SCIENCE BASED TARGETS

DRIVING AMBITIOUS CORPORATE CLIMATE ACTION

Evidence Synthesis Report Part 2: Environmental Attribute Certificates – Fuels

A synthesis of the relevant evidence on environmental attribute certificates for fuels submitted to the Science Based Targets initiative during the 2023 call for evidence on the effectiveness of environmental attribute certificates in corporate climate targets.

Version 1.0

March 2025

sciencebasedtargets.org /science-based-targets @sciencetargets info@sciencebasedtargets.org

ABOUT SBTi

The Science Based Targets initiative (SBTi) is a corporate climate action organization that enables companies and financial institutions worldwide to play their part in combating the climate crisis.

We develop standards, tools and guidance which allow companies to set greenhouse gas (GHG) emissions reductions targets in line with what is needed to keep global heating below catastrophic levels and reach net-zero by 2050 at latest.

The SBTi is incorporated as a UK charity, with a subsidiary SBTi Services Limited, which hosts our target validation services. Partner organizations who facilitated SBTi's growth and development are CDP, the United Nations Global Compact, the We Mean Business Coalition, the World Resources Institute (WRI), and the World Wide Fund for Nature (WWF).

CONTENTS

ACRONYMS AND ABBREVIATIONS

Acronym	Description
ATAG	Air Transport Action Group
BCU	Book & Claim Unit
BTC	Blender's Tax Credit
CA LCFS	California Air Low-Carbon Fuel Standard
CoO	Certificates of Origin
CORSIA	Carbon Offsetting and Reduction Scheme for International Aviation
DENA	German Energy Agency
EAC	Environmental attribute certificate
EC	European Commission
EEI	Edison Electric Institute
ETS	Emissions Trading Scheme
EU RED	European Union Renewable Energy Directive
GGCS	Green Gas Certification Scheme
GGSS	Green Gas Support Scheme
GHG	Greenhouse gas
GHGP	Greenhouse Gas Protocol
GO	Guarantees of Origin
HBE	Renewable Energy Unit in Dutch Transport Market
HEFA	Hydrotreated esters and fatty acids
IATA	International Air Transport Association
ICAO	International Civil Aviation Organization
ILUC	Indirect land use change
IRA	Inflation Reduction Act
IRR	Internal rate of return
ISCC	International Sustainability & Carbon Certification
LETS	Low emission transport solutions

LFG	Landfill gas
M-RETS	Midwest Renewable Energy Tracking Systems
NDRHI	Non-Domestic Renewable Heat Incentive
RCF	Recycled carbon fuel
REC	Renewable Energy Certificate
RFNBO	Renewable fuels of non-biological origin
RFP	Request for proposal
RFS	Renewable Fuel Standard
RGGO	Renewable Gas Guarantees of Origin
RNG	Renewable natural gas
RSB	Roundtable on Sustainable Biomaterials
RTC	Renewable Thermal Certificate
RTFC	Renewable Transport Fuel Certificate
RTFO	Renewable Transport Fuel Obligation
SABA	Sustainable Aviation Buyers Alliance
SAF	Sustainable Aviation Fuel
SAFc	Sustainable Aviation Fuel Certificates
SBTi	Science Based Targets initiative
SCS	Sustainability Certification Scheme
SFC	Smart Freight Centre
WTT	Well-to-Tank

1. EVIDENCE QUANTIFICATION

Quantification overall

In total, 418 pieces of evidence were considered in the evidence review of EACs for fuels, electricity, and commodities. This total includes unique evidence submitted as part of a list or pack of evidence, referred to as “nested” evidence. These pieces of nested evidence were reviewed individually. Note that many pieces of evidence were submitted by multiple respondents, or submitted as both standalone evidence and a piece of nested evidence; these pieces of evidence have not been counted twice towards the total.

Of the evidence considered in this review, 220 pieces of evidence were labeled by the submitter as relevant to electricity, 190 relevant to fuels, and 44 relevant to commodities. Since some evidence was labeled as relevant to more than one type of EAC, the summed numbers in this paragraph do not equal the total number submitted. Following the evidence review, 181 pieces of evidence were determined to be relevant or partially relevant to the topic of electricity EACs, 150 relevant to fuels, and twenty-eight relevant to commodities. Some evidence was reviewed and determined to be relevant to topics other or additional to what it was originally labeled, and some was determined to not be relevant to EACs or the research questions considered in this review.

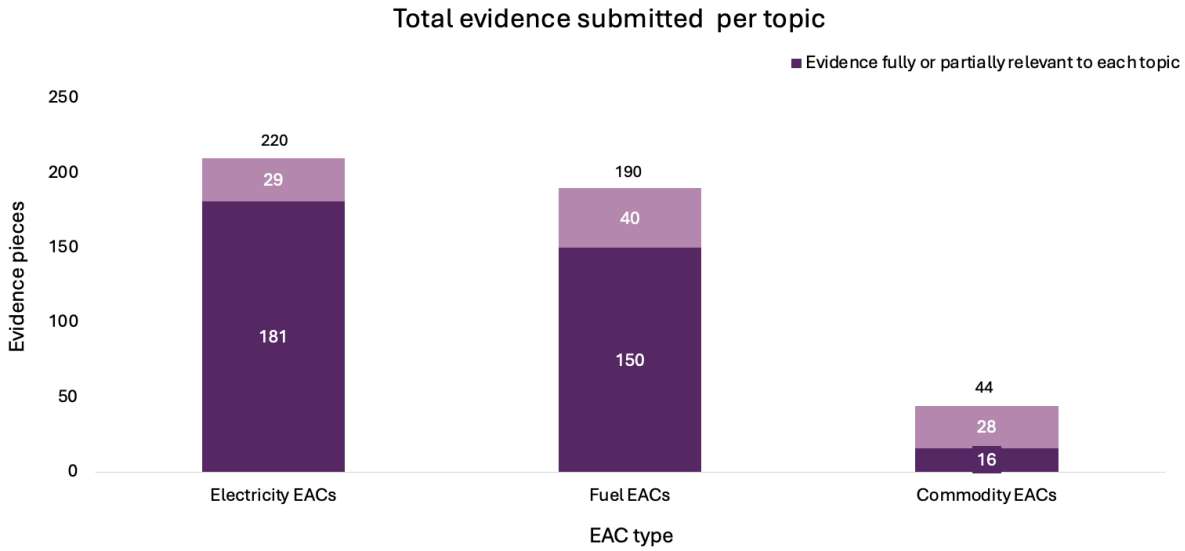

Figure 1: Overall data on evidence submitted to the call for evidence

Quantification per topic:

Of the 150 pieces of evidence assessed and deemed relevant/partially relevant for fuels, the most common type of evidence was a report or white paper (56 out of 150), followed by commentaries (27/150). The least common type of submission was a controlled research study (2/150).

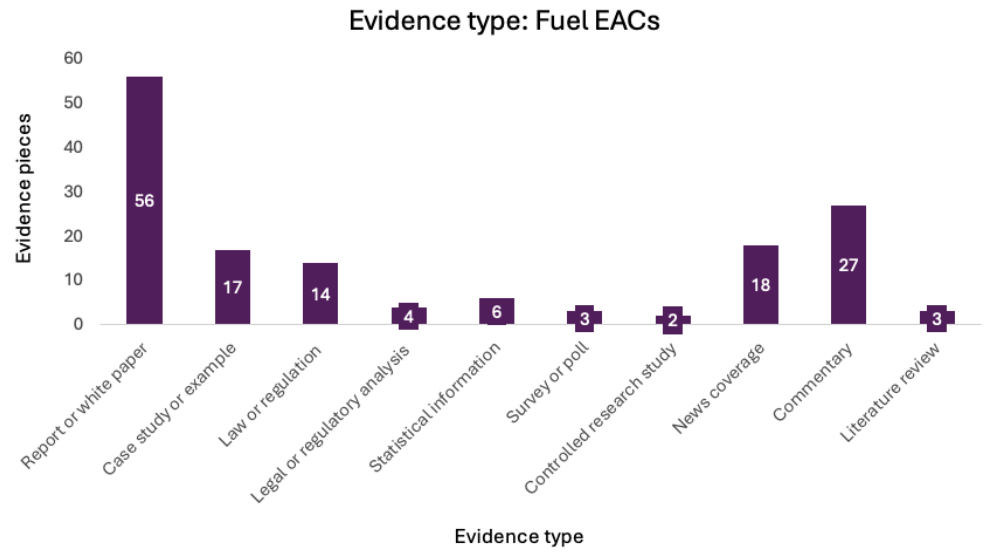

Figure 2: Number of pieces of evidence per evidence type (fuels)

Of the evidence assessed for its relevance towards fuels EACs, only one piece of evidence was designated as Tier A. Although several laws/regulations and peer-reviewed publications were submitted as evidence (and so were initially designated Tier A), generally the lack of relevance to four or more research questions resulted in these pieces of evidence being downgraded to Tier B or C. Please refer to SBTi's review methodology for more information on the Tier categorization.

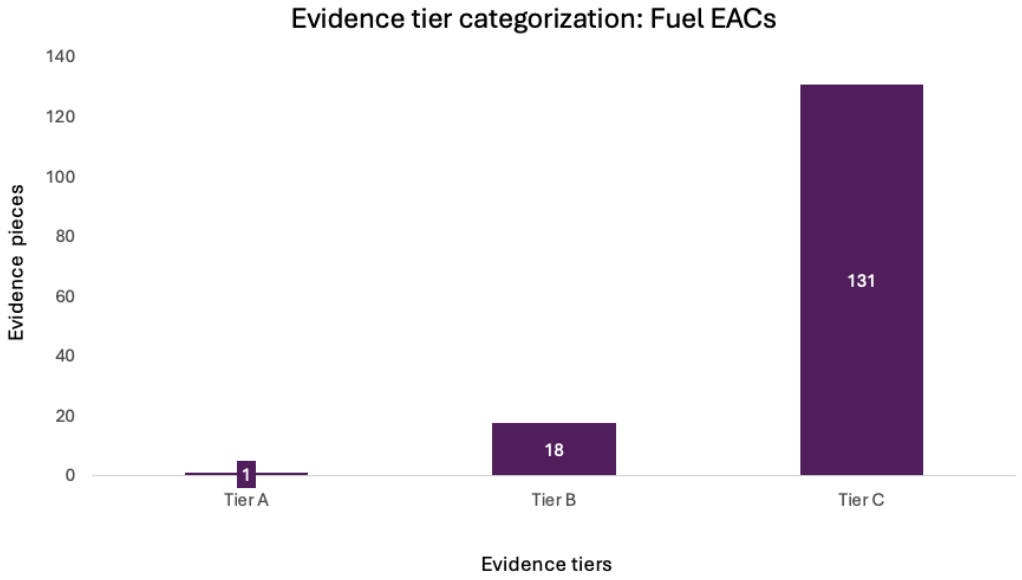

Figure 3: Number of pieces of evidence per evidence tier (fuels)

Each piece of evidence was assessed for its relevance towards the eight research questions. For the evidence assessed for fuels, over half of the evidence was deemed

relevant to Q1 (87/150) and/or Q3 (78/150). Q7 had the lowest number of relevant evidence (26/150).

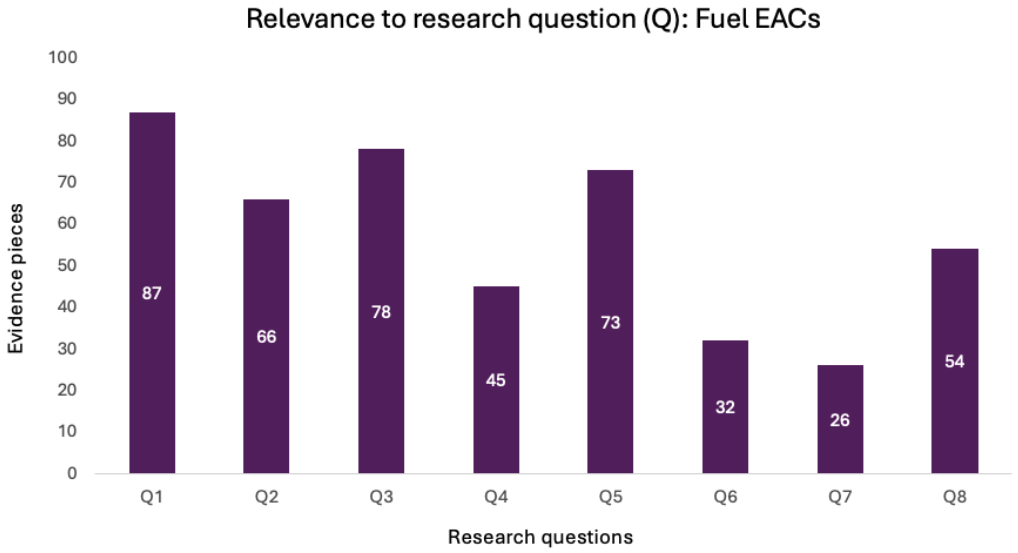

Figure 4: Number of pieces of evidence relevant to each research question (fuels)

A full table of the 150 pieces of evidence and their relevance to each research question is included in Annex A. A separate table of the evidence assessed under fuels and deemed not relevant to the research questions is also included in Annex A in Table 3.

2. KEY THEMES FOR EACs FOR FUELS

This section summarizes the key themes that emerged from the evidence. Note that this report does not exhaustively cover every point made by every piece of evidence; instead, selected relevant pieces of evidence have been quoted to highlight key points or to summarize topics addressed across multiple submissions. Moreover, italicized text in this report does not represent direct extracts from the evidence submissions but serves to aid understanding and interpretation of the findings.

The key topics from the evidence review are discussed here under six themes:

- **Theme 1** describes how low-carbon fuels are recognized as a way to enable lower emissions from the transport sector, and how EACs are used to represent the delivery of these fuels and emissions reductions relative to fossil fuels.
- **Theme 2** broadly covers the concept of whether fuels used to comply with policy targets should be used to generate EACs.
- **Theme 3** discusses how EACs drive the deployment of low-carbon fuel and improve revenue certainty.
- **Theme 4** considers how EACs are used to account for low-carbon fuels in commingled infrastructure systems, and whether EACs can address geographical mismatch between supply and demand.
- **Theme 5** presents a broad discussion of the safeguards and conditions suggested to ensure effectiveness of fuel EACs.
- **Theme 6** discusses the range of opinions on how fuel EACs should (or shouldn't) be claimed towards corporate GHG reporting.

3. EVIDENCE REVIEW

3.1 Theme 1: EACs are used to represent delivery of low-carbon fuel supply and reductions relative to fossil fuels

Research question related to this theme
Research question 1: What evidence exists about the effectiveness or ineffectiveness of environmental attribute certificates (EAC) in delivering measurable emission reductions?

Summary
Low-carbon fuels are recognized by many governments as a way to enable lower emissions from the transport sector. Governments in many jurisdictions have put in place policies to drive their uptake, in several cases requiring use of GHG emission calculation methodologies to ensure that emissions are below a threshold level, or to reward fuels based on the difference between their emissions and a fossil fuel baseline. These methodologies can lead to different lifecycle emissions due to different methodological choices. The lifecycle GHG intensity is also highly dependent on the feedstock and production pathway chosen.
Currently, fuel policies generally accept the separation of environmental attributes (i.e., the GHG intensity) from the physical input or products for certain parts of the low-carbon fuel supply chain, using a mass balance approach.
With these policies, EACs are used to represent either the delivery of products with a low GHG intensity, or the achievement of GHG emission reductions towards compliance targets, depending on the different regulatory regimes.
In the voluntary markets, companies are offering and participating in book and claim programs that provide EACs for low-carbon fuels, with most activities observed for sustainable aviation fuels (SAF), biomethane and some for low-carbon maritime fuels and road fuels. These programs use EACs to represent the delivery of fuels (e.g., 1 tonne of SAF that meets specific sustainability requirements), or relative emission reduction compared to a baseline, or both. Companies then use these to report lower scope 1 and 3 emissions than if fossil fuels were being used.
However, there is some skepticism towards EACs in the fuel market due to its nascency.

Detailed evidence

Low-carbon fuels are recognized by many governments as a way to enable lower emissions from the transport sector.

