POLLINATION

Enabling aviation sector decarbonisation through SAF accounting

MAY 2025

Virgin australia

BOEING

The purpose of this paper is to provide a preliminary exploration of market based accounting approaches that provide a pathway for domestic airlines to account SAF used in non-Australian domestic flights, to contribute to their Scope 1 emissions reduction obligations under Australia's Safeguard Mechanism.

Pollination was commissioned by Virgin Australia, with the support of Boeing, to undertake analysis of this issue to inform the work of the Jet Zero Council.

This paper is structured as follows.

EXECUTIVE SUMMARY	• Overview of the key concepts and issues discussed in the paper
THE SAF CHALLENGE	• Introduction and context • Description of key concepts and terms and how they are applied • Overview of the broader Australian SAF policy landscape and barriers to uptake of SAF from an emissions accounting perspective
ADDRESSING THE SAF CHALLENGE THROUGH A MARKET-BASED ACCOUNTING APPROACH	• Exploration of the potential to address cross-border accounting of SAF environmental attributes through the re-design of domestic policy frameworks regarding GHG accounting, including the international guidance that sits above them, as well as the reporting obligations that sit underneath them.

POLLINATION

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EXECUTIVE SUMMARY

The production and use of Sustainable Aviation Fuel (SAF) must accelerate significantly for the global aviation sector to achieve net zero goals. This requires robust accounting frameworks to ensure airlines' scope 1 emissions reductions are verifiable and can be achieved cost-effectively.

The challenge

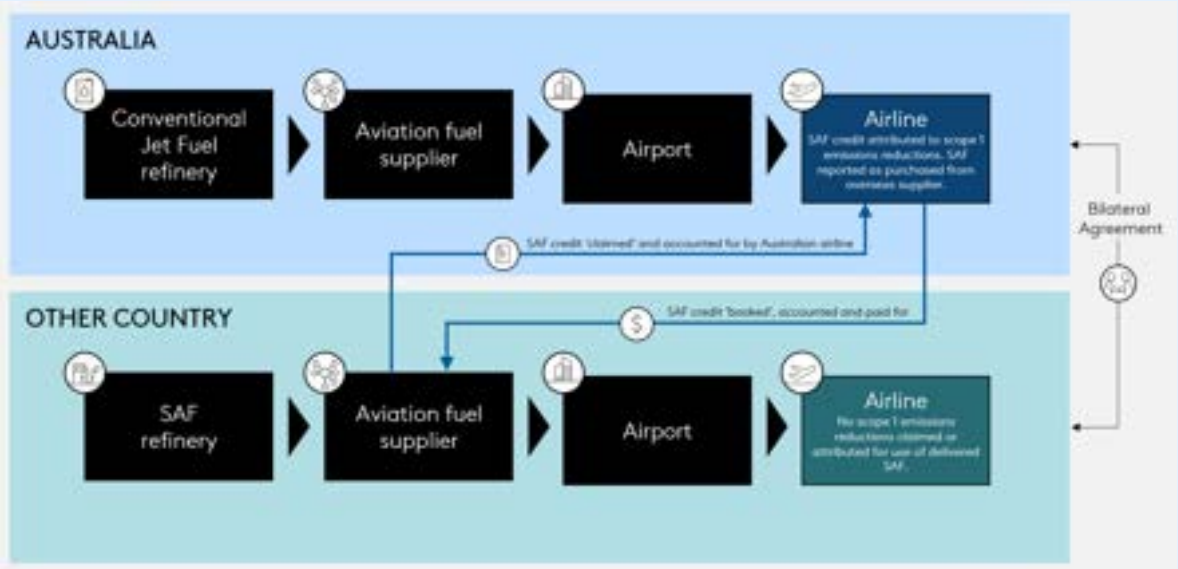
Australia's greenhouse gas (GHG) accounting system currently allows airlines to recognise emissions reductions from direct combustion of SAF, but lacks mechanisms to account for SAF that is purchased by Australian airlines but used outside the country (i.e. on overseas flights). Given that SAF production is not occurring at any material scale in Australia, emissions reductions from SAF use are not currently reflected in Australia's GHG inventory.

Domestic scope 1 emissions from Australia's largest airlines are covered under the Safeguard Mechanism (SGM), requiring these airlines to reduce emissions annually through direct reductions or use of eligible domestic units (i.e. (Australian Carbon Credit Units (ACCUs) or Safeguard Mechanism Credits (SMCs)). However, current rules do not permit international units to meet compliance obligations, limiting domestic airlines' ability to support global SAF adoption through overseas purchases.

How can SAF accounting help address this?

This paper explores a potential pathway to facilitate airlines to report SAF purchased and combusted abroad in their National Greenhouse and Energy Reporting (NGER) scope 1 emissions, by shifting to a market-based approach rather than the current location-based accounting method. This can be enabled through a 'book and claim' method of SAF accounting. Figure 1 illustrates how such a system would work in practice.

Figure 1. Illustrative operation of international book and claim system for SAF



Implementing such a system would require a range of structural and policy amendments at both the national and international levels for participating countries, including:

To accelerate SAF adoption and provide airlines with additional compliance options under Australia's SGM, Australia should consider reforms to support the integration of market-based accounting methods into domestic policy frameworks. Aligning domestic regulations with international SAF accounting frameworks will be critical to enabling cost-effective decarbonisation of the aviation sector. It will also support the long-term development of a SAF industry in Australia by enabling accelerated growth of the global market for SAF, thereby generating stronger international demand signals and a more mature market for Australian SAF producers to feed into through a book and claim system.

PART 1

The SAF Challenge

1. THE SAF CHALLENGE

KEY TAKEAWAYS

- SAF is the most critical decarbonisation lever for the aviation sector to reach net zero emissions. Accounting methodologies that determine how SAF procurement and use is reflected in GHG inventories, both at the national and corporate level, are an important enabler to the scaling of the SAF industry.
- Book and claim is a market-based approach to SAF accounting that enables trade in the physical product of SAF to be completely decoupled from the environmental attributes of SAF.
- There are a number of policy initiatives in Australia which either currently, or could in future, interface with SAF accounting mechanisms. This paper focuses specifically on how the Safeguard Mechanism could enable Australian airlines to claim the environmental attributes of SAF they purchase which is combusted on overseas flights through integration of a book and claim model.

