimed under voluntary or compliance schemes such as NGER or Safeguard. From a project financing investor perspective this becomes immediately attractive as the customer base (i.e., airline SAF purchasers) is no longer limited to those that are connected to that facility but rather any customer around the world. This is advantageous in a country like Australia where close to 90% of domestic fuel demand is attributable to two airlines. Thus, SAF accounting becomes the bridge for airlines to access the environmental attributes of SAF while domestic production in Australia comes online and scales.

Further detail on integration into the Australian context is provided by the CSIRO/Boeing SAF Roadmap published in 2023. This outlined that standardised and accepted approaches are required to enable the environmental benefits of SAF to be claimed by Australian organisations following transactions and then to be reported transparently. These require a recognition of contribution to both scope 1 and scope 3 emissions by different entities. Whilst demand exists for corporate buyers who seek to reduce their scope 3 emissions associated with business travel, for example, SAF is currently not widely recognised as a potential mitigation option in Australia. Ongoing exploration and adoption of standardised mechanisms for carbon accounting and reporting of SAF use to claim Scope 1 and Scope 3 emissions reductions for airlines and their customers, such as Book and Claim provide a significant opportunity in the Australian context.

Next steps

A second working paper will be developed in early 2024. This will further explore the manner in which SAF accounting, specifically using a Book and Claim methodology, could be incorporated into the Australian policy landscape. It will consider potential applicability and operational harmony to existing reporting instruments such as NGER and the Safeguard mechanism. It is recommended that a consistent engagement approach also be developed and adopted, guiding collaboration with relevant domestic and international stakeholders across government and industry.