- Low-carbon fuels are those with lower GHG emissions on a lifecycle basis than fossil fuels. Methodologies have been established under regulation (e.g., European Union Renewable Energy Directive [E.U. RED], California Air Low Carbon Fuel Standard [CA LCFS], Carbon Offsetting and Reduction Scheme for International Aviation [CORSIA]) to calculate the lifecycle GHG emissions of low-carbon fuels per unit delivered (e.g., per MJ), and their relative emission reduction compared with fossil fuels (gCO_2e reduced per MJ fuel, or %) (253, Majer et al., 2021) [Tier C].
    - “Low-carbon fuels are recognised by the European Commission (EC) as a solution to reduce emissions compared to fossil fuels, and so The Renewable Energy

Directive (RED) sets targets on Member States to increase their use of low-carbon fuels" (155, European Commission, 2018) [Tier A].
    - Low-carbon fuels, particularly in the aviation industry, are "crucial to meet decarbonisation goals", as they have "limited decarbonising technologies" (013, Air Transport Action Group (ATAG), 2023) [Tier C].
- Methodologies to calculate the lifecycle GHG emission of low-carbon fuels use a combination of attributional and consequential approaches in evaluating the lifecycle emission of low-carbon fuels. These approaches are mostly attributional, but during their development some consequential aspects were introduced as a result of concerns on the wider system impacts, such as indirect land use change (ILUC) for biomass feedstocks, displacement of feedstocks, and avoided methane emissions (e.g., landfill gas). The intention behind using this consequential approach is to prevent policies from driving the uptake of fuels with indirect impacts that could reduce or outweigh their benefits. In some jurisdictions, such as the EU, the alternative was to restrict or ban some feedstocks (e.g., food/feed crops) rather than quantifying the impact in the GHG methodology (155, European Commission, 2018) [Tier A].
    - CORSIA methodology requires "SAF producers to calculate the total life cycle GHG emission values for a given SAF as the sum of the core LCA value and the ILUC value" (317, Roundtable on Sustainable Biomaterials (RSB), 2023) [Tier C]. The CORSIA Default Life Cycle Emissions include ILUC values for crop-based SAF (219, International Civil Aviation Organization (ICAO), 2022) [Tier B], (227, ISCC System GmbH, 2021) [Tier C].
    - Under European transport policy, GHG calculation methodology established under RED (Directive 2018-2001 of the European Parliament and of the Council of 11 December 2018) considers GHG credits for avoided emissions associated with using manure as feedstock in biogas production (155, European Commission, 2018) [Tier A], (253, Majer et al., 2021) [Tier C], (370, Better Biomass, n.d.) [Tier C].
    - In the U.S., renewable natural gas (RNG) can have negative emissions under GREET as its GHG emission calculation methodology uses system expansion, which applies displacement credits for feedstocks and co-products (146, Coalition for RNG & Guidehouse, 2023) [Tier C]. Statistics on the EPA website claimed that a total of 25.9 million tons of CO_2e of methane emissions were avoided through landfill gas projects in 2023 (359a, US EPA, n.d.) [Tier C].
- Lifecycle emissions of low-carbon fuels are highly dependent on the carbon footprint of the feedstock, production technologies, methodological choices regarding co-product emission assignment, etc.
    - The white paper on Sustainable Aviation Fuels Certificate (SAFc) Emission Accounting and Reporting Guidelines says that "SAF can significantly reduce the carbon intensity of flying on a life cycle basis, depending on the feedstock and technological pathway (091, Clean Skies for Tomorrow, 2022) [Tier C].
    - A literature study reviewed and compared the lifecycle GHG assessments used in the context of EU (JEC) and U.S. (GREET) policies for low-carbon fuels. It shows that crop-based biofuels have higher GHG intensity compared to fuels using waste as feedstock (e.g., used cooking oil), and that "the WTT (well-to-tank) and combustion GHG emissions results for most fuel production pathways vary between two models (i.e., JEC and GREET)" due to modeling assumptions and methodological approaches (063, Cai et al., 2022) [Tier B].

Under these policies, EACs are used to represent **either the delivery of products with a low GHG intensity or the achievement of GHG emission reductions.** Some policies set targets for the supply of low-carbon fuels that meet minimum sustainability requirements, defined as a quantity of fuel (e.g., liters, GJ). Others use data on the volume and GHG intensity of the fuel supplied, plus the GHG intensity of a fossil fuel baseline, to calculate a GHG reduction achieved, and then assess compliance and reward on this basis. Respondents cited the CA LCFS as an example of this approach.

- The UK Renewable Transport Fuel Obligation (RTFO) requires fuel suppliers in the UK to supply a target percentage of renewable fuel each year (402, UK DfT, 2022; 403, UK DfT) [Tier B]. Renewable Transport Fuel Certificates (RTFCs) are awarded per litre (or equivalent) of low-carbon fuel delivered.
- The CA LCFS requires fuel suppliers in California to supply low-carbon fuel. Fuels supplied with a carbon intensity below the annual benchmark receive credits, whereas fuels above the benchmark generate deficits. Each credit represents 1 metric tCO_2 abated. Credits can be traded between obligated parties (276, Office of Administrative Law, 2020) [Tier B], (220a, International Dairy Foods Association, 2023) [Tier C].
- The U.S. Renewable Fuel Standard sets obligations on fuel suppliers to supply a target percentage of renewable fuel each year (413, US EPA, 2023) [Tier B]. Each gallon (or equivalent) of renewable fuel supplied is assigned a Renewable Identification number (RIN) that is used to track compliance with the regulation.

Policies currently accept the **separation of environmental attributes** from physical feedstocks, intermediates or products for certain aspects of the low-carbon fuel supply chain (i.e., a physical link between the environmental attribute and the material is not always required). As a minimum, this environmental attribute consists of the GHG intensity of the material but can also include other sustainability-related attributes.

- Mass balance is accepted under EU RED, several German policies, and CORSIA. Programs supporting low-carbon fuels in California should accept a book and claim RNG if producers and users are connected by a common gas network; this physical connectivity resembles a mass balance chain of custody and has been referred to as such below.
    - Under EU RED, targets can be met via a mass balance system which “allows consignments of raw material or fuels with differing sustainability and GHG emissions saving characteristics to be mixed” (155, European Commission, 2018) [Tier A].
    - Several German regulatory programs allow mass-balanced certificates including the Renewable Energy Source Act, the Building Energy Act (repealed), and the Biofuel Sustainability Ordinance (368, European Biogas Association, n.d.) [Tier B], (180, German Federal Ministry of Justice and the Federal Office of Justice, 2023) [Tier B].
    - Mass balance is also allowed under CORSIA (327, Roundtable on Sustainable Biomaterials, 2023) [Tier C].
    - EACs are used in GO schemes endorsed by the government to fulfil EU RED targets, particularly for low-carbon gaseous fuels (e.g., biomethane) which are injected into the gas grid. “Book and claim chain of custodies with tradable certificates already exist in EU legislation, such as Guarantees of Origin (GO) under the Renewable Energy Directive for biomethane in Germany” (251, Lufthansa, 2023) [Tier C]. The book and claim chain of custodies referred to in the evidence is in fact

more representative of a mass balance approach, given the connectivity of the gas grid in the EU.
    - In the Carbon Intensity Calculator Instruction Manual for California's LCFS program, "book and claim [CI] inputs for RNG and alternative electricity CI, specifically for on-site hydrogen production from natural gas or grid electricity" are accepted when calculating the lifecycle emission of low-carbon fuels produced via hydrotreated esters and fatty acids (HEFA) pathways (064, California Air Resources Board, 2023) [Tier C]. Similar to the evidence above, book and claim under the CA LCFS requires that the RNG must be connected to a common gas network, which is more representative of a mass balance approach. Additionally, biomethane delivered to California through a common carrier pipeline is also eligible for the procurement program under the California Renewable Gas Standard legislation.
    - California Senate Bill 1440 proposed to add an Article to California's Public Utilities Code, requiring the Public Utilities Commission to consider setting specific biomethane procurement targets on gas corporations. It states that biomethane "injected into the common carrier pipeline" can be eligible to count towards the targets, indicating a mass balance approach will be accepted if policy is adopted (062, California Legislative Council Bureau, 2018) [Tier C].
    - The U.S. Renewable Fuel Standard permits mass-balance reporting of RNG that has been injected into the common pipeline system from which it is withdrawn, providing that sufficient documentation is submitted (413, US EPA, 2023) [Tier B]. All fuels being used to fulfil obligations must also prove that they have lower emissions than fossil fuels.
- Under some policies, certificates related to a quantity of fuel supplied or emissions reduced within the jurisdiction of the policy can be traded between obligated parties and in some cases with other non-obligated companies. Respondents considered this certificate trading mechanism was equivalent to EAC programs or allowing a book and claim chain of custody.
    - "Book and claim chain of custodies with tradable certificates already exist in EU legislation, such as [..] Renewable Energy Units (HBE) in the Netherlands" (251, Lufthansa, 2023) [Tier C].
    - Under the RFS, a RIN can be separated from its corresponding fuel volume and transferred between registered parties any number of times (413, US EPA, 2023) [Tier B].
    - The Railway Association of Canada stated that the existing Clean Fuel Standard (operating federally and in many Canadian provinces) operates with "the essence of an EAC program", in that blending credits can be transferred between parties (291, Railway Association of Canada, 2023) [Tier C].
- Not allowing EACs for companies operating under regulations that accept them could lead to inconsistencies.
    - The Edison Electric Institute remarks that "not allowing the use of market-based instruments to support achieving voluntary GHG reduction goals creates a direct contradiction between the Science Based Targets initiative (SBTi) process" and policies such as the California LCFS and the U.S. Renewable Fuel Standard (122, EEI, 2023) [Tier C]. This sentiment is shared by the UK Chamber of Shipping, who states that if the concept of EACs is accepted by "national/regional regulatory frameworks", then "by default such measures, models or mechanisms should also

be endorsed for use in corporate climate targets" (398, UK Chamber of Shipping, 2023) [Tier C].

In the **voluntary markets**, companies are offering and participating in book and claim programs that offer EACs for low-carbon fuels, with most activities observed for SAF, biomethane, and some for low-carbon maritime fuels and road fuels. Some companies are also using this approach to buy EACs outside of book and claim programs. EACs are used to represent the delivery of fuels (e.g., 1 tonne of SAF), or relative emission reduction compared to a baseline, or both. Companies then use these to report lower scope 1 and 3 emissions than if fossil fuels were being used. This follows an attributional accounting approach which assumes that EACs represent low GHG fuel use rather than fossil fuel use within the system boundary of the reporting company.

- **Voluntary EAC purchases** are being offered by airlines, shipping, and logistics companies to transport service users (e.g., corporate users/customers), or biomethane producers via different purchasing mechanisms such as book and claim programs or bilateral contracts (226, Irigoyen et al., 2023) [Tier C], (401, BEIS, 2021) [Tier C].
  - In aviation, evidence of existing book and claim programs include Air France KLM's Corporate SAF Program (012, Air France KLM, 2022) [Tier C], Avelia (341, Shell, n.d.) [Tier C], DHL's book and claim program (116, DHL, 2023) [Tier C], Delta SAF Program (113, Delta Air Lines, 2023) [Tier C], and many others (213, International Air Transport Association (IATA), n.d.) [Tier C], (238, Kuehne+Nagel, 2023) [Tier C].
  - Companies are also buying EACs via bilateral agreements, such as Southwest Airlines' SAF beta partnership with their corporate customers (353, Southwest Airlines, 2023) [Tier C] and the collaboration announced between American Airlines and their customers, Deloitte and Kuehne+Nagel, to use SAF (018, American Airlines, 2021) [Tier C], as well as through organizations such as the Sustainable Aviation Buyers Alliance (SABA), (373, SABA, 2023) [Tier C].
  - In shipping, Norden offers a program (015, Ajdin, 2023) [Tier C] that tokenizes CO_2 equivalent reductions generated from voyages that consume biofuels and sells them to customers looking to report lower emissions from their shipping activities. Norden refers to this as "carbon insetting", though it is unclear whether this aligns with SBTi's definition of insetting, so it will be referred to as a book and claim program.
  - Similar programs are in development for RNG-electric hybrid locomotives in the U.S. (279, OptiFuel, 2023) [Tier C].
- Current industry guidelines, registries on low-carbon fuel EACs, and participants of book and claim programs say that EACs should **represent the environmental attributes of a unit of fuel.** One case study stated that EACs should represent GHG mitigation outcomes but only when the EACs are linked to a claimant's value chain.
  - In a white paper on SAFc Emissions Accounting and Reporting Guidelines, "a SAFc represents the environmental attributes of a metric ton of neat (i.e., unblended) SAF" (091, Clean Skies for Tomorrow, 2022) [Tier C].
  - In the RSB book and claim Registry, the unit of traceability is a "Book & Claim Unit (BCU) and corresponds to 1 tonne of neat, certified product" (323, Roundtable on Sustainable Biomaterials, 2023) [Tier C], (322, Roundtable on Sustainable Biomaterials, 2024) [Tier C], (038, Bart, Hutchinson and Ehirim (EDF and Rocky Mountain Institute), 2023) [Tier C].

    - A commentary authored by Lufthansa Group also says that “a SAF certificate represents one unit of neat SAF and its environmental properties according to the Proof of Sustainability” (251, Lufthansa, 2023) [Tier C].
    - In Denmark, each GO represents 1 MWh of green gas (e.g., biomethane) injected into the gas grid, and documents where and when it was produced (128, Energinet, n.d.) [Tier B].
    - SustainCERT, in partnership with CarbonLeap, provided a case study discussing how a commodities trader used EACs to invest in supply chain mitigation actions and reduce Scope 3 emissions for themselves and other organizations within their value chain (375, SustainCERT, 2023) [Tier C]. In the case study, the environmental attributes are reported as IUs, a unit of "verified GHG mitigation outcomes stating the absolute [emissions] reductions" as measured against a baseline. However, it specifies that this requires the environmental attribute to have “a verifiable link to a claimant's value chain” (e.g., mass balance) and does not apply to instances that unbundles the physical flow and GHG emissions (i.e., a book and claim chain of custody) as there is greater uncertainty over the relevance and accuracy of applying these goods/services to a company's supply chain.
- Book and claim programs which use EACs to represent the environmental attributes of a unit of fuel may, however, report the impact of EACs as **a quantity of low-carbon fuel delivered or an emission reduction** against a fossil fuel baseline. Transport providers (e.g., airlines) claim lower scope 1 emissions associated with EACs, while downstream transport service users (e.g., corporate users) who purchase the EACs use these to report lower 3 emissions than if fossil fuels were being used. They may also report percentage or total reductions against a fossil baseline.
    - In the RSB Book & Claim system, information on the GHG emissions and the GHG savings of the book and claim unit (i.e., one tonne of certified product) must be provided to register the BCUs in the RSB Registry, such that the BCUs can be linked to emission reductions. RSB advises this reduction to be calculated against the CORSIA jet fuel fossil baseline (i.e., 89 gCO_2e/MJ) (322, Roundtable on Sustainable Biomaterials, 2024) [Tier C].
    - Book and claim programs in SAF often report both the amount of fuels consumed, along with its emission reduction against a fossil fuel baseline (012, Air France KLM, 2022) [Tier C], (407, United Airlines, 2023) [Tier C].
    - Many purchases of EACs have been (publicly) reported as “emission reductions”, such as the program operated by Norden (015, Ajdin, 2023) [Tier C], (353, Southwest Airlines, 2023) [Tier C]. The book and claim system developed by Mærsk Mc-Kinney Møller Centre for Zero Carbon Shipping for the shipping sector also books transactions on the basis of emissions (i.e., gCO_2/MJ) (252, MMMCZCS, 2023) [Tier C]. This is designed to facilitate an exchange of emissions, meaning that when trading a token (book and claim unit), a participant must accept the same number of tokens in return. This means that, to claim a certain emission level, a participant must find a counterparty willing to accept their emission. MMMCZCS claims that this mechanism removes the risk of emission leakage.
    - In others, it is unclear how EACs are assigned to transport service users (018, American Airlines, 2021) [Tier C], (341, Shell, n.d.) [Tier C].
- The above book and claim programs use methodologies to assess the lifecycle GHG emissions of the fuels supplied, typically those defined by policies (e.g., CORSIA, EU RED) with verification by approved schemes (e.g., RSB-CORSIA, ISCC-CORSIA). This

means that there is greater consistency of approaches to GHG calculation in the fuels sector than in the commodities sector, and more consistent third-party verification. However, transport sectors with less global harmonization in GHG intensity calculations, such as the shipping and road sector (particularly across different powertrains), could lead to higher inconsistencies.
    - Delta's SAF Program uses CORSIA methodology (113, Delta Air Lines, 2023) [Tier C].
- The methodologies apply mass balance approaches to chain of custody up to the point of fuel production. From this point, a book and claim approach is used, where the environmental attributes are separated from the physical fuel flow.
- Respondents also reported purchases of biomethane from producers through GO programs. These use a mass balance approach and lead to reporting of lower emissions and/or reductions.
    - AstraZeneca has agreed to purchase 100 GWh/yr of biomethane from Future Biogas, which will be provided from 2025 via Renewable Gas Guarantees of Origin (RGGOs) generated when the biomethane is injected into the gas grid. The RGGOs will be used to decarbonize AstraZeneca's heat demand at four UK sites by displacing natural gas, reducing emissions by 20,000 tCO_2 over the course of the partnership (026, AstraZeneca, 2023) [Tier C], L'Oreal (245, Leung and Meyer, 2018) [Tier C].
- There is some scepticism towards EACs in the fuel market and overall, due to the lack of studies proving their effectiveness of delivering low carbon products and their GHG intensity.
    - The EEI argues that many EACs, excluding Renewable Energy Certificates (RECs), are new and potentially not sufficiently regulated or lack a mature certificate market. Outside of RECs (which EEI claims have a mature market), the EEI recommends delaying assessment of the overall effectiveness of EACs until the newer markets and systems for other EACs are more mature (122, Edison Electric Institute, 2023) [Tier C].
    - National Grid states that internal research indicates that the majority of the EAC market is in its nascent stages and, as such, they cannot infer on the overall effectiveness or ineffectiveness of EACs to deliver low-carbon products or emissions reductions. They point to the absence of credible, extensive, and unbiased third-party evidence (265, National Grid, 2023) [Tier C].

3.2 Theme 2: There is debate over whether fuels used to comply with policy targets should be used to generate EACs

Research questions related to this theme

Research question 1: What evidence exists about the effectiveness or ineffectiveness of environmental attribute certificates in delivering measurable emission reductions?
Research question 2: What evidence supports or opposes a causal link between specific operating conditions (geographies, regulatory schemes, presence or absence of tracking mechanisms or registries, etc.) and the effectiveness of environmental attribute certificates to deliver emission reductions? Which conditions?
Research question 4: What evidence supports or opposes the ability of environmental attribute certificates to accurately reflect and quantify emission reductions in the context of corporate climate abatement targets?

Summary

EACs are used in both regulatory and voluntary markets and, as such, there is **inherent overlap between regulatory and voluntary reporting along the low-carbon fuel supply chain.** The same unit of low-carbon fuels and its lower emission attributes could be used to meet regulatory compliance targets (generally by fuel suppliers), as well as being claimed towards scope 1 and scope 3 emission targets through voluntary programs further downstream in the low-carbon fuel supply chain (e.g., airlines, logistics operators, corporate purchasers, etc.). This relates to the issue of additionality; while fuel EACs could contribute to lower emissions within the system boundary of the reporting companies, they may not further reduce economy-wide emissions, as the fuel would have been supplied regardless under the regulatory obligation.