1.1 Introduction and context

Sustainable aviation fuel (SAF) is expected to play a pivotal role in the pathway for the aviation industry to achieve net zero, with up to 65% of the sector's required emissions reductions by 2050 anticipated to rely on replacement of convention jet fuel with SAF.[1] The SAF market is poised for rapid growth, with projections indicating an increase in market value from $1.22 billion in 2025 to $5.69 billion in 2029. However, the scaling of SAF production and utilisation continues to face a number of headwinds. SAF remains two to five times more expensive than conventional jet fuel due to the costs of feedstocks, complex production processes, and limited economies of scale. As a result, SAF currently only accounts for less than 0.1% of all aviation fuel consumed, with existing and planned SAF projects currently only expected to meet 2-4% of jet fuel demand by 2030.[2] Increasing the use of SAF to exceed 10% by 2030, as required under the International Energy Agency's (IEA) Net Zero Emissions (NZE) scenario, will necessitate substantial investment to expand production capacity, as well a supportive and coordinated policy environment that appropriately incentivises uptake of SAF by airlines operating in a competitive global market.

SAF accounting frameworks have an important role to play in helping to scale SAF production and utilisation, both in an Australian and international context. In particular, a market-based accounting approach based on a chain-of-custody model, where the physical use of SAF is decoupled from its environmental benefits, can address barriers presented by the limited geographic availability of SAF, high procurement costs and limitations on SAF transport, storage and blending infrastructure. Integration of such a model with Australia's national GHG inventory frameworks would allow greater access to the environmental benefits of SAF, even while local production industries are still being established in Australia. Development of an international system for book and claim accounting may also help accelerate domestic SAF industry development, providing Australian producers with access to a larger pool of potential customers.

The purpose of this paper is to explore how a market-based method for SAF accounting could enable Australian airlines to claim SAF used on international flights as scope 1 emissions reductions under Australia's Safeguard Mechanism, focussing on pathways for implementation to maximise global uptake of SAF to enable the decarbonisation of domestic aviation.

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1 IATA Fact Sheet on Sustainable Aviation Fuel

2 IEA's aviation tracking of key performance indicators on the sectors road to net zero

1.2 Key concepts

This paper includes a number of key terms and concepts, which are described in further detail in Table 1.

Table 1. Overview of key concepts

National GHG inventories	National GHG inventories are intended to provide an accurate picture of emissions sources and sinks within the territory of the country.[3] They are compiled using data on direct emissions and emissions sinks across different sectors from sources located within the country. National GHG inventories can be used to inform government policy and planning to address activities occurring in the country associated with key emissions categories and track the country's progress towards its national targets. National governments may use scope 1 emissions data reported by companies to help inform the national GHG inventory.
Corporate GHG inventories	GHG inventories prepared for an individual company are designed to provide an accurate picture of the company's direct and indirect emissions associated with its value chain. They can be used to inform strategies to manage and reduce emissions, as well as provide greater transparency to customers and investors on interventions taken and investments made to reduce emissions within its value chain. Under the Greenhouse Gas Protocol's (GHGP) current Corporate Standard, any emissions reductions or removals which are funded by the company, but which do not actually occur within the company's value chain, cannot be reported as direct scope 1, 2 or 3 emissions reductions but rather are reportedly separately (e.g., towards a voluntary emissions reduction target[4]).
International aviation emissions	GHG emissions from international flights are governed by the International Civil Aviation Organization (ICAO), a UN agency that sets global aviation standards. ICAO regulates emissions primarily through the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA), which aims to cap net CO_2 emissions from international flights at 2019 levels. Airlines must monitor, report, and offset emissions exceeding this baseline. ICAO also promotes the use of Sustainable Aviation Fuel (SAF) and technological improvements to reduce aviation's carbon footprint. Domestic aviation emissions remain under national jurisdiction.
SAF accounting approaches	There are three main types of SAF accounting approaches: 1. Physical segregation, which requires 'physical separation' of different product streams throughout the supply chain. 2. Mass balance, which allows for products with different characteristics to be physically mixed, but kept administratively separate.

[3] IPCC. 2006. Guidelines for National Greenhouse Gas Inventories

[4] This working paper does not address methodologies and guidance on the use of offsets to achieve voluntary emissions reduction targets (including e.g., ensuring integrity and transparency).

3. Book and Claim, which enables trade in the physical product of SAF to be completely decoupled from the environmental attributes of SAF (represented by the trade in information or certificates).

Of these three approaches, only the Book and Claim model is relevant to this paper's focus on Australian airlines' accounting for SAF benefits occurring in overseas markets (i.e., separating the environmental attributes of SAF from the physical product).

There are a variety of Book and Claim models emerging in the market. Some operate on the model that customers (whether airlines or their corporate customers) purchase environmental attributes associated with SAF which is supplied directly into fuel distribution networks by the fuel supplier.[5] Some operate in more of a market-based context, in which units representing standardised units of SAF (and its environmental attributes) are traded through a centralised registry.[6] In each case, the environmental attributes of the SAF and can be purchased (and 'claimed') by customers, even where they have no physical connection to the SAF's distribution channel.

1.3 Relevant Australian Policy Context

The policy landscape for SAF is continuously evolving. At present, there are a number of initiatives and policy development processes underway that will likely have a direct influence on efforts to decarbonise domestic aviation in Australia, and at some point, may work alongside or even in place of aspects of the SGM's current arrangements. A non-exhaustive list of these developments and their relevance to SAF accounting in Australia is outlined in Table 2 below.

Table 2. Overview of policy in development and its relevance to SAF accounting

POLICY INITIATIVE	DESCRIPTION	RELEVANCE TO SAF ACCOUNTING IN AUSTRALIA
AUSTRALIA'S NET ZERO PLAN AND SIX SECTOR DECARBONISATION PLAN	The Net Zero Plan reflects Australia's commitment under the Paris agreement to develop a new medium-term emissions reduction target for 2035, while also ensuring adequate arrangements to reach net zero by 2050. In September 2024 the Climate Change Authority advised the government on specific sector pathways, outlining technology opportunities for decarbonising different areas of the economy. Their second piece of advice, advising on a suitable 2035 target, is yet to be released and will include consideration of the role of domestic and	One of the six sectoral decarbonisation plans to inform the Net Zero Plan will be the Transport and Infrastructure Net Zero Roadmap and Action Plan. Its development provides a strategic opportunity to account for the aviation sector's interests, including opportunities and barriers for SAF benefits to be accounted for in the Australian system. The paper explicitly

[5] An example of this Avelia – a blockchain powered digital SAF book and claim solution jointly launched by Shell, Accenture, American Express Global Business Travel (Amex GBT) and Energy Web Foundation.