To avoid this, and to ensure that EACs in the voluntary market lead to low-carbon fuel supply beyond what is mandated by policy, there is evidence which states that **voluntary claims should only be made for fuels that are not used to meet regulatory targets.**

Separately, evidence has suggested that regulatory and voluntary markets should be separated, but environmental claims should be allowed to be made regardless of whether the fuel was subject to obligations. Others suggest that regulatory additionality should be assessed on a case-by-case basis. However, some argue that stringent EAC program requirements such as additionality could stifle project development.

How regulatory and voluntary reporting currently interact is generally unclear under book and claim programs. In aviation and maritime, this is likely because there are few mandatory obligations set by policies (e.g., as seen in Norway and France). However, this will change starting from 2025 in the aviation sector as ReFuelEU Aviation and the UK SAF Mandate begin obligating fuel suppliers to supply SAF. Further SAF mandates have been proposed by Japan, Brazil, Singapore, UAE, and others. For airline operators, this will change in 2026 following the implementation of EU Emissions Trading Scheme (ETS) and CORSIA. *In their answers to the research questions, submitters stated that there is no consistency in how additionality is considered between sectors or programs. For example, the Smart Freight Centre guidance does not require additionality for direct emissions reductions, but many SAF programs do: as such a corporate purchaser may buy EACs from different sectors with different approaches to additionality.*

Detailed evidence

EACs are used in both regulatory and voluntary markets, as such, there is **inherent overlap between regulatory and voluntary reporting along the low-carbon fuel supply chain.** The same unit of low-carbon fuels and its lower emission attributes could be used to meet regulatory compliance targets by suppliers, as well as being claimed towards scope 1 and scope 3 emission targets through voluntary book and claim programs downstream of the low-carbon fuel supply chain (e.g., airlines, logistics operators, corporate purchasers, etc.). This could mean that while fuel EACs could contribute to lower emissions within the system boundary of the reporting companies, they may not reduce economy-wide emissions, as the fuel would have been supplied anyway under the regulatory obligation.

- Lufthansa authored a piece of evidence that explores this interaction in the aviation industry. It points out that there are "direct (e.g., ReFuelEU Aviation, EU RED) and indirect (e.g., [EU ETS], EU Taxonomy) obligations for SAF supply to aviation". "In addition to these obligations, airlines can voluntarily procure SAF. Airlines can decide to claim their SAF (from obligations or voluntary procurement) in EU ETS or CORSIA to reduce the corresponding duties". Through book and claim programs, the "environmental benefits from SAF will be claimed by airlines and airline customers in CO_2 reporting, regardless of whether the SAF originated from obligations or voluntary procurement" (251, Lufthansa, 2023) [Tier C].

To avoid this, and to ensure that EACs in the voluntary market generate lower emissions systematically, some programs have stated that **voluntary claims should only be made for fuels that are not used to meet regulatory targets for fuel supply and/or GHG reduction**. One respondent also considered that fuels that had benefited from supply side incentives should also not be used to make voluntary claims (038, Bart, Hutchinson and Ehirim (EDF and Rocky Mountain Institute), 2023) [Tier C].

- SABA's Sustainability Framework for SAF states "emissions reductions from SAF being claimed for use towards voluntary climate targets will need to generate emission reductions beyond those already incentivized by compliance obligations, creating an atmospheric benefit" (374, SABA, 2023) [Tier C].
- "Emission reductions from SAF being claimed for use toward voluntary climate targets should constitute emissions reductions that are additional to those already resulting from government incentive mechanisms or compliance obligations" (038, Bart, Hutchinson and Ehirim (EDF and Rocky Mountain Institute), 2023) [Tier C], i.e., that these SAF certificates have generated emissions reductions that would not otherwise have occurred because of policy mandates or supply side incentives. In this case, SAF that has been used to claim compliance towards mandates like ReFuelEU will not be eligible to generate SAFc certificates which represent Scope 3 emissions reductions.
- The SAFc Emissions Accounting and Reporting Guidelines (091, Clean Skies for Tomorrow, 2022) requires that SAFs cannot be claimed by end users for voluntary claims if the physical SAF is used towards a compliance obligation. In order to enable new and additional production, voluntary actors need transparency about which fuels are used towards which compliance schemes and the incentives that fuels receive.
- The International Sustainability & Carbon Certification (ISCC) system only accepts credible SAF transactions that provide atmospheric benefits above those required by regulatory schemes (223, ISCC, 2023)[Tier C].
- In the submission made by Norden, they say that additionality "needs to be assessed on a case-by-case basis for each regulations in different industries to ensure that

environmental attributes/claims can only be generated from fully additional interventions and guarantee a level playing field"(015, Ajdin, 2023) [Tier C].

Some of these schemes use defined approaches to determine whether or not policy additionality can be claimed. For example, under SABA's atmospheric benefit principle, volumes can be additional if used to comply with a non SAF-specific low-carbon fuel mandate, but not a SAF mandate or GHG mandate in aviation (374, SABA, 2023) [Tier C]. The Smart Freight Centre guidelines state that "a voluntary solution for one mode of transport may generate credits that are applied towards achievement of a regulatory requirement for another mode of transport" (345, Smith & Lewis, 2023) [Tier C]. This encourages, for example, SAF supply even if economy-wide GHG reduction is not made, as the regulatory credits generated mean that non-SAF fuel sale is displaced.

None of the schemes consider supply side support such as U.S. Inflation Reduction Act (IRA) tax credits to conflict with voluntary credit generation, on the grounds that one company claiming these does not affect whether or not others can do so. However, none address the issue of financial additionality that arises as a result. This is a difficult issue to resolve, particularly as policies in several countries aim to reward projects or production volumes to a level necessary to cover the cost gap with higher carbon incumbents, considering revenues from other sources, including any credits sold.

- For example, the UK Green Gas Support Scheme impact assessment determined the tariff that would need to be paid to biomethane producers assuming a biomethane certificate price received (079, Centrica, 2023) [Tier C]. This could mean both policymakers and corporate purchasers are trying only to cover the cost gap after the other one's willingness to pay to avoid overcompensation or a lack of additionality.

Separately, other evidence suggests that environmental claims could be made regardless of whether the fuel was subject to obligations or voluntary purchases. Alternatively, additionality could be assessed on a case-by-case basis.

- A commentary authored by Lufthansa advocates for an EU-wide book and claim system suggests that the registry should clearly track mandatory and voluntary SAF reporting, but "airlines and other stakeholders in the aviation value chain must be able to claim the associated environmental benefits according to the GHG Protocol and SBTi – regardless of whether the fuel was subject to obligations or voluntary purchases" (251, Lufthansa, 2023) [Tier C].
- The Smart Freight Centre (SFC) has published guidelines on "Voluntary Market Based Measures Framework for Logistics Emissions Accounting and Reporting" (345, Smith and Lewis, 2023) [Tier C]. The SFC aims to address barriers to heavy transport decarbonization (that are not mode specific) by providing a framework that outlines how shippers, logistics service providers, carriers, and solution providers can most effectively partner with each other to provide and report low emission transport solutions (LETS). In the guidelines, the SFC argues that additionality requirements should be determined by the type of chain of custody EACs are supplied through since additionality is not required for direct generation of a low emission transport service (i.e., when there is a "physical tie between a low emission solution [i.e., low-carbon fuels] and the carrier [e.g., airline] generating the LETS [low emission transport service]") but is required for indirect generation of emissions (e.g., "a physical tie cannot be made between a solution and a LETS [low emission transport service]").
- The Mærsk Mc-Kinney Møller Center for Zero Carbon Shipping (MMMCZCS) is developing a book and claim system for the maritime sector which will not assess or

require additionality for any corporate claims (252, MMMCZCS, 2023) [Tier C]. Instead, it will provide information for participants to judge “whether the low-carbon transport services are additional based on the participants’ criteria".
    - They state that the GHG Protocol defines additionality as a term specifically associated with offsets, which is a different methodology than their book and claim system is built on. The evidence also says that “the Maritime Book & Claim system aims to reduce the size of the pool of emissions by replacing conventional fuel emissions with alternative fuel emissions over time. Therefore, additionality assessments used to qualify and quantify emission reductions against baselines are not applicable for emissions registered on the Maritime Book & Claim system”.
    - They also point out that “the variety of maritime industry regulations can make it difficult to assess whether low-carbon maritime transport services are additional”. Examples given include blending mandates (e.g., FuelEU for Maritime), emission intensity regulations (e.g., IMO EEDI/EEXI, EEOI, and CII), emission caps (e.g., EU ETS), and reporting obligations.

However, there is evidence that suggests stringent EAC program requirements such as additionality could stifle project development.

- A whitepaper published by UC Irvine Clean Energy Institute suggests that a balance is required between providing effective incentives to stimulate investment in low-carbon technologies, while guaranteeing the desired emissions reductions are attained. Stringent EAC program requirements (e.g., proving sustainability and additionality) have the “potential to stifle project development such that the total investment pipeline creates fewer benefits than would be the case under more permissive or inclusive program requirements”. However, requirements that are too loose could reduce the effectiveness of the EACs in achieving environmental benefits (306, Reed et al., 2023) [Tier C].

How regulatory and voluntary reporting currently interact is unclear under many book and claim programs. In aviation and maritime, this is likely because there are currently few mandatory obligations set by policies. However, this will change starting from 2025 in the aviation sector as ReFuelEU Aviation, and the UK SAF Mandate begin obliging fuel suppliers to supply SAF. For airline operators, this will change in 2026 following the implementation of EU ETS and CORSIA. *In the answers to the research questions, submitters said that there is no consistency in how additionality is considered between sectors or programs. For example, the Smart Freight Centre guidance does not require additionality for direct emissions reductions, but many SAF programs do. A corporate purchaser may buy EACs from different sectors with different approaches to additionality. Clear standards should be set on additionality.*

- For example, in a case study submitted by Delta Air Lines on their SAF program, which distributes Scope 3 emission attributes of SAF to participatory customers, they do not mention whether the SAF volume was used towards meeting their CORSIA obligation and, if it had been, whether the environmental attributes of that SAF were distributed to the program’s customers (113, Delta Air Lines, 2023) [Tier C].
- A commentary authored by ABB says that for the shipping sector specifically, “concerns exist over the additionality and overall environmental credibility in different approaches being used by industry”. From this, ABB concludes that “greater guidance and harmonisation is needed for corporate GHG reporting” (006, ABB, n.d.) [Tier C].

How additionality is applied in EACs will also impact whether and how residual emissions factors need to be developed for emission reporting. For example, if mandated volumes are

excluded from voluntary schemes, the mandated volumes could be included in national accounts leading to emission factors that can be used by any company.

3.3 Theme 3: Respondents considered that EACs can drive low-carbon fuel deployment and improve revenue certainty

Research questions related to this theme

Question 5: What evidence exists that uptake of attribute certificates leads to or hinders the transformation needed to reach climate stabilization?
Question 7: Is there evidence that supports or undermines that the market value of this type of instrument is commensurate with the abatement costs of the underlying activity?
Question 8: Is there evidence that shows that the use of these instruments (i.e. procurement of the attribute certificate) could contribute to scale-up of climate finance compared to alternative interventions? Or could it result in climate finance dilution?

Summary

Evidence argues that the acceptance of EACs under vario policies has led to increased production and supply of low-carbon fuels. Although many corporates are not obligated to use low-carbon fuels, the evidence describes many deals being signed between low-carbon fuel producers and corporates which use EACs as a means to "deliver" low-carbon fuel to the corporate end-customer. While the deals may support investment and capacity building, the fuel produced may not be physically supplied to the investor/customer. In the evidence assessed, biomethane and SAF are the most common fuels being used to generate EACs.

It is suggested that EAC purchases through book and claim programs, long-term procurement agreements, or other forms of contractual mechanism can boost the demand signal and bring greater revenue certainty for producers and investors. This could lead to greater investment in, and greater deployment of, low-carbon fuels.
Evidence also suggests that book and claim schemes could allow stakeholders throughout the value chain to share the price premium of low-carbon fuels over fossil fuels, reducing the financial burden on operators like airlines and potentially furthering investment in low-carbon technology.

Detailed evidence

Many stakeholders expressed the view that the acceptance of EACs for biofuels reporting under various policies (including mass balance or book and claim chain of custody methods) has led to a growth in biofuels supply in those regulatory regions.

- Centrica remarks that "The EU and UK have been global leaders in the move to renewable energy and in reducing their carbon emissions. The RED framework has been the foundation of those efforts since 2010 including the clear framework for market-based reporting via EACs" (079, Centrica, 2023) [Tier C]. EU RED permits the mass balance chain of custody method for tracking a Member State's fulfilment of biofuel targets (155, European Union, 2018) [Tier A]. Many other stakeholders who submitted the RED framework and other evidence discussing biomethane investment and production noted that the Directive's acceptance of GO for biomethane has been central to the rapid increase in biomethane supply in the EU and UK in recent years. Other evidence highlights the €5 billion invested in biomethane capital in Europe in 2022, with a further €10 billion pledged by "large players" (277, Oliver Wyman, 2023) [Tier C].
- The California Low Carbon Fuel Standard operates as a credit-based system, where credits are awarded based on a fuel's emissions savings against a fossil baseline. These

tradable credits represent the environmental attributes of the fuel (276, Office of Administrative Law, 2020) [Tier B].
    - The LCFS saw an overcompliance of credits between 2011-2030, meaning that there has been greater uptake of low-carbon fuels than required by policy (339, Seymour, 2021) [Tier C]. Seymour reports that over the same time period, 4.5 billion gallons of fossil diesel in California have been replaced with lower-carbon fuel alternatives.
    - The LCFS explicitly permits “indirect accounting”, which includes “book and claim accounting”, for pipeline-injected biomethane (276, Office of Administrative Law, 2020) [Tier B]. The book and claim approach for RNG permitted by the LCFS would actually be considered mass-balance under the Definitions outlined in Section 1.2.
    - The International Dairy Foods Association submitted a time series data analysis and interpretation on dairy digester capacity and growth in the U.S., in relation to the implementation of LCFS-type marketplaces across the U.S. (220c, International Dairy Foods Association, 2023) [Tier C]. "Given the relatively high capital costs and existence of LCFS marketplaces currently in California, Oregon, and Washington (and British Columbia, Canada), we argue that at least some portion of digestor growth since approximately 2009, when California’s LCFS policy was first approved (implementation began in 2011), was directly caused by the demand for environmental attribute certificates. We propose that it is highly likely that at least some portion of the U.S. digestor system development (and associated decarbonization) would not have occurred in the absence of environmental marketplace opportunities to transact environmental attribute certificates (a hypothetical counterfactual scenario)".
    - Other examples of new RNG production facilities were submitted to demonstrate how the producers benefit financially from their ability to sell credits in LCFS-type marketplaces (142a, Guidehouse & The Coalition for RNG, n.d.; 443, NGVAmerica, 2023; 443a, Capital Press, 2023; 443b, Seattle Times, 2023) [All Tier C].
    - In their submission, JetBlue “acknowledges the vast majority of SAF being delivered [in the U.S.] today is to California airports as a result of the state’s low-carbon fuel program” (230, JetBlue, 2023) [Tier C]. The California LCFS does not obligate jet fuel to reduce emissions below the benchmark but does allow SAF to opt in to receive credits based on its carbon intensity.
- The U.S. Renewable Fuel Standard promotes the use of RNG in transport by permitting mass-balance reporting of RNG supplied via the commercial natural gas pipeline system (413, US DoE, 2023) [Tier B]. Like the California LCFS, fuel suppliers are awarded credits for delivery of renewable fuels which can be traded with other parties.
    - The Edison Electric Institute (EEI) discussed how the growing supply of biomethane in the U.S. can be “attributed to the value of tradeable credits” under market-based accounting systems “employed by” the U.S. Renewable Fuel Standard (RFS) and California LCFS, which aims to reduce emissions in the transport sector (122, Edison Electric Institute, 2023) [Tier C].
    - Other pieces of evidence highlight the growth in RNG production and uptake in transport across the U.S. since the RFS program’s acceptance of RNG as a renewable fuel; although not all evidence directly comments on the use of EACs (384, The Coalition for Renewable Natural Gas, 2022; 362a, NGV America & The Coalition for Renewable Natural Gas, 2023; 306, Reed et al., 2023; 339, Seymour, 2021) [All Tier C].

    - In their white paper on EAC program design, Reed et al. comment that “the [RNG] facility count has been growing at an average rate of 20% per year over the past decade. Because tradeable credits have been used in all clean fuel programs in North America, direct comparison of a case where tradeable [EACs] are not allowed is not possible. However, the geographic distribution of production facilities and the location of demand suggests that the locational flexibility enabled by the use of tradeable clean-fuel credits has enabled supply expansion and reduced cost” (Reed et al., 306, 2023) [Tier C].

Although many corporations are not obligated under policy, the evidence provides examples of partnerships between fuel producers/transport providers and corporations purchasing low-carbon fuels via EACs as a means to reduce their Scope 1 and/or 3 emissions. Some submissions suggest that these deals have led directly to greater supply of low-carbon fuels, though there is no clear evidence that indicates voluntary purchases have led to deployment beyond what was driven by policy.

Biomethane has been procured by companies via GOs or green gas certificates. For example:

- ENGIE has signed purchase agreements to supply biomethane to Arkema and RATP via GOs to replace fossil natural gas (138, ENGIE, 2023; 295, RATP, 2021) [Tier C]. ENGIE claims that the agreements will send a “price signal for additional biomethane production over a long period of time” (138, ENGIE, 2023) [Tier C].
- AstraZeneca has signed a 15-year agreement to purchase RGGOs from Future Biogas in the UK to reduce its Scope 1 emissions from heating (026, AstraZeneca, 2023) [Tier C]. AstraZeneca’s investment has supported Future Biogas in building the UK’s “first unsubsidised, industrial-scale biogas facility”. In their submission, AstraZeneca remarks that “Future Biogas expects this model to be adopted by many other innovative organisations with strong net-zero ambitions”, suggesting that further partnerships of this nature could lead to greater deployment of biogas production facilities.
- Similar biomethane purchase agreements have been made by the Saint-Gobain (391, TotalEnergies, 2023), Heineken (202, Heineken, n.d.), University of California (313, Renewable Thermal Collective, 2022), and L’Oreal (245, Leung and Meyer, 2018) [All Tier C].
- The European Biogas Association (EBA) submitted its 1st Biomethane Investment Outlook, demonstrating a significant scale up of climate finance related to biomethane production. According to a survey of their members, €18 billion worth of investment has already been earmarked. However, the evidence does not demonstrate whether this investment was driven by policy or EACs (156, European Biogas Association (EBA), 2023) [Tier C]. RNG facility growth is also observed in the U.S., mostly as a result of policy mandates (384, The Coalition for Renewable Natural Gas, 2022) [Tier C]. A commentary submitted by STX states that “this growth is correlated with and reliant upon programs which aim to promote the use of RNG via market-based instruments” (366, STX, 2023) [Tier C].