[6] An example of this may be RSB's book and claim programme, which includes the RSB Book & Claim Manual (normative procedure), the RSB Registry (digital data storage system), and the RSB Book & Claim Recognition Framework (normative procedure for a registry ecosystem).

[16] DCCEEW status of the Australian Governments Net Zero Plan.

POLICY INITIATIVE	DESCRIPTION	RELEVANCE TO SAF ACCOUNTING IN AUSTRALIA
	international carbon markets, and Australia's position on Article 6 transfers.[16]	states there is no focus on international aviation emissions.
Aviation White Paper	The Aviation White Paper will set the long-term policies to guide the next generation of growth and innovation in the aviation sector. Four specific areas were identified by the Government when announcing the White Paper, one of which includes maximising the aviation sector's contribution to achieving net zero carbon emissions, including through SAF and emerging technologies.	Like the Net Zero Plan and Transport and Infrastructure Net Zero Roadmap and Action Plan, the Aviation White Paper presents an opportunity for sector-specific needs to be accounted for, such as the benefits of a market-based approach to account for SAF use in Australia's domestic aviation.
Guarantee of Origin Scheme	The Guarantee of Origin scheme was passed in December 2024 and is expected to be operational by the second half of 2025. The scheme is designed to be a product-based emissions accounting framework that measures and tracks emissions and associated information across the value chain. It will set the foundation for creation of and participation in new markets by providing a streamlined process for reporting emissions information based on robust internationally aligned emissions accounting methodologies. It will enable producers to make credible low emissions claims about their products, unlocking opportunities for trade, decarbonisation and investment.	While it currently has a hydrogen and renewable energy focus, the Guarantee of Origin scheme is intended to cover other lower-carbon commodities such as SAF in due course, which may allow for market-based approaches for SAF in an Australian system, similar to how the Renewable Energy Target has supported trading of renewable energy certificates to decarbonise Australia's national electricity market. Depending on the export potential for Australian SAF, it may consider international trading of SAF environmental benefits.
Safeguard Review in 2026/2027	The Government will review SGM policy settings in 2026-27, to ensure they are appropriately calibrated. The review will consider, among other things, the initial impacts of resetting and declining baselines, including the costs and availability of domestic offsets; the appropriate treatment of international units; the suitability of arrangements for emissions-intensive, trade-exposed activities; whether the cost containment measure is sufficient; and treatment of flexibility mechanisms beyond 2030.	This process will likely be the earliest the Government will consider the potential role of a book and claim mechanism for facilities covered by the SGM.
NATIONAL GREENHOUSE AND ENERGY REPORTING	In late 2023 the Climate Change Authority (CCA) finalised their legislated review of the NGER legislation to ensure it is fit-for-purpose. As of July 2024, the government has introduced market-based reporting for renewable liquid fuels under the NGER measurement determination. In addition, the government has	Implementing these recommendations would allow for the approval of certifications that can guarantee the renewable status of renewable liquid and gaseous fuels, allowing for a market-based reporting method for SAF within

POLICY INITIATIVE	DESCRIPTION	RELEVANCE TO SAF ACCOUNTING IN AUSTRALIA
(NGER) REVIEW OUTCOMES.[7]	agreed on the importance of certifications that verify the renewable status of both liquid and gaseous fuels. To support this phase, the government has committed $20.9 million over four years for its implementation.	the Australian domestic context via NGER, and subsequently the SGM. It will be important to follow Government's actions post their initial response to the recommendations..[8]

[7] In Late 2023 the Climate Change Authority finalised their legislated review of NGER, requiring specific outcomes by the Australian Government.

[8] In the Australian Government's response to the CCA's 2023 NGER review regarding renewable fuel accounting, the Government noted they '*will consider how best to make improvements in this area including through opportunities to leverage existing international certification schemes and best practice, recognising the importance of incentivising the purchase of low carbon fuels, particularly for facilities covered by the Safeguard Mechanism*'.

INDUSTRY PERSPECTIVES ON SAF POLICY IN AUSTRALIA

The Sustainable Aviation Fuel Alliance of Australia and New Zealand (SAFAANZ) is an aviation industry body that facilitates collaboration to advance SAF production, policy, education and marketing in Australia and New Zealand.

Key insights relating to SAF policy in Australia obtained through consultation with industry members facilitated by SAFAANZ, and led by Virgin Australia and Boeing, include[9]:

- Industry sees a strong need for greater policy certainty and support with respect to SAF, including establishment of clear demand signals through mandates and/or government co-investment in SAF production.
- Book and claim is viewed by the majority of SAFAANZ members as the accounting approach that is best able to deliver optimal outcomes. Key reasons for this include:
    - its ability to reduce the costs of accessing SAF;
    - the ease of tracking custody of SAF and associated environmental attributes through a book and claim model; and
    - the fact that it reduces the physical infrastructure needed to support uptake of SAF across the industry.
- Many survey respondents consider that a book and claim system, if introduced in Australia, should apply to both domestic and international SAF purchases.
- While establishment of an international book and claim system can support the development of a SAF production industry in Australia, this also requires clear domestic policy incentives. In addition, it would be critical for other governments to recognise and adopt this system for Australian SAF producers to benefit.

[9] This consultation included a series of discussion papers and associated workshops in 2024 to explore industry views on the benefits and risks of different SAF accounting approaches and potential regulatory changes required to accommodate accounting for SAF based on the perspectives and experiences of SAFAANZ members. The insights expressed here are not exhaustive and represent a summary of some of the key findings of this process that are relevant to this report.

2. ACCOUNTING FOR SAF USE UNDER EXISTING EMISSIONS ACCOUNTING REGIMES

KEY TAKEAWAYS

- Australia's National Greenhouse and Energy Reporting (NGER) scheme and Safeguard Mechanism (SGM) framework do not currently enable Australian airlines to claim SAF used on international flights as emissions reductions for the purposes of their reported GHG inventories.
- Purchases of neat SAF are typically reported separately in corporate climate-related disclosures (e.g. to demonstrate progress against voluntary SAF procurement targets).
- Integration of a market-based method for SAF accounting into existing regulatory frameworks, utilising the book and claim model, could enable accelerated uptake of SAF to support the decarbonisation of the aviation sector.

Two main GHG reporting 'frameworks' exist that are relevant to SAF accounting in Australia:

1. The Australian Government's GHG reporting framework, which is used to track progress against international emissions reduction targets and inform policy development. This framework draws from mandatory corporate ('facility') reporting as well as different data and information.
2. Corporate climate change and sustainability reporting (which has historically allowed more flexibility in approach and methodology, but is becoming increasingly regulated).

Given the separate functions and end-use for these frameworks, it is useful to unpack how each operates and their strengths and limitations, while taking into account their interaction with SAF.

2.1 Australia's National Greenhouse Gas Inventory and the role of the National Greenhouse and Energy Reporting (NGER) scheme

In support of Australia's international emissions reduction obligations, Australia has built a well-renowned national GHG inventory. At its core, it allows Australia to track progress against its international emissions reduction targets and informs policy development. Australia's national inventory is consistent with the IPCC Guidelines for National Greenhouse Gas Inventories (IPCC Guidelines), which do not currently enable countries to include emissions data for activities which have actually occurred outside of the national territory in their national inventories (to avoid the double counting of emissions in two different national inventory sectors).

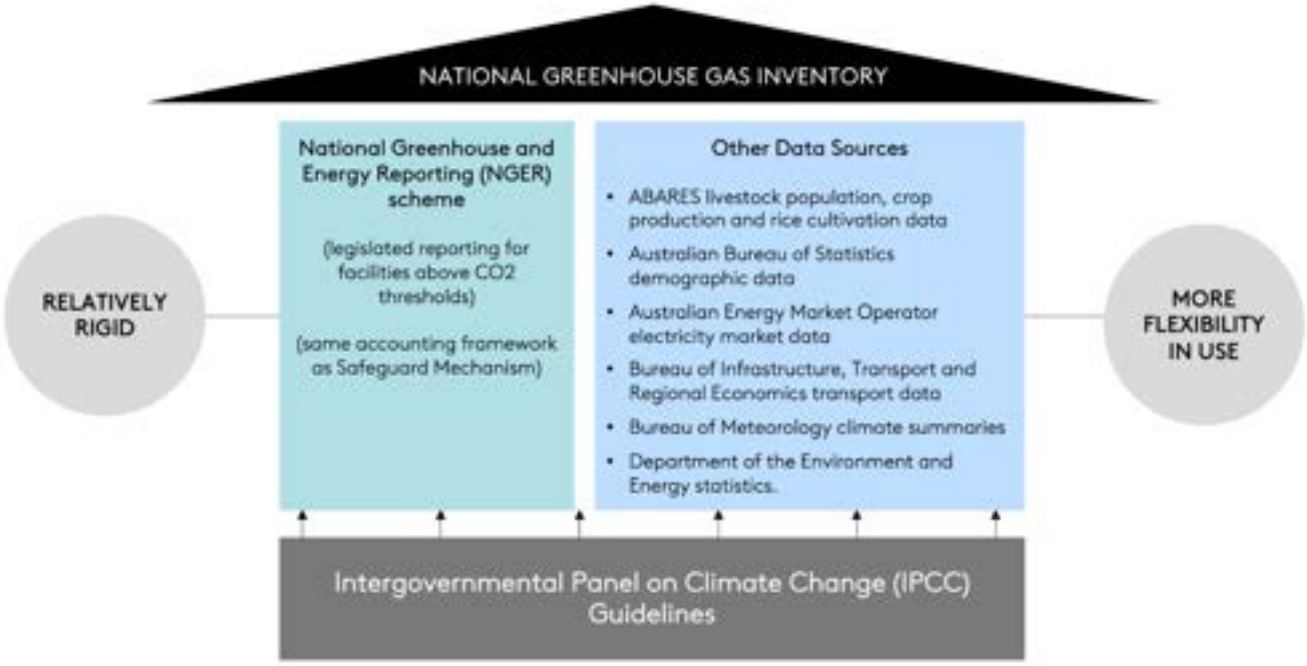
Australia's national inventory builds an estimate of Australia's direct (scope 1) emissions using a range of methodologies, legislated approaches, and data and intelligence sources. Consistent with international best practice, the inventory undergoes continuous improvement to build a more accurate depiction of Australia's GHG accounts.

2.1.1 Function of NGER and current SAF reporting requirements

Australia's NGER scheme feeds into Australia's national GHG inventory and ultimately inform progress against Australia's international emissions reduction targets. See Figure 2 below.

In 2023, the NGER scheme's emissions measurement requirements[10] were revised to allow reporting entities to account for some types of SAF that has been combusted as a fuel (scope 1 emissions), providing a zero carbon emissions factor, which is consistent with international accounting, in recognising biogenic feedstock for SAF as having a short carbon cycle and thus being considered renewable.[11]

Figure 2. Australia's National Greenhouse Gas Inventory Framework



[10] National Greenhouse and Energy Reporting (Measurement) Determination 2008

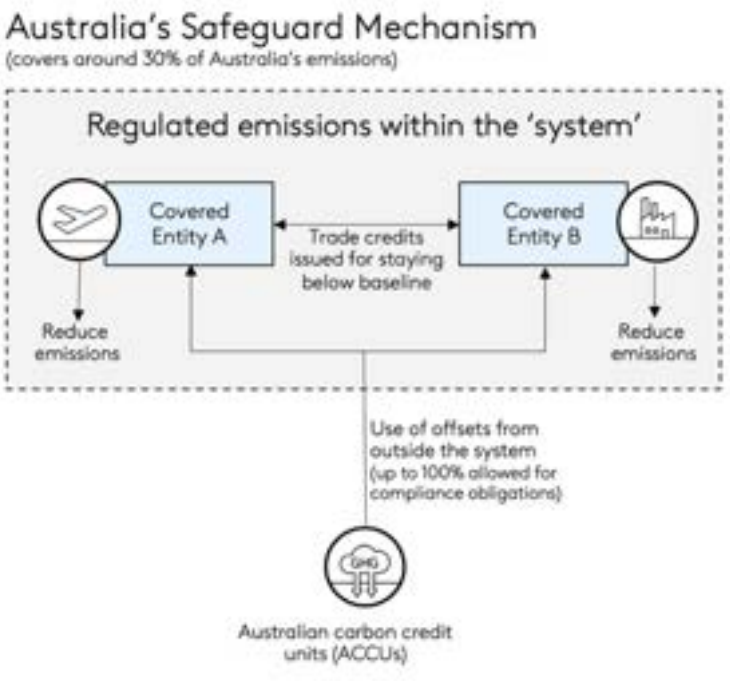
[11] The IPCC distinguishes biogenic fuels from fossil fuels by the time taken for their formation, which are months-to-years for biogenic fuels (short carbon cycle), and millions of years for fossil fuels (long carbon cycle)

Australia's baseline and credit compliance regime – the Safeguard Mechanism

Part of the NGER legislation includes an objective to contribute to Australia's international emissions reduction targets. It does this through the SGM, which is effectively a baseline and credit program covering around 30 per cent of Australia's emissions.