- Some airline operators and freight providers are operating their own EAC schemes to provide Scope 3 claims to their corporate and cargo customers. Through these programs, customers help to invest in, and boost the demand signal for, low-carbon fuels. Most programs described in the evidence are for SAF.

    - DHL operates a book and claim system which allows customers to select a sustainable option when purchasing a DHL service. The related Scope 3 emissions reduction will be credited to accounts belonging to those who purchase the sustainable option (116, DHL, 2023) [Tier C]. In 2022, it was announced that DHL would purchase 800 million litres of SAF from Neste and BP until 2026, with Scope 3 emissions claims passed onto customers via the book and claim system.
    - In 2022, United Airlines procured 3 million gallons of SAF: the Scope 1 emissions were allocated to United, and the Scope 3 emissions allocated to customers of United's Eco-Skies Alliance program, including Microsoft, DHL, Deloitte, Nike, and Maersk (407, United Airlines, 2023; 444, United Airlines, 2023) [Tier C].
    - In 2022, the Delta SAF Program included 30+ corporate and cargo customers, which resulted in 1.3 million gallons of SAF delivered to Los Angeles, San Francisco, and Schiphol airports (113, Delta Air Lines, 2023; 114, Delta Air Lines, 2023) [Tier C].
- Other EAC schemes are not run by specific transport providers but instead connect fuel suppliers with airlines/customers.
    - Purchases through the Avelia book and claim scheme have generated the deployment of 3.4 million gallons of SAF into the fuel network (341, Shell, n.d.) [Tier C].
- Microsoft has purchased SAF via EACs through a partnership with Alaska Airlines and SkyNRG (258, Microsoft, 2023) [Tier C]. The parties involved hope that "this partnership sets an example for other companies and organizations to purchase SAF and support the development of the SAF industry by creating a stable demand signal, increasing supply and reducing the cost of SAF".
- It is argued that aggregating corporate demand for low-carbon fuels/transport solutions can lead to greater investment and scaling up of climate finance.
    - SABA submitted a report giving insights into SABA's first and second SAF procurement rounds. SABA aggregates requests for SAF from its members, purchases SAF using the funds received, and provides SAFc certificates in return to those members (373, SABA, 2023) [Tier C].
    - The Sustainable Aviation Fuels Offtake Manual by the First Movers Coalition (434, World Economic Forum, 2023) [Tier C] states that the Coalition has "generated an unprecedented demand signal, with the private sector pledging a remarkable $12 billion by 2030 to procure innovative green technologies" (although this is not solely through the use of EACs). The authors point out that, as a group, they can use the "purchasing power of its members to accelerate the deployment of high-quality SAF while bringing the global cost curve down".
    - The U.S. Government's SAF Grand Challenge roadmap states that "Commercial arrangements that provide more certainty around revenue for SAF projects can increase their financeability. These could include pooled offtake agreements that mitigate offtaker credit risk [and] book and claim systems that allow corporate buyers to enter into long-term offtake agreements with producers for the Scope 3 environmental attributes associated with SAF" (408, United States Department of Energy, 2022) [Tier C].
    - Demand aggregation "can help strengthen the business case for carriers and fuel producers to invest in zero-emission vessels and fuel" (226, Irigoyen et al., 2023) [Tier C].
    - In a report on book and claim systems, RMI states: "The Zero Emission Maritime Buyers Alliance (ZEMBA) launched earlier this year with the goal of pooling

corporate demand for decarbonized shipping and will rely on book and claim systems to facilitate their effort… Book and claim also has the potential to inspire and enable action beyond corporate consumers and supply chain enabling large, joint, and advance offtake agreements and other forward-looking investments from corporate customers and air transport providers, like Microsoft and Alaska Airlines' investment in Twelve. These strong demand signals are starting to give financial institutions the confidence to invest in new production facilities that will break ground this decade" (142c, RMI, 2023) [Tier C].

Low-carbon fuels can be significantly more expensive than fossil fuels. Before the development of corporate book and claim programs, corporates and customers did not have a channel through which to contribute to SAF premiums and receive environmental attributes in return. In general, the evidence supports the idea that EACs allow **stakeholders throughout the value chain to contribute to the price premium associated with low-carbon fuels**, spreading the green premium across multiple parties and driving further investment over time.

- In their commentary, the Railway Association of Canada remarks that "there is substantial cost to implementing a biofuel or hydrogen transportation project… [and the] ability to share the capital costs of the implementation with customers is a critical factor in companies moving forward." By "shifting the burden of the premium to organizations that place a premium on alternative fuel, it not only incentivizes production but also broadens the spectrum of potential investors. This expansion extends beyond the constraints of physical proximity or temporal limitations, encompassing any player within the value chain who recognizes the value and is willing to invest" (291, Railway Association of Canada) [Tier C].
- For SAF:
  - The Clean Fuels Alliance submitted a commentary which states that the rising application of book and claim programs for SAF "has mitigated the impacts of airlines' willingness-to-pay by allowing them to socialize the cost of SAF with customers whose willingness-to-pay for sustainable flight is less price sensitive" (088, Clean Fuels Alliance, 2023) [Tier C].
  - Southwest Airlines submitted a case study in which they describe how they offer Scope 3 SAF claims to corporate customers (353, Southwest Airlines, 2023) [Tier C]. They explain how a third-party corporate customer executes a bi-lateral agreement with Southwest Airlines to "contribute funds that will be applied towards the premium of SAF over conventional jet fuel".
  - The Delta SAF Program aims to promote SAF demand by reducing the financial burden of SAF premiums on Delta Air Lines, while providing an in-sector decarbonization measure for both the airline and customers. The case study quotes a ~2.3x price premium of SAF over jet fuel, and the SAF Program enables a cost-sharing approach to this premium between Delta, corporate, and cargo customers who participate, in exchange for distribution of scope 3 emission attributes across the value chain (113, Delta Air Lines, 2023) [Tier C].
- SustainCERT discusses how EAC programs must "maximize co-investment in decarbonisation whilst preventing double counting. EACs from [value chain] interventions can be reported in multiple companies' inventories, and multiple firms can make claims from them (co-claiming), according to GHG-P Scope 3. This will create the incentive for companies to take collective action". By sharing collective responsibility for emissions, the submitter explains that it could be more efficient for "certain firms to drive

investment in mitigation outcomes, allowing others to claim resulting impacts". They explain further that "in value chains where there is low access to supplier data, and sourcing is inconsistent, EACs shift the paradigm from investing on a short-term basis with individual suppliers with direct traceability, to investing in whole regions or service categories, on a long-term basis while getting the desired returns. EACs thus de-risk companies' investments and operations, helping to scale up climate finance" (375, SustainCERT, 2023) [Tier C].

- Kuehne + Nagel submitted a commentary discussing their book and claim system for transport logistics providers. They state that "the high cost of reducing freight transportation GHG emissions is a significant barrier to the deployment of low-carbon fuels and transportation services in the sector. Typically, the cost of purchasing low-carbon fuels is paid by the asset owner or operator as they are under their control and operation. However, their high cost means that carriers often cannot voluntarily and without regulatory imperatives use them while remaining competitive". They suggest that enabling all value chain players to act can decrease the overall cost burden of decarbonization (238, Kuehne + Nagel, 2023) [Tier C].
- AB Texel submitted a letter in which they discuss how they have "committed to SBTi and to buying 50 trucks on LNG". As their trucks are not "dedicated" to single clients, AB Texel claim they need to "allocate the CO_2 reduction to clients that want to pay, otherwise it is impossible to scale up our reduction efforts" (004, AB Texel, 2023) [Tier C].

Evidence has demonstrated how EACs can or have been incorporated into business models for low-carbon fuel production, to provide greater revenue certainty to investors.

- Centrica submitted a press release (080, Centrica, 2023) [Tier C] outlining Centrica and Yorkshire Water's 15-year biomethane partnership with SGN Commercial Services (a manager of natural gas and green gas networks in the UK). Centrica explains that "the value of biomethane certificates was built in [to] the business modelling and, along with other factors, helped make this project economically viable and will result into additional biomethane production in the UK" (079, Centrica, 2023) [Tier C].
- The Green Gas Certification Scheme (GGCS) is a UK-based scheme that issues, transfers, and retires RGGOs within their registry. The Annual Report 2022 (192, Green Gas Certification Scheme, 2022) illustrates that the volume of RGGOs issued has grown year-on-year and state that the "main source of revenue for green gas producers is income from the sale of their gas and from Government incentive schemes, being either the Non-Domestic Renewable Heat Incentive (NDRHI), the Green Gas Support Scheme (GGSS), or the RTFO". Evidence states that green gas producers say that "the 'green premium' realised by the sale of RGGOs is essential to their business model" (192, Green Gas Certification Scheme, 2022) [Tier C], (151, ERGaR, 2023) [Tier C].
- The Landfill Gas Energy Project Handbook (411, United States Environmental Protection Agency, 2021) [Tier C] discusses the economic requirements for a landfill gas (LFG) facility and how EAC sales can provide a source of revenue that makes the project economically viable. LFG energy projects may be eligible for RECs and the handbook gives an example project where "applying a 2¢/kWh credit on top of the [electricity] buy-back rate increases the internal rate of return (IRR) for a private 3-MW internal combustion engine project to 9 percent with a payback of 15 years". Thus EACs provide a market signal for safer investment in projects that release lower emissions.
- In a report submitted by the UC Irvine Clean Energy Institute, the authors describe how "for clean energy projects, particularly for nascent technologies, EACs may be a primary

source of project revenue. Both credit value and credit value certainty are important". Further, allowing exchanges or registries for EAC trading can "create market efficiency and stimulate investment" (306, Reed et al., 2023) [Tier C].

- Evident EV (an EAC registry operator) carried out a survey with their customers (166, Evidence EV Ltd, 2023) [Tier C]. When asked about how EACs impact financial scale up, one of the responses pertains to biomethane, which said "There are project developers seeking to implement biomethane projects in Australia for whom the ability to connect the consumer to the project through an instrument like the I-REC(G) is fundamental [to] establishing a market, which in turn is critical for financial viability. This is less so the case for electricity projects".

Partnerships involving Scope 3 customers could be considered more financially stable than partnerships with airlines:

- "… long term offtake agreements with credit-worthy parties seeking to reduce their Scope 3 emissions [are] crucial as the SAF industry pursues scale… According to S&P, airlines demonstrate high financial risk and business risk due to their consistently low margins and their highly volatile variable costs including fuel and labor. Airlines are therefore hesitant to enter long term offtake agreements covering the SAF premium, as they cannot demonstrate that their customer base will accept those costs being passed along and incorporated into the ticket or freight prices charged. Long term offtake agreements with Scope 3 customers are a clearer sign of "bankability", and these agreements are only possible with book and claim. World Energy's agreements with Microsoft and DHL help us justify demand for a premium product and can be used to demonstrate the viability of our plant expansions in Paramount and Houston" (435, World Energy LLC, 2023) [Tier C].

Evidence has discussed the cost of abatement by comparing the production cost of low-carbon fuels to the sale price of EACs. Evidence has also considered whether additional financial support from policy measures should be accounted for when determining the price of EACs.

- For SAF, evidence suggests that the cost of EACs should cover the remaining cost of production after accounting for any financial support received from policies. In this way, the EACs will ensure the full cost of abatement is covered.
    - World Energy LLC submitted a commentary in which they discuss their cost build-up model for SAF (435, World Energy LLC, 2023) [Tier C]. The model accounts for production costs as well as revenue sources under various U.S. policies. They explain that a SAF premium over jet fuel remains even after accounting for other revenue streams such as LCFS credits. World Energy has developed a "variable 'contract for differences' pricing model where customers only pay for the incremental cost of the [EAC] after removing all other income generating elements (the cost of Jet A, LCFS Credits, RIN Credits, and the Blender's or SAF Tax Credit). A Book & Claim mechanism allows for this transparency across the industry, rather than fixed price models that may not accurately capture the incremental cost of abatement as transparently as the Book & Claim model allows for". In this way, the cost of the EAC will remain linked to the cost of abatement.
    - SABA submitted a report providing insights into SABA's first and second request for proposal (RFP) rounds which aggregated corporate demand for SAF purchasing (373, SABA, 2023) [Tier C]. In each round, corporates invest in SAF and in return receive SAFc certificates through the SAFc Registry, representing the environmental attributes of the SAF. As part of the additional information submitted, RMI explains

that the SAFc certificates are “designed to cost the price premium for SAF over conventional jet fuel, minus any government incentives”.

- Evidence on biomethane discusses the traded price of GO compared to the biomethane production cost.
  - The Renewable Gas Tracking Systems report collected sample pricing data for biomethane certificates from independent parties including Argus Media, Cornwall Insights S&P Platts (158, EBA; WBA; ERGaR; RNGC, 2023) [Tier C]. The report found that the average price of GO or Certificates of Origin in several European countries accounts for a significant share of the average production cost of biomethane (€84/MWh). The average certificate price covered between 27% of the production cost in the UK, and up to 55% of the production cost in Germany. “For the Netherlands and Germany, prices reflect guarantees or certificates of origin for certified biomethane volumes (environmental sustainability certified as per the RED Framework) which explains the higher spot prices compared to the ones assessed in the U.K.” The average price of GO for specifically manure-based biomethane in Denmark was shown to cover 83% of the production cost, on average.
  - A report on biomethane trading from Oliver Wyman shows a model for how the cost of biomethane production can be met via the GO and Proof of Sustainability certificate income stream complementing the sale of the gas price (277, Oliver Wyman, 2023) [Tier C].
  - In 2023, TotalEnergies signed a three-year deal to supply biomethane to Saint-Gobain via GO certificates (391, TotalEnergies, 2023) [Tier C]. TotalEnergies will provide 100GWh to support Saint-Gobain in reducing their emissions. The article reports that the contract represents a “purely commercial sale” of non-subsidized biomethane. It could be inferred that the GO purchased by Saint-Gobain cover the full production cost of the biomethane.
  - A document on training material on Biomass in the EU ETS (160, European Commission, 2023) [Tier C] was discussed in a separate submission by Centrica (079, Centrica, 2023) [Tier C]. Centrica states that “where unsubsidised biomethane production is used under the EU ETS via EACs”, then the price paid by the consumer for the EAC is expected to “reflect the carbon price plus any premium they were willing to pay. Currently there is some use of EACs based on subsidized biomethane where the abatement costs are shared between direct production support and income from EAC sales to EU ETS sites”. It is assumed that “subsidized” here refers to production support (e.g., biomethane tariff payments paid to producers).
  - Centrica further discusses the cost of biomethane certificates while referring to the EU Renewable Energy Directive (155, European Union, 2018) [Tier A] and the UK Green Gas Support Scheme (GGSS) Impact Assessment (400, UK BEIS, 2021) [Tier B]. Centrica reports the production cost of biomethane to be £50-85/MWh, whereas biomethane certificate prices in 2023 traded around £20/MWh (079, Centrica, 2023) [Tier C]. Centrica explains that the Renewable Energy Directive expects the Guarantee of Origin market for biomethane to be complementary to the “public support” generated by national policies like the GGSS:
    - “Certificate prices in 2023 have been over £20/MWh which does not match this cost but the RED II framework… makes it clear that the GoO market is complementary to the public support which is provided at the level needed to produce. SBTi guidelines should capture the nuanced picture that has emerged

between the costs paid by consumer via EACs and public support. For example under the RED II framework public bodies have the option to claim the GoO themselves in order that they control claims over the carbon abatement from biomethane production and be releasing them to the market they are fully aware that those claims are being made by consumers who have not paid the full cost of production" (079, Centrica, 2023) [Tier C].

– "The GGSS impact assessment shows the regulatory safeguard for accounting for EAC income in public support, to avoid overcompensation of producers and ensure that maximum [amount] of carbon saving can be achieved for the public support given… It shows that for the EAC market to be effective and sustainable we need a more extensive consultation process between the biomethane industry and the SBTi and for the SBTi to engage directly with policy makers in the UK and EU to look at how non-government and government frameworks can complement and enhance each the other" (079, Centrica, 2023) [Tier C].

3.4 Theme 4: Fuel supply chains involve co-mingled infrastructure

Research questions related to this theme
Question 5: What evidence exists that uptake of attribute certificates leads to or hinders the transformation needed to reach climate stabilization?
Question 8: Is there evidence that shows that the use of these instruments (i.e. procurement of the attribute certificate) could contribute to scale-up of climate finance compared to alternative interventions? Or could it result in climate finance dilution?

Summary
As fuels like SAF and biomethane are often injected into common supply pipelines alongside fossil fuels, mass balance or book and claim accounting is considered by many to be a more practical way of accounting for delivery of these fuels than other chain of custody options. Overwhelmingly, the evidence is supportive of using EACs to address geographical mismatch between low-carbon fuel supply and demand, allowing organizations without physical access to low-carbon fuel or influence on the supply chain to benefit from the environmental attributes of the fuel. As well as increasing the "supply" of low-carbon fuels to more end users, evidence suggests that using mass balance and/or book and claim chain of custody systems could increase the efficiency of decarbonization by reducing costs, administrative burden, and lifecycle emissions associated with the transport and delivery of fuels (in comparison to physical delivery of low-carbon fuels to customers wishing to reduce their emissions).