The SGM was reformed through legislative amendments in 2023, to require over 200 high emitting facilities (who are reporting more than 100,000 tonnes CO2-e scope 1 emissions p.a.[12]) to reduce their net scope 1 emissions by around 4.9 per cent per annum out to 2030. Interplay between emissions accounting frameworks

Figure 3. Australia's Safeguard Mechanism



Australia's SGM architecture rests within and relies on the NGER emissions reporting framework. There is no separate emissions reporting for SGM covered entities – instead, the SGM uses NGER reported emissions to calculate the SGM facility 'baseline', which then informs annual net emissions requirements as well as the creation of SMCs. SMCs are achieved by reducing emissions below the baseline and can be traded to other SGM entities and used in the same way as ACCUs to meet compliance obligations.

The gross emissions of SGM entities (before use of ACCUs or SMCs) informs Australia's annual National Greenhouse Gas Inventory as outlined above. In turn this is used in Australia's international reporting of its emissions reduction commitments via the UNFCCC. Because the NGER framework informs Australia's international reporting obligations, its GHG estimation methodologies are based on international guidelines (see Figure 3), and as such NGER and SGM entities are reporting in line with accounting approaches that are Paris-compliant.

2.2 Overview of corporate GHG accounting methodologies for SAF use

Corporate reporting methodologies allow companies to identify material areas of the business in relation to GHG emissions (across scopes 1, 2 and 3), which can inform strategies to manage and reduce emissions. As a result, corporate emissions inventories have a different purpose and function to national GHG inventories, which seek to provide holistic overview of emission sources and sinks across the various sectors of the economy.

This also means that GHG inventory accounting methodologies can be (and have been) developed to reflect different corporate circumstances and objectives. For example, SAF Book and Claim models have primarily been developed for use in a voluntary corporate reporting context to enable corporate customers of airlines to 'claim' SAF used by the supplier airline as a reduction in their scope 3 emissions profile. This allows companies that choose to invest in the (currently) more expensive option of SAF-powered flights to have that contribution recognised in their scope 3 reporting.

Many airlines voluntarily report their scope 1, 2 and 3 emissions. With regards to SAF, the GHGP requires that emissions data for direct CO_2 emissions from the burning of biomass/biofuels be reported separately from scope 1,

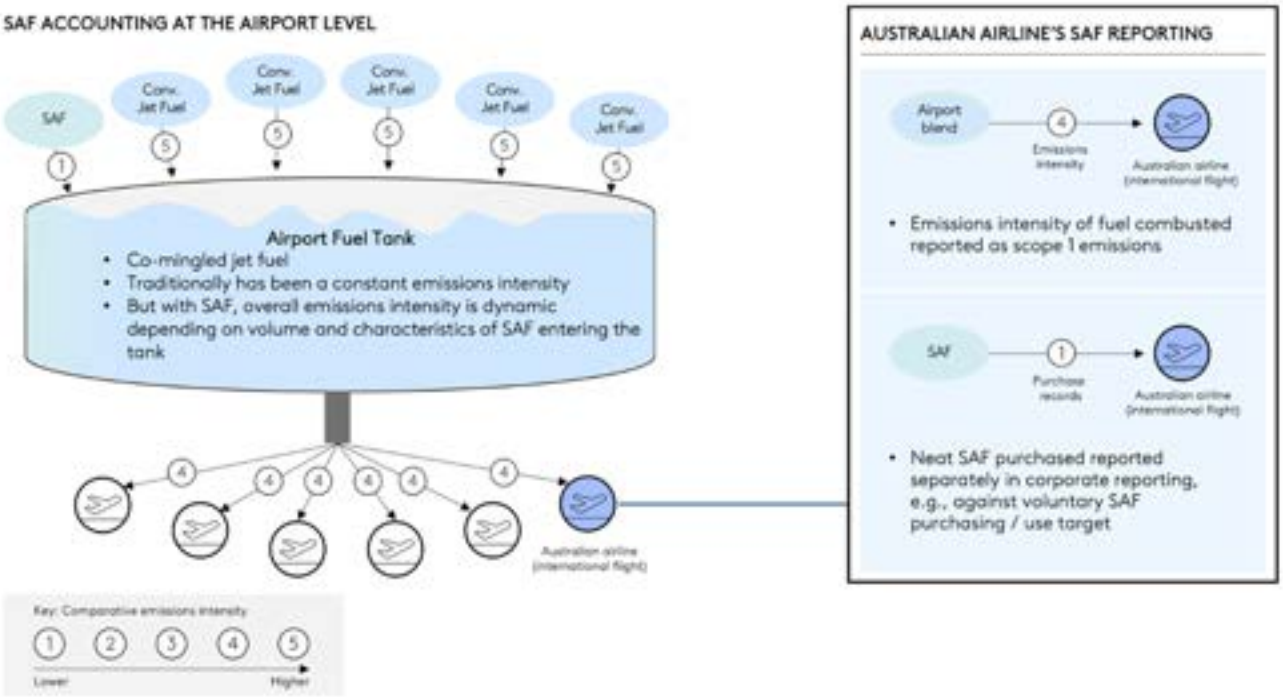
[12] The SGM's coverage excludes scope 1 emissions from electricity production facilities feeding into the electricity market.

2 and 3 emissions.[13] However, airlines may report SAF use against voluntary SAF sourcing/use targets to demonstrate the airline's contribution to the development of the SAF industry and the broader decarbonisation of the aviation sector.

There are still complexities in how the environmental attributes of neat SAF (particularly when unbundled from its physical use) are accounted for in the achievement of scope 1 emissions reduction targets (as opposed to SAF purchasing/sourcing targets).[14] While work has been done at the international level to standardise corporate reporting of the environmental attributes of neat SAF,[15] this is yet to be fully realised in international best practice guidelines and standards. The GHGP is based on inventory accounting methods using a physical or average-based accounting approach for scope 1 and scope 3 emissions. Market-based accounting approaches are not included (though this is currently being reviewed[16]).

One way to examine the interaction between these accounting frameworks is to examine what occurs at an international airport where SAF uptake is currently occurring, as shown in Figure 4. We have used the example of an Australian airline's SAF purchase and supply through an international airport (given there is no current supply of SAF in any Australian domestic airports).

Figure 4. Case study of current SAF accounting and reporting



[13] Greenhouse Gas Protocol. Corporate Standard, page 63

[14] Neat SAF refers to SAF in its pure, unblended form, before it is mixed with conventional jet fuel.

[15] World Economic Forum. October 2022. Sustainable Aviation Fuel Certificate (SAFc) Emissions Accounting and Reporting Guidelines: White Paper

[16] Greenhouse Gas Protocol. Survey on Need and Scope for Updates or Additional Guidance: Market-based Accounting Approaches Survey Memo, page 2

PART 2

Addressing the SAF challenge through a market-based accounting approach

3. INTRODUCTION

As outlined in Part 1, the relatively diverse and evolving web of GHG accounting and reporting arrangements between countries, emitting facilities and supply chains indicates there are no 'easy' solutions for a new SAF accounting approach at the country level that recognises SAF used overseas in Australia's GHG reporting and compliance systems.

Notwithstanding, it is worth exploring how SAF benefits could be more broadly recognised through market-based approaches either: during the compilation of GHG accounts; or in subsequent adjustments to accounts through policy that supports eligible transfers, offsets and units to treat surplus emissions. In Australia's context this is through the NGER arrangements or the Safeguard Mechanism's policy framework.

Part 2 of this paper explores a theoretical pathway to attribute SAF consumed outside of Australia's GHG boundary against scope 1 emissions for Australian airlines. This pathway would involve enabling SAF purchases (regardless of location) to reflect direct scope 1 emissions accounts. This would be through how Australia's national inventory operates, as well as how other countries who are producing and combusting the SAF.

4. ACCOUNTING FOR SAF BENEFITS IN SCOPE 1 EMISSIONS BASED ON SAF PURCHASED

KEY TAKEAWAYS

- The NGER scheme allows airlines to report renewable aviation fuel as an eligible fuel with zero CO2 scope 1 emissions. However, this is limited only to the fuel directly consumed by the airline (i.e. consistent with a 'physical segregation' accounting approach).
- To account for SAF via a market-based approach, it may be necessary to establish international agreements, consider how to leverage emissions accounting frameworks under the IPCC and/or Paris Agreement, amend national GHG inventories and legislation, and determine if a unified international accounting system is needed.
- When considering a market-based approach to SAF accounting, corporate Scope 3 reporting, traceability, bankability, and alignment with other market-based and certification schemes should be investigated to ensure feasibility and credibility of the proposed approach.

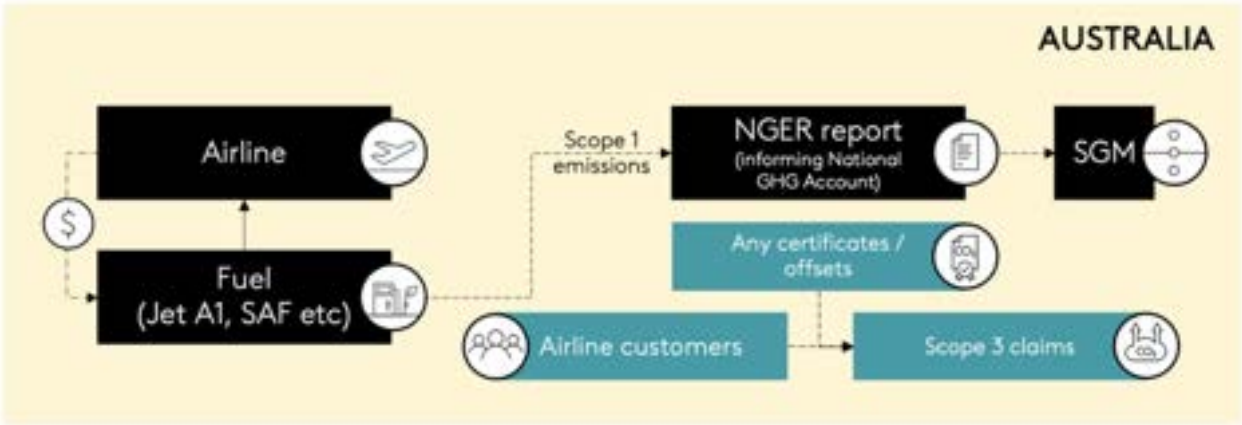
4.1 How do national GHG inventories currently account for SAF and what would need to change?

As outlined in Section 2, the IPCC guidelines set out the methodology for compiling national GHG inventories, with the particular way countries meet those requirements left to respective countries to decide. In essence, scope 1 emissions reflect sources and sinks of GHG emissions that have physically occurred within the country during the relevant reporting year.

In Australia, the NGER scheme is used to estimate scope 1 emissions for a large portion of Australia's emissions, including aviation. It is based on mandatory reporting from responsible companies who are required to follow methodologies in NGER that are consistent with IPCC guidelines.

For GHG accounting from SAF use, Australia's NGER scheme now allows airlines to report renewable aviation fuel as a fuel type, which in effect provides a zero CO_2 scope 1 emission for eligible fuel that is consumed by the airline. A simplified overview of the current approach is represented in Figure 5, below.

Figure 5. How domestic emissions from aviation fuel are currently reported in NGER



The NGER scheme currently allows for the emissions intensity of aviation fuel to be based on manufacturer specifications or on direct sampling for the fuel that is provided to the aircraft[17,18]. However, there are limitations in these options as they don't adequately reflect the shared nature of aviation fuel, with fuel infrastructure at airports being shared by all airlines due to no ability for fuel suppliers to supply directly to each airline.