Detailed evidence
Drop-in fuels like biomethane and SAF are often **comingled with fossil fuels in supply pipelines**, which makes physical tracking of specific batches of fuel impossible. As discussed in other themes, mass balance (and occasionally book and claim) chain of custody systems can be permissible ways to report delivery of low-carbon fuels to fulfil regulatory obligations.

- "SAF is a 'drop-in fuel' which can use existing pipelines and storage infrastructure, which allows it to comingle with conventional jet fuel. The ability to track SAF molecules becomes limited beyond the point of blending, and as such, a book and claim framework, relying on the accounting of environmental attributes, rather than the physical product is necessary from a carbon accounting perspective" (113, Delta Air Lines, 2023) [Tier C].
- "The complexity and intermixing of fuel deliveries at most airport locations make tracking of SAF molecules to specific flights unfeasible" (407, United Airlines, 2023) [Tier C].

There can be geographical discrepancies between the supply of low-carbon fuels and demand, such that organizations wishing to decarbonize may not have access to physical delivery of low-carbon fuels, unblended or through common pipelines. Evidence submitted supports the idea that mass balance and book and claim chain of custody methods can help to **overcome geographical separation between low-carbon fuel supply and demand**, allowing organizations without physical access to low-carbon fuel to invest in and benefit from the environmental attributes of the fuel via EACs.

- In their commentary, the Association of American Railroads highlighted that "transportation providers… have witnessed a rising demand for lower emissions

transportation solutions from their customers". However, "it has become evident that physically supplying [biofuel] to the rail industry in all fueling locations adds considerable complexity" (025, AAR, 2023) [Tier C].

- "SAF [delivery] is often physically constrained to specific airports and regions closest to production" (113, Delta Air Lines, 2023) [Tier C].
- The Business Council for Sustainable Energy submitted evidence discussing an RNG production facility in Arizona and claim that "there is no feasible end-user close enough to purchase the RNG directly" and, as a result, the RNG is injected into the common carrier pipeline (379, BCSE, 2023) [Tier C].
- In their discussion of U.S. State renewable gas programs, STX comments that "both [California] and [Oregon] programs are designed to rely on the use of market-based instruments for renewable gas procurement given that supply is very rarely co-located with demand" (365, STX, 2023) [Tier C].
- "Requiring a direct pipeline between the biomethane source and consumption is not technically or financially feasible; additionally, there are limited biomethane sources co-located near generation facilities" (142b, University of California (Office of the President), 2022) [Tier C].
- World Energy expresses that "without Book & Claim, World Energy would face enormous logistical hurdles delivering fuel to our customers. For example, ensuring that the fuel is delivered to the point of origin for flights carrying Microsoft servers around the globe to fulfill our contractual obligations to Microsoft" (435, World Energy LLC, 2023) [Tier C].
- In their report on book and claim for shipping, Irigoyen et al. discuss how "even as vessels and fuels become available, logistical challenges threaten to slow progress in these early stages. Already, carriers seeking to provide low-emission journeys (via, e.g., biofuels) face difficulties aligning demand with routes where physical bunkering is actually available. This situation is likely to be similar for all new fuels in the first years after their introduction and, therefore, suggest the need for a virtual option to help address initial logistical challenges" (226, Irigoyen et al., 2023) [Tier C].

EACs can accelerate the uptake of low-carbon fuel by providing a "supply" of low-carbon fuel to those looking to decarbonize but without physical access to low-carbon solutions. For some organizations, EACs may be the only feasible decarbonization option in their sector at present: downstream customers may be limited by what is available upstream, and/or unable to influence the supply chain.

- The news coverage of Norden's book and claim program states that the "goal of the platform is to link emission reductions made by Norden with customers that, due to trading routes or other constraints, are unable to bunker low-carbon fuels but are still looking to decarbonise their operations or supply chains" (015, Ajdin, 2023) *[Tier C]*.
- The SAFc Emissions Accounting and Reporting Guidelines (091, Clean Skies for Tomorrow, 2022) *[Tier C]* state that book and claim for SAF "enables air transport consumers and providers without physical access to SAF to invest in this nascent industry and make valid emission reductions claims associated with a given amount of SAF, thus more directly addressing their aviation climate impact".

- In the survey on EACs published and reported on by the Book and Claim Community (317, Rocky Mountain Institute, 2023) *[Tier C]*, several respondents remarked that EACs were the only decarbonization option in their sector. The following comments were presented:
  - "For purchased transportation, you are limited by what's available within the fuel systems, as well as the infrastructure. If there's no flexibility with accounting mechanisms, some flows do not have a low carbon fuel option and therefore there is no viable pathway forward."
  - "To [sic] expensive to buy own vessels that work with sustainable fuels or to assign service providers to physically transport our goods with a sustainable vessel."
- IATA submitted their recommendations to policymakers on robust SAF accounting. They discuss how SAF "insetting" would stimulate "SAF uptake where demand would not justify local SAF production (i.e., notably in smaller airports and remote locations), or where physical supply is too expensive or otherwise impeded", and would "[expand] the customer base compared to if physically matching supply and demand, thus providing a clear market signal favoring the ramp up of SAF production" (214, IATA, n.d.) [*Tier C*].
- In their guide on decarbonizing freight shipping, GoodShipping states that "decarbonising the transportation sector involves multiple stakeholders, especially cargo-owning companies that lack ownership of the vessels, trucks, or airplanes used for transportation. To overcome this obstacle, it's important to allow the transfer of emission reduction actions throughout the transportation supply chain, a process that can be facilitated via Book and Claim (B&C) model" (189, GoodShipping, 2024) *[Tier C]*.
- A report from the Coalition of Renewable Natural Gas states that "not all entities seeking to procure clean and renewable energy have direct or local access to such resources. A book-and-claim system enables geographically separated suppliers and end-users to connect" (147, Coalition for Renewable Natural Gas, n.d.) *[Tier C]*.

As well as opening up the "supply" of low-carbon fuels to more end users, EACs could also **increase the efficiency of decarbonization by reducing costs, administrative burden, and the lifecycle emissions** associated with the transport and delivery of fuels. *These statements are made in comparison to the physical delivery of fuel to all organizations and customers who wish to reduce their emissions.*

- In their letter to the U.S. Treasury Secretary, the SAF Blender's Tax Credit (BTC) Coalition asks the Secretary to consider allowing book and claim accounting for both SAF feedstocks and process inputs, such as hydrogen or electricity. The Coalition claims that book and claim accounting "not only drives supply chain efficiency and ensures adequate supply is available where it is needed, but it also can significantly reduce transport emissions from the SAF supply chain, supporting the emission reduction goals of both the 40B and 45Z credits" (331, SAF BTC Coalition, 2022) *[Tier C]*. No data is provided to substantiate this claim.
- The SAFc Emissions Accounting and Reporting Guidelines (091, Clean Skies for Tomorrow, 2022) *[Tier C]* suggest that book and claim accounting will "help limit supply

chain inefficiencies in [delivering] fuel around the world, which add to SAF's lifecycle emissions".

- In their paper on EAC traceability in agro-food value chains, Mol and Oosterveer argue that mass balance and book and claim chain of custody systems "(i) lower the costs of traceability because they require no separate systems of storage, transportation and processing; (ii) are less complex (and thus less costly) in implementation, monitoring, auditing and certification for all intermediate value chain actors, and (iii) make sustainably produced products really competitive with conventional ones. Only in this way sustainably produced products can seize significant market shares beyond niche markets" (262, Mol and Oosterveer, 2015) *[Tier B]. Although this paper was focused on agro-food value chains, its key arguments are applicable to the discussion of EACs for fuel.*
- "A book and claim system has the potential to significantly streamline the regulatory and voluntary reporting and verification processes related to SAF, reducing administrative burdens, and mitigating unnecessary logistics, including associated emissions and costs, while enhancing their objectives of accelerating decarbonization" (251, Lufthansa, 2023) *[Tier C].*
- "Importantly, the use of market-based instruments within the interconnected gas system will continue to incentivize the most rational, GHG- and cost-effective buildout of renewable gas supply. Importantly, conventional gas is often moved from out-of-state sources—from supply centers to demand centers—and is governed by market rules which cause gas to move from supply to demand in the most efficient way from both a GHG and cost standpoint. It follows that rules which do not allow for use of market-based procurement of renewable gases would create re-dispatch of the natural gas system in a way that is likely GHG-increasing" (STX, 365, 2023) *[Tier C].*

3.5 Theme 5: Several conditions for effectiveness were proposed

Research questions related to this theme

Question 2: What evidence supports or opposes a causal link between specific operating conditions (geographies, regulatory schemes, presence or absence of tracking mechanisms or registries, etc.) and the effectiveness of environmental attribute certificates to deliver emission reductions? Which conditions?

Question 3: What regulatory safeguards and market infrastructure, if any, would need to be put in place for environmental attribute certificates to be effective and sustainable?

Question 6: What specific evidence-based claims can and cannot be made when employing environmental attribute certificates to corporate decarbonization?

Summary

In general, the evidence submitted supports the use of registries to track the issuance and trading of EACs, to ensure transparency and reduce the risk of the same volume of renewable fuel being reported twice. Registries are already in use by some countries to track low-carbon fuels like biomethane and are also being used by some organizations as part of a book and claim system.

The evidence proposes a range of conditions and safeguards to ensure the effectiveness of EACs in delivering economy-wide emissions reductions. These include temporal conditions (e.g., length of time between a low- carbon fuel being consumed and the environmental attributes being claimed), modal (e.g., EACs should only be reported in the transport sector from which they were generated), geographical (e.g., what is the geographical system boundary in which EACs can be purchased), and sustainability-related requirements. Some of these conditions have been incorporated into existing EAC schemes for the voluntary market.

Detailed evidence

EAC registries could help to standardize the issuance and reporting of EACs by providing a transparent chain of custody systems and preventing any double counting of environmental attributes (i.e., two organizations claiming the same attributes from the same quantity of fuel). Registries will typically issue certificates when proof of production/delivery of a volume of fuel is supplied and will then cancel or "retire" that certificate when an organization claims the environmental attributes.

- "Our members recognise the role of robust and well-regulated registries, to ensure that: there is a transparent and robust chain of custody; mechanisms are in place to prevent double-counting and/or double-claiming; and existing best practices are proliferated within our industry" (398, UK Chamber of Shipping, 2023) *[Tier C].*
- "A global central registry for SAF [Declarations of Environmental Attributes] does not currently exist. Instead, fuel suppliers generate and issue their own DEAs directly to

buyers through a variety of means. A global centralized registry may need to develop as SAF production increases" (340/3441, SFC and MIT, 2021) *[Tier C].*

- "SAFc requires… a transparent registry to streamline and showcase the creation and use of certificates and clear accounting protocols to avoid the possibility of double counting the environmental benefits" (091, Clean Skies for Tomorrow, 2022) *[Tier C]*.
- "A book and claim system needs a central registry as the primary database to ensure integrity. It should distinguish between SAF supply to meet obligations and additional voluntary SAF procurement (i.e., direct purchases by airlines)" (251, Lufthansa Group, 2023) *[Tier C].*
- REGATRACE published a set of guidelines for EU and national policy makers regarding the set-up and operation of national biomethane registries (307, REGATRACE, 2019) *[Tier C]*. The guidelines state that biomethane registries are "key for the development of domestic biomethane/renewable gas markets", and that registries have a responsibility to be a "neutral and trustworthy" platform for customers.

Some registries already exist for low-carbon fuels, with others under development. Registries form one part of a functional book and claim system, alongside standards for how the registry and book and claim system should operate.

- The RSB Book & Claim Registry can be used to register and track any renewable fuels which adhere to RSB's sustainability criteria (323, Roundtable on Sustainable Biomaterials, 2023) *[Tier C]*. The Registry is being used by RSB to develop a comprehensive book and claim system for SAF.
- The ISCC Credit Transfer System "extends the traceability of SAF transactions and sustainability claims downstream of SAF delivery, thereby allowing the transfer of credible sustainability claims between SAF suppliers, aeroplane operators, logistics providers and end-customers" (223, ISCC, 2023) *[Tier C]*. "Participating organisations can transfer SAF claims via a standardised electronic registry operated by ISCC to partner organisations in their downstream value chain". The ISCC system is "governed by clear and transparent set of rules, designed to ensure traceability and credibility of SAF transactions and related sustainability claims."
- SABA, RMI, EDF, and other stakeholders have been working to "develop detailed specifications for a book and claim registry for SAFc. The registry is an IT system that will record all issued and retired certificates and prevent double claiming of environmental attributes across the value chain" (091, Clean Skies for Tomorrow, 2022) *[Tier C]*. The SAF Certificate Registry Rulebook describes this registry as a "secure and standardized electronic database that enables — inter alia — the issuance, holding, transfer, and retirement of units" (038, Bart, Hutchinson and Ehirim (EDF and Rocky Mountain Institute), 2023) *[Tier C]*.
- Midwest Renewable Energy Tracking Systems (M-RETS) for biomethane tracking in the U.S. (118, Downstream Natural Gas Initiative, 2023) *[Tier C].*

Evidence suggests that aligning book and claim systems, policy, and existing corporate GHG reporting standards would improve trust and acceptance in the system.

- "Although a Book & Claim system is not a compliance tool, aligning with the regulatory bodies' approaches to calculating emissions of maritime transportation services is essential to improve the system's acceptance by ensuring that the administrative burden of collecting and processing data is reduced… Our book & claim system must align with accounting and reporting schemes of standards to facilitate adoption and create a common language… reliable and accurate emission accounting is the bedrock for building trust among users and for leveraging their efforts in order to achieve efficient and timely sectoral decarbonization goals… Our proposed Book & Claim system will incorporate several elements from the mentioned voluntary schemes [including GHG Protocol and Global Logistics Emissions Council] since some are referents for the industry and enable a common language between the system and the ecosystem around the decarbonization of the maritime industry" (252, MMMCZCS, 2023) [*Tier C*].
- "Robust systems are already in place in both voluntary and compliance markets to assess and transparently report the carbon intensity of clean fuel and electricity sources; generate, verify, track, and retire certificates; and prevent double counting. These programs have been designed to enable the effective use of market-based instruments in voluntary and compliance markets. SBTi must seek to align its framework with existing mandatory policies to avoid issues in reporting between compliance markets, voluntary markets, and those who may be required to report all purchases under the GHG Protocol and/or SBTi" (060, BCSE, 2023).

The evidence has suggested a **wide range of "safeguards" or conditions (including within registries) to ensure the effectiveness of EACs** in creating measurable emissions reductions. Many of these safeguards have already been implemented in existing EAC programs (187, GoodShipping, n.d.) *[Tier C]*, (015, Ajdin, 2023) *[Tier C]*, (238, Kuehne + Nagel, 2023) *[Tier C],* (374, SABA, 2023) *[Tier C],* (178, Gasum, 2023) *[Tier C]*.

- **Temporal conditions**: once an EAC has been issued or booked, the environmental attributes should be claimed within a certain period of time.
  - "[EACs] registered in the RSB Registry shall be retired within a maximum 24 calendar months from the date of BCU registration" (324, RSB, 2023) *[Tier C]*.
  - In their guidance on SAF GHG emissions accounting and insetting, the Smart Freight Centre and MIT Center for Transportation and Logistics suggest that "SAF EACs are valid for up to two consecutive reporting periods from the date of SAF production". This principle ensures that SAF suppliers do not "stockpile" certificates and "sell those environmental attributes at a premium years later". It also ensures that customers who purchase EACs cannot report them "against their GHG emission footprint several years later" (340, SFC & MIT, 2021) *[Tier C]*.
  - IATA note that "at current time, there are no specific restrictions on SAF vintage under aviation regulatory frameworks such as CORSIA and EU ETS, but this is

currently being considered and discussed under voluntary frameworks" (214, IATA, n.d.) *[Tier C]*.

- The Mærsk McKinney Møller Center for Zero Carbon Shipping is developing a book and claim system specifically for the shipping sector (252, MMMCZCS, 2023) [*Tier C*]. The system will initially use a fixed fungibility period of three months between each step of the process (voyage completed, booking, claiming, and passing/swapping the tokens). The length of this period may be adjusted over time as the system expands beyond the pilot.

- **Geographical conditions**: For example, what is the geographical system boundary of the book and claim scheme?
  - In their whitepaper on EAC program design, the UC Irvine Clean Energy Institute suggests that a balance is required between providing effective incentives to stimulate investment in low-carbon technologies, while guaranteeing the desired emissions reductions are attained. The authors state that "wider geographic market boundaries better optimize the overall resource supply portfolio" and that restrictions to the program/trading boundaries result in the lowest-cost resource being prohibited from "supplying the marginal consumer" (306, Reed et al., 2023) *[Tier C].*
  - Lufthansa submitted a whitepaper outlining how an EU-wide book and claim scheme for SAF could allow for easier mandatory and voluntary SAF reporting and improve the transparency and confidence in SAF certificates (251, Lufthansa, 2023) *[Tier C]*. Lufthansa states that a "key success factor" for book and claim will come from "carefully defining system boundaries": this includes a condition that certificates being reported for regulatory obligations should only be traded in the geographic scope specified in the regulation for which the obligation is being met. Kuehne + Nagel discuss geographical constraints within their book and claim program for transport logistics providers: "In the case of Road Logistics, we also apply geographical restrictions as it does not have the same intercontinental characteristics as the aviation and shipping industry. For example, EACs created by the usage of HVO in France can only be claimed for transportation activity within Europe" (238, Kuehne + Nagel, 2023) *[Tier C]*.

- **Sectoral/modal use**: Several pieces of evidence suggest that EACs should only be used for in-mode GHG claims (e.g., EACs generated from SAF should only be used to address a company's aviation-related emissions).
  - The RSB book and claim system states that EACs should only be claimed within a sectoral use and up to the total footprint of the organization in that sector (i.e., SAF BCU can only be used to address aviation emissions, and cannot exceed the total emission generated by the claimant in the aviation sector) (324, RSB, 2023) *[Tier C].*
  - The Smart Freight Centre and MIT's guidelines for SAF GHG emissions accounting and insetting suggest that "environmental attributes of SAF can only be used to inset air transportation" (340, SFC & MIT, 2021) *[Tier C]*. However, it does not explicitly define what the boundary for insetting is.

- In their guidelines for Voluntary Market Based Measures Framework for Logistics Emissions Accounting and Reporting, the Smart Freight Centre suggests that "an organization is precluded from assigning the emission profile of a [low emission transport solution] in one mode of transportation towards the emission footprint of other modes of transportation". However, "a voluntary solution for one mode of transport may generate credits that are applied towards achievement of a regulatory requirement for another mode of transport" (345, Smith & Lewis, 2023) *[Tier C].*
- *"*Book and claim assumes the acceptability of at least one kind of insetting: the transfer of credits for emissions reductions from a company's vessel that uses zero-emission fuel to another of the company's vessel that does not. But some questions about credibility of different options remain: Do the reductions need to take place on the same type and size of vessel? In the same segment? Could reductions achieved on, for example, vessels that cover short distances e.g. feeders be transferrable to deep sea cargo ships?" (226, Irigoyen et al., 2023) *[Tier C].*
- Kuehne + Nagel's book and claim program for transport logistics vehicles introduces a "modal constraint" (238, Kuehne + Nagel, 2023) *[Tier C]*.

- **Interoperability**: evidence suggests that certificate registries be set up to allow for information exchange, with the aim of providing greater transparency for certificate tracking and to avoid double-counting.
  - In their recommendations to policymakers on SAF EAC accounting, IATA suggests that registries should be interoperable so that unique IDs can be identified for specific batches of SAF within different operating systems, to ensure no double issuance, usage or claiming (214, IATA, n.d.) *[Tier C]*. "Emissions reduction from the same batch of SAF [should be] recognizable in all operating SAF accounting platforms/registries."
- Regarding the concept of regulatory additionality: the regulatory and voluntary market could be separated and the regulatory support received by a unit of fuel should be clearly stated in the registry (288, Piris-Cabezas, n.d.). The concept of additionality is discussed in greater detail under Theme 2.
  - In their report on how an EU-wide book and claim system for SAF could simplify both regulatory and voluntary reporting, Lufthansa describes how the system **must clearly define the "system boundaries" of certificate trading to separate mandatory and voluntary markets**: for SAF supplied for voluntary procurement, airlines/suppliers should make individual arrangements for the procurement and supply of SAF through transaction of voluntary certificates, which are then "redeemed" and allocated to customers. Lufthansa explains that existing market infrastructure approved by the EU (e.g., biomethane registries for GOs), could serve as the "blueprint" for an EU-wide SAF B+C scheme (251, Lufthansa Group, 2023) *[Tier C].*
  - The RSB Book & Claim Manual sets out the requirement for registering, transferring, and retiring the sustainability attributes of SAF, including the GHG emission reduction benefits, in the form of a BCU. It includes aspects related to sustainability

certification, sustainability data points, claims, double counting, and additionality (324, Roundtable on Sustainable Biomaterials, 2023) *[Tier C]*.

- **Sustainability -** For example, what lifecycle emissions, feedstocks, mitigation of indirect impacts, or Proof of Sustainability should be required to ensure the effectiveness of EACs.
  - In REGATRACE's recommendation to EU policymakers, the authors suggest a "harmonized certification and documentation approach for renewable gases" which would allow GOs and Proof of Sustainability certificates to be intrinsically linked (308, REGATRACE, 2022) *[Tier C]*.
  - The SAFc Emissions Accounting and Reporting Guidelines suggest that SAF should meet a 60% lifecycle CO2e emission reduction relative to conventional jet fuel (091, Clean Skies for Tomorrow, 2022) *[Tier C]*. The guidelines also suggest that SAF should not threaten food security, result in direct or indirect land-use changes, or have significant emission footprints from production.
  - Lufthansa suggest that SAF certificates should include all environmental characteristics of the SAF as defined in its Proof of Sustainability documentation, so that the certificate represents the fuel and its environmental properties, rather than its emissions or an emissions reduction (251, Lufthansa, 2023) *[Tier C]*.

The evidence acknowledges that various standards exist to certify the sustainability and GHG emission profiles of low-carbon fuels, which can be required for policy targets or to register fuel in a book and claim scheme (411, United States Environmental Protection Agency, 2021) *[Tier C]*.

- There are two CORSIA Approved Sustainability Certification Schemes—ISCC and RSB (218, International Civil Aviation Organization (ICAO), 2020) *[Tier B]*.
  - The ISCC's SAF certification standard ensures that SAF is produced in accordance with "strict sustainability requirements", which includes use of sustainable feedstocks, traceability through the supply chain, and verified reduction of GHG emissions against a fossil baseline (225, ISCC, n.d.) *[Tier C]*. ISCC certification is acknowledged under policies like EU RED as proof of sustainability of fuels supplied to meet policy targets.
  - The RSB Standard for ICAO CORSIA details requirements for SAF relating to sustainability criteria (includes a minimum GHG emission reduction threshold, and requirements relate to the conversation of carbon stocks), requirements related to the calculation of SAF lifecycle GHG emissions (including considerations for indirect emission impacts), and the use of low indirect land use change (ILUC) risk feedstocks (327, RSB, 2023) *[Tier C]*.
- The RSB Standard for Advanced Fuels describes requirements for the production of advanced fuels including fuels from biogenic end-of-life productions and production residues, recycled carbon fuels from non-biogenic end-of-life products and production residues, renewable liquid and gaseous fuels of non-biological original (321, Roundtable

on Sustainable Biomaterials, 2023) *[Tier C]*. The standard outlines requirements to track biogenic portion of fuels for co-processing, for recycled carbon fuel (RCF) feedstock, and renewable electricity sourcing for renewable fuels of non-biological origin (RFNBOs) to ensure no wider negative impact on the grid (i.e., additionality; temporal correlation).

- Under the EU ETS, obligated parties must use voluntary schemes to prove compliance with RED criteria in order to claim a zero emissions rating for their fuels (162, European Commission, 2022) *[Tier C]*.

National/regional policies generally permit the use of EACs to deliver biomethane and have developed their own systems and safeguards, which in some cases has included instating **national biomethane registries**.

- The EU's Renewable Energy Directive (RED) was submitted by multiple parties (155, European Commission, 2018) *[Tier A].* In the Directive, GOs have a defined role for consumer disclosure of renewable gas consumption, and the text lays out conditions for how GOs should be administered and accounted for to ensure no double-counting of renewable energy (and associated emissions reductions). RED states that "Member States or designated competent bodies shall supervise the issuance, transfer and cancellation of guarantees of origin… [and] shall put in place appropriate mechanisms to ensure that guarantees of origin are issued, transferred and cancelled electronically and are accurate, reliable and fraud-resistant." The Renewable Gas Tracking Systems report highlighted that, in practice, practical aspects of GOs are set in national legislation and differ between the Member States (158, EBA; WBA; ERGar; RNGC, 2023) *[Tier C]*.
- DENA (German Energy Agency) submitted a guide to its biogas certificate registry, which is based on a mass balance system (115, DENA Biogas register, n.d.) *[Tier C].* The registry has been used for more than a decade in the German biomethane market, and the guide highlights the stringent safeguards in place. Verification is implemented at every interface (production, injection into the gas grid, trading, and withdrawal from the gas grid). Additional audits are carried out on the biomethane plant, as well, to verify the quantities produced. The report is uploaded to the register and checked by DENA register management for consistency with the biomethane producers' data. The German government's Renewable Energy Source Act is another example of this, which outlines safeguards to ensure the traceability of biogas used for electricity generation to claim policy premiums (180, German Federal Ministry of Justice and the Federal Office of Justice, 2023) *[Tier B]*.
- The French Decree No. 2022-640 lays out legislation for the formation of a biogas production certificate scheme in France (173, French Ministry of Ecological Transition, 2022) *[Tier B]*. In France, the biomethane production registry operates separately from the GO registry; for biomethane to be issued with a production certificate, it must not have already generated a GO.
- A report by Energinet (the Danish national transmission system operator for electricity and natural gas) states that to avoid double counting, "sellers of the guarantees of origin are obliged to cancel a number of guarantees of origin in Energinet's registry,

corresponding to the number they have sold". The cancellations ensure that the GOs are only sold once. The GO also "documents from which biogas plant the gas was produced and when it was produced", which enables traceability (128, Energinet, n.d.) *[Tier C].*

- The Renewable Gas Tracking Systems report (158, EBA; WBA; ERGar; RNGC, 2023) *[Tier C]* describes the M-RETS system as the most widely used renewable gas tracking system in North America. The M-RETS tracks Renewable Thermal Certificates (RTCs) in both voluntary and compliance markets (including the California Renewable Gas Standard, Oregon Renewable Gas Standard, Washington Clean Fuel Standard). Quality of certificates are guaranteed through a verification protocol fulfilling two functions:
  - Safeguarding authenticity by validating the originating generator via a review of mandatory Professional Engineering Reports, Interconnection Document, LCA reports and other requisite paperwork.
  - Preventing double-counting by cross-referencing with other tracking systems, which encompasses carbon offset registries.
- The UK Renewable Transport Fuel Obligation guidance document and additional guidance on biomethane outline several requirements and safeguards for the reporting of biomethane (402, UK DfT, 2022; 403, UK DfT, 2022) *[Tier B]*. "Suppliers of biomethane… can use national or international gas grid systems as part of their chain of custody provided that certain conditions are met." However, "renewable guarantees of origin and other commercial green gas certificates are not acceptable to support an application" for certificates representing fulfilment of the renewable fuel obligation.
- Guidance on the California LCFS sets out requirements for using book and claim accounting for biomethane (068, California Air Resources Board, 2019) *[Tier C]*. Those claiming the environmental attribute must demonstrate proper accounting to mitigate double counting (e.g., an exclusive right to claim environmental attribute, environmental attributes that are retired when claimed under the LCFS, chain of custody information, records showing contracts along the supply chain, price per unit of the attribute). The guidance also outlines the temporal correlation requirement that environmental attributes for biomethane must be claimed within three quarters of a year.
- REGATRACE has developed advisory documents for how each EU member state should implement a biomethane registry to robustly track GOs, harmonize standards, and facilitate cross-border trading within the EU. They also recommend that policymakers allow the transition from individual national registries to a common European renewable gas market (308, REGATRACE, 2022) *[Tier C]*.
- ERGaR also discuss their biomethane Certificates of Origin (CoO) scheme which is designed for "National registries who are operating with or without a government mandate and may or may not have been appointed by their government as the competent body under RED II" (153, ERGaR, n.d.) *[Tier C]*. CoOs are defined as "an electronic document that records information about consignments of biomethane injected into the Natural Gas Network". The sustainability standards for CoOs are less strict than for GOs; CoOs must meet ERGaR scheme standards rather than international standards (GOs requirements are defined through REDII and CEN-EN 16325). *The*

submitter claims that the Registry aims to enable cross-border transfer of renewable gas certificates based on reliable and robust tracking systems, but the evidence does not prove this has been the outcome (154, ERGaR, CoO Scheme Rules, 2022).

In the **voluntary market**, existing EAC purchase programs and schemes have already incorporated some conditions and safeguards to ensure the effectiveness of EACs.

- Corporate EAC scheme examples:
  - In their book and claim program, DHL sets out sustainability requirements for the SAF it purchases, which are that it must be from waste sources (to not compete with other needs such as food production and land use), and the SAF must be certified by a sustainability certification scheme (116, DHL, 2023) *[Tier C]*.
  - Air France KLM's corporate book and claim program includes the following conditions: 1) SAF lifecycle emissions have been certified by relevant bodies; 2) SAF feedstocks used are not from first generation or palm related oils; 3) a mass balance chain of custody approach was used to avoid double counting (012, Air France KLM, 2022) *[Tier C].*
  - As part of their Eco-Skies Alliance program, United Airlines operates their own internal SAFc registry to track SAF deliveries and mitigate the risk of double counting. United claims that the internal registry “provides full visibility into the SAF chain of custody” (407, United Airlines, 2023) *[Tier C]*.
- General EAC schemes:
  - RSB’s Book and Claim program requires that each EAC be certified as sustainable under an eligible list of certification schemes, and that batch-specific information (i.e., Proof of Sustainability, which includes information on the fuel batch, supplier, customer, and product) is provided to link the environmental attribute to a product that has been produced with the same specified characteristics (324, RSB, 2023) *[Tier C].*
  - To register SAF in ISCC’s Credit Transfer System, the SAF must be registered as sustainable via a scheme recognized by ICAO, a voluntary scheme recognized by the European Commission, or ISCC PLUS (223, ISCC, 2023) *[Tier C]*.
  - Shell submitted information about Avelia, the book and claim “solution” which Shell co-founded, that provides "fully traceable environmental attributes of SAF" (341, Shell, n.d.) *[Tier C]*.
  - The Green Gas Certification Scheme is a UK-based scheme that issues, transfers, and retires Renewable Gas Guarantees of Origin (RGGOs) within their registry. The Annual Report 2022 (192, Green Gas Certification Scheme, 2022) *[Tier C]* lays out the sustainability criteria on which gases qualify as green and may be issued with RGGOs. These rules are not as strict as the EU RED II criteria and allow for gas produced from renewable or non-renewable sources to be issued with RGGOs. GHG saving criteria require that the gas has “lower GHG emissions from its production and consumption than an equivalent fossil fuel product”, rather than a

specific (e.g., 70%) savings compared to a baseline fossil fuel product. The GGCS report claims that the scheme protects against double counting by "carefully controlling the number of RGGOs issued and ensuring that they are retired at the point they are allocated to a consumer". While RGGOs can be issued to voluntary customers, the certificates can also be retired and put towards a party's obligation under the UK Renewable Transport Fuel Obligation.

Concerns regarding mass balance and/or book and claim accounting for low-carbon fuels are focused on fraud and green-washing allegations.

- For SAF and shipping fuels (i.e., LNG, methanol, etc.), ABB expressed its concern over the mass-balance approach, and that "it represents a potential greenwashing risk", when the SAF premium paid for a flight that does not have any SAF on board. Specifically for the shipping sector, ABB states that "concerns exist over the additionality and overall environmental credibility in different approaches being used by industry" (006, ABB, n.d.) *[Tier C]*.
- Mol and Oosterveer claim in their paper that "it is widely conceived that book and claim systems are more vulnerable to fraud than identity preserved and segregation systems, with mass balance systems in between. As the administration of sustainable primary production and the final certified products that are sold are decoupled, more vulnerabilities emerge in terms of illegal introduction of non-sustainable products, creation of certificates, fraud in monitoring and registration" (262, Mol and Oosterveer, 2015) *[Tier B]*.
- The draft Land-Sector-and-Removals-Guidance (184, GHG Protocol, 2022) *[Tier C]* states that "accounting for GHG emission and removals from the production of land-based products requires physical traceability of the materials or products to their origin", and therefore doesn't allow corporations to claim Scope 3 emissions reductions via EACs that rely on chain-of-custody models that don't ensure physical traceability, such as mass balance or book and claim.

3.6 Theme 6: Respondents had varying views on how lower emissions should be claimed

Research question related to this theme

Research question 4: What evidence supports or opposes the ability of environmental attribute certificates to accurately reflect and quantify emission reductions in the context of corporate climate abatement targets?

Research question 6: What specific evidence-based claims can and cannot be made when employing environmental attribute certificates to corporate decarbonization?

Summary

Currently, the use of fuel EACs in corporate GHG reporting is not allowed by Greenhouse Gas Protocol (GHGP) in some cases, and not mentioned in other scenarios. Some guidance exists for insetting measures towards scope 3 reporting, but approval is not guaranteed.
There is evidence which argues that emission claims should only be made if EACs are generated within the user's value chain (i.e., the low-carbon fuel is used by the company from whom the claimant purchases transport services). This practice is referred to as insetting.
Respondents have different views on the book and claim accounting approach. EACs differ based on whether there is a physical link between the low-carbon fuel and transport carriers (i.e., organizations that operate transportation activities in providing transportation services).
Emission reporting and reduction claims should be made transparently, supported with proof that backs up the emission claims. An example proposed is to use dual reporting (i.e., reporting emissions as if fossil fuels *or, presumably, a future average of fuel supplied in the location* were used and reduced emissions calculated by subtracting emissions related to retiring SAFc).
Currently, companies only report emissions from fuel combustion. Evidence suggested that this may need to be reviewed to account for GHG emissions of low-carbon fuels on a lifecycle basis.

Detailed Evidence

Currently, accounting approaches for EACs for low-carbon fuels are unclear and inconsistent under GHG reporting guidelines (i.e., GHG Protocol) and regulation (e.g., CORSIA, CA LCFS, etc.). SBTi currently allows companies to include "emission reduction or removals from insetting projects", where insetting refers to "mitigation projects that are wholly contained within a scope 3 supply chain boundary of a company, and a project adjacent to a supply chain boundary". The approval of insetting projects is assessed on a case-by-case basis, which adds risk and uncertainty to EAC purchasers.[1]

- The GHG Protocol does not have a clear guidance on treatment of biomethane certificates, but they are allowed under regulations in several jurisdictions.