Other countries that are party to the Paris Agreement can develop their own approaches to account for aviation fuel emissions, in line with the IPCC guidelines. For instance, in the United States the national GHG inventory estimates aviation fuel through a modelled approach using the Federal Aviation Administration (FAA) Aviation Environmental Design Tool (AEDT)[19]

For GHG accounting of SAF use to take a market-based approach and align with fuel purchased rather than fuel consumed, Figure 6 sets out the intended outcome of a market-based accounting approach. In summary the approach would provide arrangements for:

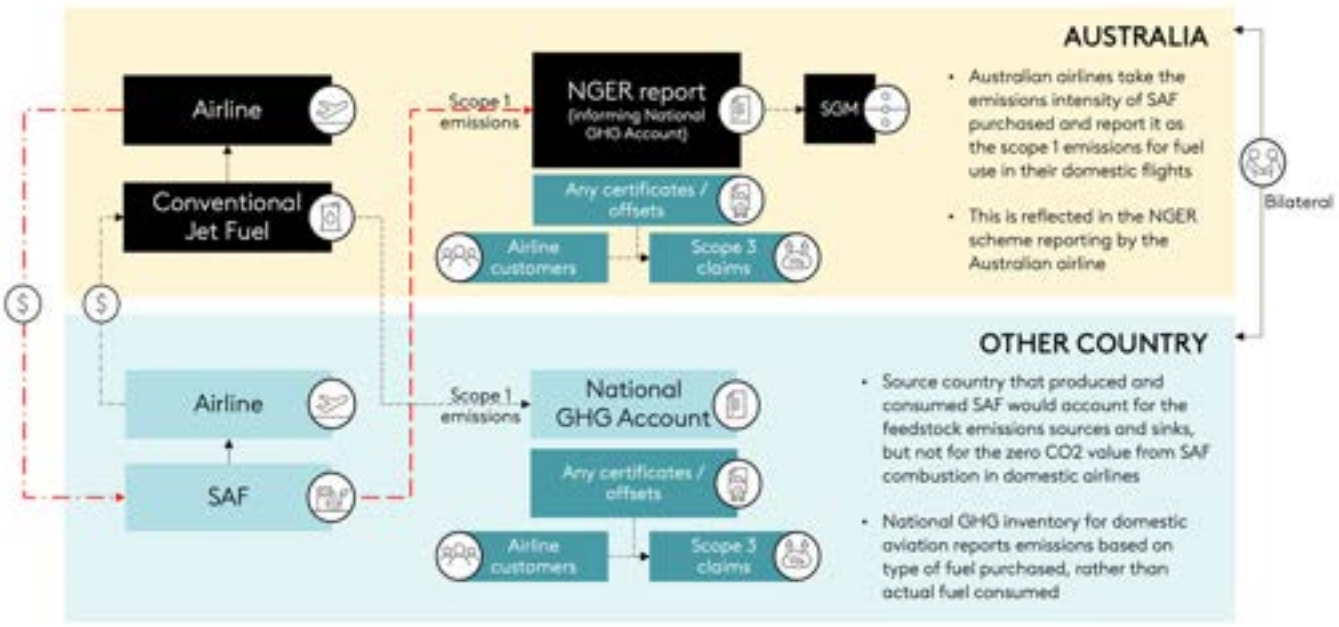
- Australian airlines buying SAF entering supply chains overseas would be able to use the emissions intensity of the SAF purchased and report as the scope 1 emissions for fuel use in their domestic flights.
- This would be reflected in the NGER scheme reporting by the Australian airline directly impacting the scope 1 emissions associated with the airlines coverage under the Safeguard Mechanism. It would also flow through to Australia's GHG accounts and international emissions reduction targets.
- The country that has produced and consumed the SAF would account for the feedstock emissions sources and sinks, but could not account for the zero CO_2 value from SAF combustion in its domestic airlines as this would result in double counting.
- Instead, the national GHG inventory for domestic aviation in other countries would have to report emissions based on type of fuel purchased, rather than the actual fuel consumed.

[17] The NGER scheme's methodology for jet fuel accounting is in accordance with the Tier 2 methodology set out in the 2006 IPCC Guidelines.

[18] As outlined by DCCEEW in assisting the Climate Change Authority undertake their legislative review of the NGER scheme in 2023

[19] The AEDT is a bottom-up accounting approach in accordance with the Tier 3B method from the 2006 IPCC Guidance.

Figure 6. A market-based GHG accounting approach for aviation fuel emissions in Australia's inventory



4.2 Next steps to facilitate SAF scope 1 accounting based on fuel purchased

To base Scope 1 emissions from aviation fuel in Australia's NGER scheme on overseas fuel purchases and consumption, rather than on fuel used by airlines, structural and policy changes are needed at both international and national levels. These changes are not insignificant, and would require structured and dedicated coordination between the Australian government and participating partner countries, as well as potential revisions to international emissions accounting guidance.

Opportunities may exist to leverage, build on or learn from the existing initiatives and examples outlined in Table 3 below to progress key enablers of this approach.

Table 3. Core considerations for accounting for SAF scope 1 emissions via purchasing arrangements

BILATERAL OR MULTILATERAL AGREEMENTS BETWEEN PARTICIPATING COUNTRIES	
This could involve the establishment of an MOU or a multi-party agreement to establish a shared vision for establishing an alternative approach to accounting for GHG emissions in domestic aviation. This agreement would likely set the bounds and intended outcomes for which national-level GHG inventories and other systems could be revised in order to accommodate the new approach for estimating domestic aviation emissions.	Existing initiatives and related examples • There do not appear to be any existing bilateral agreements that focus specifically on aligned implementation of a book and claim mechanism for SAF accounting. However, several SAF-focused partnerships have been implemented between countries that could provide a basis for progressing such policy alignment. • For example, Singapore's Green Economy Agreement with Australia includes an annexure on sustainable aviation cooperation, specifying a focus on knowledge exchange relating to relevant policy positions and regulatory mechanisms. • The Australia-United States Climate, Critical Minerals and Clean Energy Transformation Compact (signed in 2023) also includes commitments to establish information sharing exchanges on economy-wide emissions accounting schemes for products like hydrogen and SAF.

INTERNATIONAL EMISSIONS FRAMEWORKS	
Given the physical accounting boundaries (i.e. country boundaries) in the IPCC guidance for national GHG inventories, clarification as to whether attributing scope 1 emissions from aviation fuel use to purchase records rather than actual fuel consumed is consistent with the Guidelines would be beneficial for countries seeking to participate in an international book and claim system.	Existing initiatives and related examples • The most recent refinements to the IPCC Guidelines were implemented in 2019, with the seventh assessment cycle formally beginning in 2023 and expected to be published late 2029.[20] As part of this cycle, the IPCC Task Force on National Greenhouse Gas Inventories has been tasked with developing a new methodology for estimation of net GHG emissions from carbon dioxide removal technologies, which may address some of the issues identified in this paper (including the interaction between different national GHG inventories under a book and claim system for SAF).[21] • There may also be merit in exploring whether there is a pathway under the Paris Agreement emissions accounting frameworks to enable adjustments to national inventories to account for SAF used in international flights (i.e. akin to corresponding adjustments for the transfer of carbon credits between countries under Article 6).