[1] SBTi (2021), The SBTi's Net-Zero Standard Road Test, Available from: [Link]

- The draft Land Sector and Removals Guidance (which was submitted as evidence) had previously stated that "Biomethane certificates or credits cannot be used to adjust scope 1 emissions resulting from the combustion of gas (in company owned/controlled sources) delivered via a common carrier pipeline. Companies may report purchases of certificates or credits separately from the scopes in a GHG inventory report" (184, GHG Protocol, 2022) *[Tier C]. However, we note that the Annex that stated this had been removed by the GHGP in 2023 as stakeholder feedback expressed this topic should be considered further. In the meantime, there is no definitive guidance on the treatment of biomethane certificates under the GHGP. The latest guidance from the GHGP states that "In the absence of guidance, companies purchasing certificates may wish to consult with their auditors and consider rules provided by relevant target-setting programs or applicable regulatory schemes in their jurisdiction(s) on how to report these purchases in their reports, while ensuring full transparency and following all GHG accounting and reporting principles".*[2]
- In a case study submitted regarding the University of California's biomethane procurement strategies, it says that "Under California Cap and Trade and the prevailing voluntary market greenhouse gas reporting guidance when the procurements were planned, the University can procure biomethane — located both within the state and outside of the state, and injected into a common carrier natural gas pipeline — and, as long as the University owns the carbon attributes associated with the biomethane, count the biomethane as a zero-carbon fuel, reducing Scope 1 GHG emissions" (313, Renewable Thermal Collective, 2022) *[Tier C].*

- The training material on Biomass in the EU ETS published by the European Commission outlines how the use of biomethane can be allocated to EU ETS sites using EACs (described as "purchase records"). As a result, the consumption of biomethane via EACs and withdrawing gas from an EU interconnected gas grid can lead to zero-rated Scope 1 emissions under the EU ETS (160, European Commission, 2023) *[Tier C]*, (079, Centrica, 2023) *[Tier C]*. However, for SAF, it is unclear whether book and claim chain of custody models are allowed beyond fuel blending in existing policies. Separately, some fuel policies accept the separation of some environmental attributes but only in specific cases. These indicate inconsistencies on the acceptance of environmental attributes separated from the physical product.
  - The evidence "The High-Integrity Sustainable Aviation Fuels Handbook", points out that CORSIA "requires mass-balance traceability through at least the blending point with fossil jet fuel. However, the ICAO rules are vague on the traceability requirements applicable after blending, which could be interpreted as an informal book and claim system outside the scope of the SCS [Sustainability Certification Scheme]" (288, Piris-Cabezas, n.d.) *[Tier C]*. Note that CORSIA's scope is limited to airline activities, and so this does not apply to approaches to SAF claims downstream of airlines.

[2] GHG Protocol (2023), Interim Update on Accounting for Biomethane Certificates, Available from: [Link]

- The HEFA pathways carbon intensity Calculator for California's LCFS program (draft version), accepts "B&C (book and claim) RNG CI" attributes specifically for on-site hydrogen production from natural gas. It does not accept B&C inputs for other processes in HEFA production (064, California Air Resources Board, 2023) *[Tier C]*. Similar rules are observed in EU RED.

Differing views on the book and claim accounting approach for EACs are presented in the evidence, based on whether there is a physical link between the low-carbon fuel and transport carriers (i.e., organizations that operate transportation activities in providing transportation services).

- The Smart Freight Centre's (SFC) Voluntary Market Based Measures Framework for Logistics Emissions Accounting and Reporting explains that there are two ways of generating EACs (the SFC refers to this as low emission transport services or LETS) in a book and claim chain of custody. The first is "direct generation", this is when "there is a physical tie between a low emission solution (i.e., low-carbon fuels) and the carrier generating the LETS", and "indirect generation", which is when "a physical tie cannot be made between a solution and a LETS". It says that the key distinction between indirect generation to direction generation is that an "LETS [EAC] was assumed to be generated or a solution assumed to be applied somewhere – but not necessarily by the booking or claiming organization or by that organization's contracted transportation service suppliers". In these scenarios, the EAC purchasers "likely do not know what transportation activity actually was conducted with the solution", so assumptions will have to be made. It goes on to say, "Because of these assumptions inherent in indirect LETS [EAC] generation scenarios, it is reasonable to impose constraints on indirect generation scenarios to ensure that the flexibility afforded by a book and claim framework is driving additional decarbonization of the transport sector". As a result, and as seen previously, additionality is a requirement for indirect generation of EAC, but not for direct generation (345, Smith and Lewis, 2023) *[Tier C]*.
- SustainCERT, in partnership with CarbonLeap, provided a case study discussing how a commodities trader used EACs to invest in supply chain mitigation actions and reduce Scope 3 emissions. This evidence highlights that "the extent to which different EAC programmes separate the certificate from the underlying good or service determines the claims that can be made". The case study describes a "supply-shed" approach to EACs; this is similar to direct generation of EACs as defined under the SFC, "allows the reporting company to credibly claim that a low-emitting transport service, in which it invested, was potentially part of the logistics chain", (e.g., the reporting company financed the procurement of biofuel which was used by a shipping company, with whom the reporting company ships its products, although biofuel may not be used on the specific ships contracted by the reporting company). It suggests that EACs from these verified value chain interventions support claims that Scope 3 emissions have been reduced by the reporting company (375, SustainCERT, 2023) *[Tier C]*.

- In contrast, the same evidence suggests that “book and claim systems fully decouple the goods and services from their environmental attributes and do not require a verifiable link to a claimant's value chain”. Without this link, there is greater uncertainty over the relevance and accuracy of applying these goods/services to a company's supply chain. In this way, “B&C EAC programs do not support claims that Scope 3 emissions have been reduced”. Additionally, there is the risk that “this unbundling between physical flow and GHG emissions does not require companies to take environmental responsibility for their business”. However, it notes that “a book and claim model can catalyse finance from many transport sectors across different supply chains”, and that “the global supply and demand of EACs constitutes a broad market to finance decarbonisation”. As such, it concludes that “book and claim approaches should be reported separately from the inventory and leveraged as narrative claims” (375, SustainCERT, 2023) *[Tier C]*.

Evidence discusses how EACs and their attributes should be distributed along the supply chain, in terms of which companies can use them to report lower Scope 3 emissions. They agree that scope 3 claims can be made multiple times by stakeholders along the fuel supply chain.

- The environmental attributes of one unit of low-carbon fuel are relevant to many stakeholders along the fuel supply chain, so that the same GHG intensity can be reported multiple times within scope 3 reporting.
  - The SAFc Emissions Accounting and Reporting Guidelines (091, Clean Skies for Tomorrow, 2022) *[Tier C]* “acknowledges that double counting within scope 3 emission can occur when multiple entities in the same value chain account for the scope 3 emissions from a single emission source” (though should be reported in different scope 3 categories).
  - In Delta Air Lines’ case study, it states that the GHGP recognizes the multiple and overlapping emissions claim that can occur within the scope 3 value chain (113, Delta Air Lines, 2023) *[Tier C].*
- The case study authored by SustainCERT also discusses how multiple organizations can make Scope 3 emissions reductions claims from value chain interventions. This follows the "good double-counting" principle of the GHG Protocol Scope 3 Standard. It also suggests that “this practice creates incentives for companies to take collective action” (375, SustainCERT, 2023) *[Tier C]*.
  - The SAFc Emissions Accounting and Reporting Guidelines specifies that each SAF certificate supports at least two intimately connected claims—one that can be made by an air transport provider, and another that can be claimed by a user of aviation services (i.e., a corporate with business travel emissions and/or air freight emissions) (091, Clean Skies for Tomorrow, 2022) *[Tier C].*
  - RSB has developed a book and claim system for SAF. It sets out rules for who can make scope 1 and 3 claims. It states that “whenever a logistics provider (e.g., a freight forwarder) is involved in the transaction, […] both the logistics producer and

the corporate end-user may claim a Scope 3 emission reduction in their respective categories". It also says that "in all cases, the transport service provider (e.g., an airline) is mentioned in the retirement statement and is the exclusive owner of the Scope 1 emission reduction".

- The MMMCZCS is developing a book and claim system for shipping (252, MMMCZCS, 2023) [*Tier C*]. The evidence submitted outlines the "Market Rules" for the system, including how emissions will be allocated to different organizations in the supply chain. The system allows a token (EAC) to be claimed by multiple stakeholders but limits the claimant to one shipowner, one ship operator, one freight forwarder, and one cargo owner. For each voyage registered, participants must identify the role they play in that voyage. The system will then label them with that role for the voyage. *However, it does not address whether these claimant's downstream clients can claim the emission profile represented by the EACs (e.g., can cargo owner's customers report emissions represented by the EAC, as they are reported in the cargo owner's operations?).*

Emission reporting and reduction claims should be made transparently, supported with proof that backs up the emission claims. An example proposed is to use dual reporting, i.e., reporting emissions as if fossil fuels (or presumably, in future, an average of the fuel supplied at the location) were used, and reduced emissions calculated by subtracting emissions related to retiring SAFc.

- The SAFc Emissions Accounting and Reporting Guidelines (091, Clean Skies for Tomorrow, 2022) *[Tier C]* proposes that "airlines retiring and reporting unbundled SAFc should continue to report their actual as well as reduced emissions, calculated by subtracting emissions represented by retired SAFc from actual emissions". This is termed "dual reporting" in the GHG Protocol.

Currently, companies only report emissions from fuel combustion. Evidence suggests that this may need to be reviewed to account for GHG emissions of low-carbon fuels on a lifecycle basis.

- As EAC is a novel accounting and reporting tool, the use of EACs often prompts corporate buyers to deviate from the GHGP recommended reporting. One key modification is the reporting of lifecycle aviation fuel emissions, instead of just direct emissions from jet fuel combustion as set out under the GHGP. This is to ensure that corporate buyers of SAF (for whom SAF is a scope 3 emission) are credited for purchasing SAFc (091, Clean Skies for Tomorrow, 2022) *[Tier C].*
- "Corporations and other end-customers who want to claim SAF as an emissions reduction in value-chain emissions would need to account for the full supply chain emissions of transport fuels instead of just combustion emissions" (288, Piris-Cabezas, n.d.) *[Tier C]. We note that further guidance would be needed on this. For example, lifecycle emissions could be reported by corporate users under scope 3 cat 6, whereby both upstream emissions and combustion emissions of air travel are reported. For SAF, combustion emission could be reported as zero.*

Annex A

Table 2 below gives the evidence #, name, date, and title of evidence reviewed as relevant or partially relevant to fuel EACs. The table indicates "Y" where the evidence was relevant or partially relevant to each of the eight research questions. An evidence number that is followed by a letter (e.g., 142a) denotes nested evidence that was submitted as part of a "parent" piece of evidence.
Table 3 lists the pieces of evidence reviewed under fuels EACs that were not deemed relevant to the review, and so are not discussed in the Evidence Review above.

Table 2: Evidence reviewed as relevant to fuel EACs

Evidence relevant to fuel EACs				Relevant/partially relevant to research question							
#	**Author**	**Date**	**Title**	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**	**Q8**
003	3Degrees	2023	Renewable Markets Insight Report U.S. EDITION - 2024	Y					Y		
004	AB Texel Group	2023	SBTi Call for Evidence Submission	Y				Y			Y
006	ABB	2023	SBTi Call for Evidence Submission on other		Y						Y

			energy carrier certificates								
012	Air France KLM	2022	SAF Program Customer Report	Y	Y						Y
015	Ajdin	2023	Norden looks to drive down emissions using carbon insetting	Y		Y	Y				
018	American Airlines	2021	American Airlines and Deloitte Pioneer Market-based Solution to Reduce Carbon Emissions from Air Travel	Y				Y			Y
019	American Airlines	2021	American Airlines Builds on Commitment to	Y							

			Sustainable Fuels with Kuehne+ Nagel								
020	American Express	2023	Carbon Pricing applicable to Sustainable Aviation Fuel			Y		Y		Y	Y
025	Association of American Railroads	2023	SBTi Call for Evidence Submission		Y	Y		Y		Y	Y
026	AstraZeneca	2023	AstraZeneca advances UK clean heat and energy efficiencies with £100m commitment	Y	Y		Y	Y	Y	Y	Y
038	Bart, Hutchinson and Ehirim (EDF and Rocky	2023	SAFc Registry Rulebook Version 2 (draft for public	Y	Y	Y	Y		Y		

	Mountain Institute)		consultation)								
053	Brander	2022	The most important GHG accounting concept you may not have heard of: The attributional-consequential distinction						Y		
054	Brander and Bjørn	2023	Principles for accurate GHG inventories and options for market-based accounting				Y		Y		
055	Brander and Bjørn	2022	Principles for accurate corporate GHG inventories and				Y		Y		

			options for market-based accounting – Working Paper								
060	Business Council for Sustainable Energy	2023	Submission to the Science Based Target Initiative in Response to the Call for Evidence on the Effectiveness of Environmental Attribute Certificates (EACs)	Y	Y	Y	Y	Y			Y
062	California Legislative Council Bureau	2018	SB-1440 Energy: biomethane: biomethane		Y			Y			

			procurement								
063	Cai et al.	2022	Decarbonization potential of on-road fuels and powertrains in the European Union and the United States_ a well-to-wheels assessment	Y							
064	California Air Resources Board	2023	Tier 1 Simplified CI Calculator Instruction Manual	Y	Y						
068	California Air Resources Board	2019	Low Carbon Fuel Standard (LCFS) Guidance 19-05			Y					
079	Centrica	2023	SBTi Call for	Y	Y	Y	Y	Y		Y	Y

			Evidence Submission								
080	Centrica	2023	Centrica signs UK Biomethane Agreement with Yorkshire Water and SGN Commercial Services								Y
088	Clean Fuels Alliance America	2023	SBTi Call for Evidence Submission	Y				Y		Y	
091	Clean Skies for Tomorrow	2022	Sustainable Aviation Fuel Certificate (SAFc) Emissions Accounting and Reporting Guidelines	Y		Y	Y	Y	Y		Y

109	Davydenko, et al.	2022	Mass-Balance Method for Provision of Net Zero Emission Transport Services	Y	Y	Y					Y
113	Delta Air Lines	2023	Delta Air Lines Environmental Attribute Certificates Case Study Submission	Y			Y			Y	
114	Delta Air Lines	2023	Delta 2022 ESG Report	Y							
115	DENA Biogasregister	n.d.	Functionality: How does the verification process work		Y	Y	Y				
116	DHL	2023	Evidence Submission on Sustainable	Y		Y		Y			Y

			Aviation Fuels								
118	Downstream Natural Gas Initiative	2023	Response to the Call for Evidence on the Effectiveness of the Use of Environmental Attribute Certificates in Corporate Climate Targets Issued by the Science Based Targets Initiative	Y		Y					
122	Edison Electric Institute	2023	SBTi Survey Response	Y	Y			Y			
128	Energinet	n.d.	Statistics on guarantees of origin - gas	Y		Y		Y			

129	Energinet	n.d.	Upgraded biogas is called biomethane					Y			
130	Energinet Systemansvar	2022	Danish biomethane experiences: From 0-100 % in 5 steps	Y		Y		Y			
138	Engie	2023	ENGIE signs major biomethane supply agreement with Arkema to further reduce the carbon footprint of its bio-based polyamide 11 materials	Y				Y			
146	Coalition for RNG & Guidehouse	2023	Using RNG to meet GHG Targets:	Y	Y	Y		Y			

			A Primer for Sustainability Directors (see pages 98-112)								
147	Environmental Markets Association	2023	Renewable Natural Gas and "Book and Claim" Accounting (see pages 114 and 115)		Y			Y			
151	ERGaR	2023	SBTi Call for Evidence Submission			Y		Y			Y
153	ERGaR	n.d.	ERGaR CoO Scheme		Y	Y					
154	ERGaR	2022	ERGaR Certificate of Origin (CoO) Scheme: Scheme		Y	Y					

			Rules V1.2								
155	European Union	2018	Directive 2018-2001 of the European Parliament and of the Council of 11 December 2018	Y	Y	Y	Y	Y	Y	Y	
156	European Biogas Association (EBA)	2023	1st EBA Biomethane Investment Outlook								Y
158	European Biogas Association (EBA), World Biogas Association (WBA), European Renewable Gas Registry (ERGaR), Renewable Natural	2023	Renewable Gas Tracking Systems			Y		Y		Y	

	Gas Coalition (RNGC)										
160	European Commission	2023	Training Material: Training Events on Biomass in the EU ETS 20 and 27 October 2022, Updated version of May 2023						Y	Y	
161	European Commission	2022	Implementing the Repower EU Action Plan: Investment Needs, Hydrogen Accelerator and Achieving the Bio-Methane Targets		Y						

162	European Commission Directorate-General for Climate Action	2022	Guidance Document - Biomass issues in the EU ETS		Y	Y			Y		
163	European Commission Directorate-General for Climate Action	2012	Guidance Document - Biomass issues in the EU ETS		Y	Y			Y		
166	Evident EV Ltd	2023	Issuer Case Studies			Y	Y				Y
173	French Ministry of Ecological Transition	2022	Décret no 2022-640 du 25 avril 2022 relatif au dispositif de certificats de production de biogaz		Y	Y					
178	Gasum	2023	Viking Line passengers can								Y

			reduce their emissions from travel by up to 90 percent with biogas provided by Gasum								
180	German Federal Ministry of Justice and the Federal Office of Justice	2023	German Renewable Energy Act EEG 2023		Y	Y					
182	GHG Management Institute	2023	What is Greenhouse Gas Accounting - Fitting to Purposes	Y			Y				
184	GHG Protocol	2022	Land Sector and Removals Guidance, Draft for Pilot		Y	Y	Y		Y		

			Testing and Review, Part 2								
186	Gillenwater	2022	Examining the impact of GHG accounting principles				Y		Y		
187	Good Shipping	n.d.	Client Certification	Y	Y	Y					
188	GoodShipping	2022	Impact Summary report 2021 - 2022				Y				
189	GoodShipping and Routescanner	2024	Route CO2 Zero: A step-by-step guide to decarbonise your scope 3 emissions	Y			Y	Y			
192	Green Gas Certification Scheme	2022	Annual Report 2022	Y		Y		Y			

202	Heineken	n.d.	Example of Heineken and its French subsidiary					Y			Y
211	Intergovernmental Panel on Climate Change (IPCC)	2006	Guidelines for National Greenhouse Gas Inventories, Chapter 2: Approaches to data collection				Y				
212	International Air Transport Association (IATA)	2023	SBTi Call for Evidence Submission	Y		Y					
213	International Air Transport Association (IATA)	n.d.	EACs facilitate SAF financing deployment and scale-up	Y				Y			
214	International Air Transport	n.d.	SAF accounting based on robust	Y	Y	Y		Y	Y		

	Association (IATA)		chain-of-custody approaches								
215	International Air Transport Association (IATA)	n.d.	IATA Recommended Practice - RP 1726 - Passenger CO2 Calculation Methodology		Y		Y				
218	International Civil Aviation Organization (ICAO)	2020	CORSIA Approved Sustainability Certification Schemes			Y					
219	International Civil Aviation Organization (ICAO)	2022	CORSIA Default Life Cycle Emissions Values for CORSIA Eligible Fuels	Y							
223	International Sustaina	2023	ISCC Credit	Y	Y	Y	Y	Y	Y	Y	Y

	bility and Carbon Certificati on (ISCC)		Transfer System								
224	Internatio nal Sustaina bility and Carbon Certificati on (ISCC)	2023	Retireme nt declaratio n 2167	Y	Y	Y	Y	Y	Y	Y	Y
225	Internatio nal Sustaina bility and Carbon Certificati on (ISCC)	n.d.	Certificati on for Sustaina ble Aviation Fuels			Y					
226	Irigoyen et al.	2023	Accelerati ng Maritime Decarbon isation: A Book and Claim Chain of Custody System for the early transition to		Y	Y		Y			

			Zero-emission Fuels in Shipping								
227	ISCC System GmbH	2021	ISCC CORSIA 205 Life cycle emissions Version 1.1	Y							
230	JetBlue	2023	JetBlue and Shell Aviation Announce Agreement Bringing New Supply of SAF to LAX		Y						
238	Kuehne + Nagel	2023	SBTi Call for Evidence Submission	Y	Y	Y		Y	Y		Y
244	LEK Consulting LLC	2023	Fuelling The Future of Aviation	Y							Y
245	Leung and Meyer	2018	Sustainable Options	Y				Y		Y	Y

			for Reducing Emissions from Thermal Energy: Showcasing successful outcomes from six case studies								
251	Lufthansa Group	2023	Book-and-Claim for Sustainable Aviation Fuel	Y	Y	Y	Y	Y	Y		Y
252	Mærsk Mc-Kinney Møller Center for Zero Carbon Shipping	2023	Maritime Book and Claim. Design decisions and justification	Y	Y	Y	Y		Y		
253	Majer et al.	2021	REGATRACE Assessment of integrated concepts	Y		Y					

			and identification of key factors and drivers								
258	Microsoft	2020	Alaska airlines and Microsoft sign partnership to reduce carbon emissions with flights powered by sustainable aviation fuel in key routes					Y			Y
262	Mol and Oosterveer	2015	Certification of Markets, Markets of Certificates: Tracing Sustaina		Y						

			bility in Global Agro-Food Value Chains								
265	National Grid	2023	SBTi Call for Evidence Submission	Y	Y		Y	Y			Y
267	Neste	n.d.	ISCC and Neste Credit Transfer System	Y	Y	Y	Y		Y		
276	Office of Administrative Law	2020	Title 17 California Code of Regulations sections 95480-95503 (2020), Low Carbon Fuel Standard Regulation	Y	Y	Y		Y		Y	Y
277	Oliver Wyman	2023	Biomethane: Study Results	Y				Y		Y	Y
279	OptiFuel Systems	2023	Case Study:	Y				Y			

			OptiFuel RNG Solution for Zero Emission Line Haul Locomotives								
288	Piris-Cabezas	n.d.	The High-Integrity Sustainable Aviation Fuels Handbook		Y	Y	Y		Y		
291	Railway Association of Canada	2022	Environmental Attribute Credit Opportunities in the Rail Sector		Y	Y	Y	Y		Y	Y
295	RATP	2021	La RATP et ENGIE signent un contrat d'approvisionnement pour du bioGNV	Y							

			produit en Île-de-France								
306	Reed et al.	2023	Environmental Attribute Credits - Analysis of Program Design Features and Impacts	Y	Y	Y	Y	Y		Y	Y
307	REGATRACE	2019	Guidelines for establishing national biomethane registries			Y					
308	REGATRACE	2022	Recommendations for EU and national policy makers			Y					
313	Renewable Thermal	2022	Case Study: University of	Y	Y		Y				Y

	Collaborative		California Renewable Natural Gas (Biomethane) Procurement								
317	Rocky Mountain Institute	2023	Book and Claim Community Survey Responses		Y	Y	Y	Y	Y		Y
321	Roundtable on Sustainable Biomaterials (RSB)	2022	RSB Standard for Advanced Fuels V2.5			Y					
322	Roundtable on Sustainable Biomaterials (RSB)	n.d.	Extract of RSB Book and Claim Recognition draft			Y					
323	Roundtable on Sustainable Biomaterials (RSB)	2023	RSB Book and Claim Registry - Rulebook V1.0 (extract)			Y					
324	Roundtable on	2023	RSB Book and	Y		Y			Y		

	Sustainable Biomaterials (RSB)		Claim Manual Version 3.0								
325	Roundtable on Sustainable Biomaterials (RSB)	2020	RSB Procedure for Operators Taking Part in the RSB Certification Scheme			Y					
326	Roundtable on Sustainable Biomaterials (RSB)	2016	RSB Principles and Criteria			Y					
327	Roundtable on Sustainable Biomaterials (RSB)	2023	RSB Standard for ICAO CORSIA			Y					
331	SAF BTC Coalition	2022	Letter To IRS - December 2022	Y		Y		Y			
339	Seymour	2021	California's LCFS is successfully	Y	Y	Y		Y			Y

			proliferating. Is it also successfully decarbonizing transport?								
340	SFC and MIT	2021	SAF GHG Emissions Guidelines	Y	Y	Y	Y		Y		
341	Shell	n.d.	Evidence related to Avelia solution – Bringing environmental attributes of SAF to market	Y		Y	Y	Y		Y	
342	Shell UK Limited	2023	Declaration of Environmental Attribute	Y			Y				
344	Smart Freight Centre and MIT Center	2021	Decarbonizing the Air Transportation	Y	Y	Y	Y		Y		

	for Transportation and Logistics		Sector: New greenhouse gas accounting and insetting guidelines for sustainable aviation fuel								
345	Smith and Lewis	2023	Voluntary Market Based Measures Framework for Logistics Emissions Accounting and Reporting	Y	Y	Y	Y	Y	Y	Y	
353	Southwest Airlines	2023	Southwest Airlines Sustainable Aviation Fuel Certificates Case Study	Y			Y	Y		Y	

354	Southwest Airlines	n.d.	Southwest Sustainable Aviation Fuels	Y					Y		
365	STX Group	n.d.	State Renewable Gas Standard Programs	Y	Y	Y		Y			Y
366	STX Group	n.d.	RNG Facility Growth, Attributable Agricultural Sector Methane Reductions					Y			Y
370	Better Biomass	n.d.	Anonymized Transaction Certificate for Biogas and biomethane	Y							
373	Sustainable Aviation Buyers	2023	Request for Proposal Process	Y	Y	Y		Y		Y	Y

	Alliance (SABA)		and Collective Purchase (SABA RFP)								
374	Sustainable Aviation Buyers Alliance (SABA)	2023	Sustainability Framework for Sustainable Aviation Fuel (SAF) Version 2.0	Y	Y			Y			
375	SustainCERT	2023	Environmental Attribute Certificates from Value Chain Interventions: A transport case study	Y	Y	Y	Y	Y	Y	Y	Y
379	The Business Council for Sustainable Energy	2023	Case Study: Ameresco City of Phoenix, AZ	Y	Y			Y			

383	The Coalition for Renewable Natural Gas	2023	Chart: Growth of RNG facilities in U.S. 1982 - 2022					Y			
384	The Coalition for Renewable Natural Gas	2022	Decarbonize Transportation with Renewable Natural Gas					Y			
391	TotalEnergies	2023	Decarbonizing Industry in France: TotalEnergies to Supply Certified Sustainable Biomethane to Saint-Gobain					Y		Y	Y
398	UK Chamber of Shipping	2023	SBTi Call for Evidence Submission		Y	Y					

400	UK Department for Business, Energy and Industrial Strategy	2021	Final Stage Impact Assessment BEIS009(F)-21-CG	Y	Y	Y		Y		Y	Y
401	UK Department for Business, Energy and Industrial Strategy	2021	Designing a Framework for Transparency of Carbon Content in Energy Products: A call for evidence		Y	Y		Y			
402	UK Department for Transport	2022	RTFO Guidance Update for Biomethane, including as a Chemical Precursor		Y	Y					
403	UK Department for Transport	2022	Renewable Transport Fuel Obligatio	Y	Y	Y		Y			

			n: Compliance Guidance								
405	UK Office of Gas and Electricity Markets (Ofgem)	2023	Green Gas Levy Guidance v2.0			Y					
407	United Airlines	2023	SBTi Call for Evidence Submission	Y	Y	Y	Y	Y	Y	Y	
408	United States Department of Energy	2022	SAF Grand Challenge Roadmap					Y			Y
410	United States Department of Energy	2020	Renewable Natural Gas (RNG) for Transportation - Frequently Asked Questions	Y		Y		Y			Y
411	United States Environmental	2021	LFG Energy Project Development	Y		Y		Y			Y

	Protection Agency		Handbook								
413	United States Environmental Protection Agency	2023	Subpart M—Renewable Fuel Standard	Y	Y	Y		Y			Y
434	World Economic Forum	2023	SAF Offtake Manual	Y	Y	Y	Y				Y
435	World Energy LLC	2023	SBTi Call for Evidence Submission	Y	Y	Y	Y	Y	Y	Y	Y
443	NGVAmerica	n.d.	SBTi Evidence List	Y	Y			Y			Y
444	United Airlines	n.d.	Eco-Skies Alliance	Y							Y
142a	Guidehouse & The Coalition for Renewable Natural Gas	n.d.	How Renewable Natural Gas is Helping the Life Sciences Sector Tackle Greenhouse Gas Emissions	Y							

142b	University of California, Office of the President	2022	Comments re: Biomethane Annex of Land Sector and Removals Initiative	Y			Y	Y	Y		Y
142c	RMI	2023	Clean Energy 101: Book and Claim	Y				Y		Y	Y
142d	EMA	2023	The Importance of Market-Based Accounting and Tradable Environmental Instruments for the Achievement of Scope 1, 2, and 3 Emission Reductions				Y		Y		Y

167a	Australia Government	2021	Hydrogen Guarantee of Origin scheme - Consultation summary and next steps			Y					
182a	GHG Management Institute	2024	What is GHG Accounting? Market-based mistake	Y			Y				
220a	International Dairy Foods Association	2023	Idaho Milk Products Case Study: Environmental Market Driven Value Chain Decarbonization through Anaerobic Digestion	Y	Y		Y	Y			Y

220b	International Dairy Foods Association	2023	An example of data collected by a bio digestion system, which shows consistent flow of intended benefits	Y							
220c	International Dairy Foods Association	2023	Time series data analysis and interpretation notes relating environmental markets with U.S. dairy digestor capacity	Y	Y	Y	Y	Y			Y
359a	US EPA	n.d.	Accomplishments of the Landfill Methane	Y							

			Outreach Program								
362a	NGV America & The Coalition for Renewable Natural Gas	2023	Decarbonizing California with renewable natural gas transportation					Y			
366a	The Coalition for Renewable Natural Gas	n.d.	RNG Facilities					Y			Y
368a	German Federal Ministry of Justice	2023	Act for the Expansion of Renewable Energies (Renewable Energy Sources Act - EEG 2023) Section 44b Common provision		Y						

			s for electricity from gases								
368c	German Federal Ministry of Justice	2023	Ordinance on Requirements for the Sustainable Production of Biofuels (Biofuel Sustainability Ordinance - Biokraft-NachV) § 10 Issuance on the basis of mass balance systems		Y						
443a	Capital Press	2023	Divert/City of Longview, WA – Commercial-Scale Food	Y				Y			Y

			Waste Diversion								
443b	Seattle Times	2023	New $800M sustainable aviation fuel plant planned for Washington State	Y				Y			
443c	Offshore Energy	2023	OCI Global eyes increase in green methanol production capacity in U.S.	Y				Y			

Table 3: Evidence reviewed as not relevant to fuel EACs

#	Author	Date	Title	Rationale for exclusion in fuels report
011	AgSTAR	2023	Anaerobic Digester Facts and Trends	Not relevant to research questions.
013	Air Transport Action Group (ATAG)	2023	360 Sustainable Aviation Fuel	Does not discuss fuels EACs.
017	Alaska Airlines	2023	Sustainable Aviation Fuels: Working together to decarbonize air travel	Does not discuss fuels EACs.
022	Anew Climate LLC	2023	Case Study of Private Forestlands Managed for Climate Mitgaton: Bluesource Sustainable Forests Company	Does not discuss fuels EACs.
024	Argus Media, Cornwall Insight, Greenfact, S&P Global	2022	Price Reports of Biomethane EACs	Not relevant to research questions.
042	Berkeley Carbon Trading Project	n.d.	Repository of Articles on Offset Quality	Does not discuss fuels EACs.
052	Booth et al.	2022	Decarbonizing US gas utilities	Does not discuss fuels EACs.
073	Carbon Market Watch	2021	Two shades of green: How hot air forest credits are being used to avoid carbon taxes in Colombia	Does not discuss fuels EACs.
102	Cullenward	2023	A framework for assessing the climate value of temporary carbon storage	Does not discuss fuels EACs.
103	Cullenward et al	2023	Carbon offsets are incompatible with the Paris Agreement	Does not discuss fuels EACs.
106	Danish Energy Agency	2022	Denmark's Climate Status and Outlook 2022	Does not discuss fuels EACs.

111	De Beers Group	2022	Sustainability Report	Does not discuss fuels EACs.
123	Edmonds et al.	2021	How Much Could Article 6 Enhance Nationally Determined Contribution Ambition towards Paris Agreement goals through economic efficiency	Does not discuss fuels EACs.
125	EKOenergy	2023	Concrete Impact Made thanks to Thanks to EkoEnergy Users 2013-2023	Does not discuss fuels EACs.
152	ERGaR	2023	CoO Scheme Statistics 2023	Not relevant to research questions.
170	Finnish Ministry of Economic Affairs and Employment	2022	Amendments to distribution obligation of biofuel oil and Sustainability Act sent out for comments	Not relevant to research questions.
177	Gas for Climate and Guidehouse	2022	Biomethane production potentials in the EU: Feasibility of REPowerEU 2030 targets, production potentials in the Member States and outlook to 2050	Does not discuss fuel EACs.
190	Graham et al.	2023	GenCost 2022-23- Final report	Does not discuss fuels EACs.
210	ICF	2023	The Next SAF Summit - ABLC NEXT 2023	Not relevant to research questions.
217	International Civil Aviation Organization (ICAO)	n.d.	SAF production technologies and certification	Not relevant to research questions.
231	JetBlue	n.d.	JetBlue's Sustainable Travel Partners	Not relevant to research questions.

233	Kane et al.	2022	Biochar as a Renewable Substitute for Carbon Black in Lithium-Ion Battery Electrodes. Supporting information	Does not discuss fuels EACs.
255	Martinez-Valencia et al.	2021	Supply chain configuration of sustainable aviation fuel: Review, challenges, and pathways for including environmental and social benefits	Not relevant to research questions.
257	Melgin et al.	2023	How traders can capture value in sustainable fuels	Does not discuss fuels EACs.
270	NGVAmerica	2021	Statement on Climate Change	Does not discuss fuels EACs.
287	Piadeh et al.	2023	A critical review for the impact of anaerobic digestion on the sustainable development goals (working paper)	Does not discuss fuels EACs.
289	Preston Aragonès et al.	2022	The carbon credits conundrum: Why governments need to regulate carbon removal and voluntary markets	Does not discuss fuels EACs.
293	Ramboll	2023	Literature review - On track Indicator development study	Does not discuss fuels EACs.
343	Sky Harvest Resources LLC	2022	Carbon 2.0: A Better Yardstick for Carbon Markets	Does not discuss fuels EACs.
359	STX Group	n.d.	U.S. EPA – Landfill Gas EAC Market's Success in Creating Methane Emissions Reductions	Individual pieces of evidence reviewed separately.

362	STX Group	n.d.	Resources about U.S. EPA's Renewable Fuel Standard	Individual pieces of evidence reviewed separately.
368	Submitted by the European Biogas Association	n.d.	German regulatory programs requiring mass-balanced certificates	Not relevant to research questions.
371	Submitted by the European Biogas Association	n.d.	Preconditions regarding the feedstocks and the CI when selling green gas	Not relevant to research questions.
382	The Coalition for Renewable Natural Gas	2023	Chart: Map of RNG Facilities	Does not discuss fuels EACs.
406	UN High-Level Expert Group on the Net-Zero Emissions Commitments of Non-State Entities (HLEG)	2022	Integrity Matters: Net Zero Commitments by Businesses, Financial Institutions, Cities and Regions	Does not discuss fuels EACs.
424	WattCarbon	2023	The value of Environmental Attribute Certificates in accelerating decarbonization in market based procurement	Not relevant to research questions.
440	Argus Media	2023	Argus SAF and Jet-A price history 11_17_2023	Does not discuss fuels EACs.
167h	United Nations	2021	Economic and Social Council - Attaining carbon neutrality - The role of hydrogen	Not relevant to research questions.
167i	Y. Pan, et al.	2023	Green finance policy coupling effect of fossil energy use rights trading and renewable energy certificates trading on low carbon economy: Taking China as an example	Does not discuss fuels EACs.

365a	California Public Utilities Commission	2022	CPUC Sets Biomethane Targets for Utilities	Does not discuss fuels EACs.
368b	German Federal Ministry of Justice	2023	Act on the Saving of Energy and the Use of Renewable Energies for Heating and Cooling in Buildings* (Building Energy Act - GEG § 40 (repealed)	Does not discuss fuels EACs.