20 IPCC Seventh Assessment Report.

21 The Task Force on National Greenhouse Gas Inventories.

AMENDMENTS TO AUSTRALIA'S GHG INVENTORY AND NGER LEGISLATION

The NGER legislation for which airlines report their scope 1 emissions would need to accommodate a market-based approach for attributing aviation fuel-related emissions to fuel purchased, rather than fuel consumed (i.e. by allowing for a book and claim approach).

Further, given SAF is a form of a renewable or biofuel, broader considerations would need to be given to whether Australia's national inventory adopts a widespread approach for accounting for scope 1 emissions associated with biofuels, or whether there is sound logic to contain it to aviation fuel use.

Any changes to Australia's GHG inventory and NGER methodologies will ultimately be contained to what Australia determines is consistent with IPCC Guidance.

Existing initiatives and related examples

- In July 2024, amendments to the NGER framework were introduced to allow for market-based accounting approaches for renewable fuels.
- The Australian government will progress work in 2025 to develop a framework to approve certifications that can guarantee the renewable status of renewable liquid and gaseous fuels, including for the purposes of NGER reporting. This framework will be informed by a review of existing international certification schemes.

AMENDMENTS TO OTHER PARTICIPATING COUNTRIES' GHG INVENTORY AND LEGISLATION

The countries in which SAF is being produced and consumed for domestic aviation would need to adopt approaches in their GHG inventory to ensure the SAF that Australian domestic aviation is attributing in its account is not being double counted. Double counting could occur if the country maintained a physical consumption-based GHG accounting methodology linked to aviation fuel consumed, as it would also capture Australia counting the same fuel.

Existing initiatives and related examples

- This would require direct bilateral coordination between Australia and the relevant partner country. To date, no such initiatives have been publicly disclosed.

WHETHER THE APPROACH NEEDS TO BE CONTAINED WITHIN A SINGLE 'SYSTEM'

Similar to how CORSIA operates under a common methodology and shared parent GHG account for all of international aviation, it may be that for accounting integrity and to avoid double claiming and GHG 'leakage', that a singular system needs to be created.

This could mean that all domestic aviation emissions within participating countries GHG inventories would have to adopt the same market-based methodology, and it could also mean that fuel supply chains (whether providing SAF or traditional aviation fuel) within participating countries may need to have a clear block-chain system developed in order to ensure traceability, consistency and standardisation.

Existing initiatives and related examples

- The European Commission is exploring the feasibility of integrating a harmonised book-and-claim system as a transitional mechanism across member states to support the ReFuelEU Aviation regulation.
- IATA has recently released its new SAF accounting and reporting methodology - an important step in the preparation of the IATA SAF Registry, which is scheduled to launch in April 2025. The IATA methodology is intended to provide a consistent approach to accounting for the environmental benefits of SAF purchases, regardless of location. The methodology recommends "purchase-based calculation" of emissions reductions associated with SAF use for global consistency and simplicity, irrespective of chain-of-custody used and SAF uplift locations.

4.3 Other considerations

- Corporate scope 3 reporting – the market-based approach proposed is limited to national GHG inventories and accounting. Within participating countries there may be corporates with their own GHG accounts looking to report and mitigate their scope 3 emissions attributed to domestic aviation. Industry should consider advocating for clearer guidance from international standards bodies to enable an approach that ensures the corporate claims and GHG accounts are safeguarded against false or misleading information or double counting, and are not in breach of mandatory climate disclosures. However, this is not the focus of this paper.
- Traceability – participating countries, including Australia, would likely be significantly interested in ensuring SAF purchased actually exists, has only been purchased once, and has been consumed. Similar to Australia's product-based Guarantee of Origin scheme currently in development, it could adopt a certification approach; whether that certification extends beyond Australia's borders would need to be considered, as jurisdictionally Australia would have limited compliance and enforcement for assessing validity of participants outside of Australia.
- Bankability – unlike carbon credits which are generally bankable and can be subsequently traded over extended periods, a market-based approach for aviation fuel that is informing a national GHG account would need to be temporally contained to the emissions reporting period (for national GHG inventories this is annual). Therefore an airline would not be able to purchase and claim bulk SAF supply that extends beyond the reporting period in which it was purchased.
- Alignment with other market-based and certification schemes – as there is considerable ongoing development within the corporate greenhouse gas reporting space for SAF and market-based approaches for accounting, it is worth exploring whether alignment can be reached between government (country) and corporate GHG inventories. This includes international standards and accounting frameworks. The Australian Government's independent Climate Change Authority (CCA)

provided recommendations to the Government in its legislative review of the NGER scheme in 2023, relating to market-based accounting for renewable fuel as detailed in Section 1.

5. WHERE TO FROM HERE?

Enabling an international book and claim accounting model for SAF can be an important enabler to accelerating aviation sector decarbonisation and driving global SAF market growth. Without such a mechanism, airlines are constrained by local SAF availability, limiting their ability to invest in and scale production where it is most viable. A well-designed book-and-claim system would allow emissions reductions from SAF use to be credibly accounted for, regardless of where the fuel is physically consumed, ensuring broader adoption and investment while maintaining environmental integrity.

Complex challenges remain, including integrating book-and-claim into compliance markets, preventing double counting across national inventories, and aligning with Article 6 of the Paris Agreement. To enable this transition, industry and policymakers should focus their immediate efforts on a number of priorities:

1. Establishing bilateral or multilateral "green lanes" to facilitate trade in SAF via a book and claim system between countries that are likely to be key producers and consumers of SAF. This requires alignment on emissions accounting methods instruments and integration national policy frameworks by participating countries. Examples of countries that may be prospective green lane partners for Australia include Singapore, New Zealand, the United States and Pacific Island nations.
2. Ensuring that developments in SAF policy frameworks and corporate emissions accounting methods are closely aligned with, and leverage wherever possible, work being progressed by IATA and ICAO on these issues, including the recently released IATA SAF accounting methodology and impending SAF registry. This will support development of globally standardised approaches to SAF accounting, thereby paving the way for a well-functioning international book and claim system. In contrast, ongoing fragmentation between markets and industry actors will hinder the introduction of such a model, potentially delaying decarbonisation of the sector as a result.

Participants in the SAF value chain can play a leading role in driving this agenda forward, including through the work of the Jet Zero Council, by advocating for regulatory reforms, participating in pilot programs, and collaborating with policymakers to build a scalable, transparent framework that supports both emissions reductions and industry growth in Australia and abroad.

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