International Journal of Multidisciplinary Research and Growth Evaluation

International Journal of Multidisciplinary Research and Growth Evaluation
ISSN: 2582-7138
Received: 20-10-2020; Accepted: 22-11-2020
www.allmultidisciplinaryjournal.com
Volume 1; Issue 5; November-December 2020; Page No. 112-115

The role of sustainable aviation fuel in mitigating scope 3 emissions

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Abstract
Climate change poses a significant global challenge, with the aviation sector contributing approximately 2% of total carbon emissions. Business travel, a critical component of corporate operations, substantially increases aviation-related emissions. While strategies such as mode switching and optimized travel locations offer limited mitigation, sustainable aviation fuel (SAF) presents a viable long-term solution. SAF, derived from biological and non-biological sources, offers up to 99% lifecycle emission reductions compared to conventional jet fuel. It is compatible with existing aviation infrastructure, making it a practical alternative. However, large-scale SAF deployment faces technological and economic challenges, particularly regarding feedstock availability and production costs. To achieve meaningful reductions in Scope 3 emissions from business travel, corporations must actively support SAF adoption through financial commitments and collaboration with airlines. This paper examines current SAF technologies, industry initiatives, and the potential for SAF to decarbonize long-haul air travel, ensuring sustainable business operations.

Keywords: Climate change, Sustainable aviation fuel (SAF), Carbon emissions, Business travel

Introduction

Climate change is a global issue that needs to be addressed by everyone around the world. The Intergovernmental Panel on Climate Change (IPCC) estimates that by the year 2100, the negative impacts from climate change will increase 5% year over year (Banu, 2012) [1]. At present, 2% of the total carbon emissions across all sectors stems from the aviation industry (Capoccitti *et al*., 2010) [2]. It also shows no sign of slowing down because air transportation is increasing due to globalization of trade and travel both business and personal.

This increase in business travel is notable for companies due to large distances covered, the prevalent use of high-emission transportation modes, and frequency of the trips. Despite the cost associated with business travel, it is essential to maintaining a company's business operations as it facilitates, face-to-face interactions and support economic activity (Aguilera, 2014). However, it comes with a substantial environmental cost as the emissions from business travel can constitute a large portion of a company, total carbon footprint. Business travel involves long distance trips, which are predominantly undertaken by air (Davies & Armsworth, 2010) [4].

Existing emission reduction initiatives from business, travel, generally target, substitute and short flights with either train or bus rides. However, the impact of such mode switching measures is quite limited, and significant reductions could be achieved by replacing longer flights or choosing more central locations for meetings and conferences, where people do not have to travel as much. Although business travel as a significant source of emissions, it is a critical component of companies operations as it supports essential business functions and provides economic benefits. The challenge lies and balancing the need for travel with the imperative to reduce submissions. In the aviation sector, fuel alternatives such as electric power or bio diesel cannot be used for aviation since they lack the required energy density. Currently, fossil fuels used for jet fuel production that requires huge facilities that are complex to operate. Despite achieving huge gains in energy efficiency and better air traffic control, carbon emission reductions of less than 15% have been realized (Chao *et al*., 2019) [5]. The use of alternate jet fuel can achieve a further 50 to 80% reduction in carbon emissions and is probably the most efficient way to achieve carbon neutral aviation (Brooks *et al*., 2016) [6]. Due to new regulations and the requirement to comply with international carbon emissions standards, the airlines will be required to purchase carbon offsets to compensate for their growth in emissions (Spiekermann, 2014) [7]. This has led to urgency from the airlines in order to look for new technologies that are likely to bring down their emissions. Although the research and development of sustainable aviation fuels (SAF) are still in the early stages, airline companies are moving forward with fuel uptake agreements, certifications, etc. (Chiaramonti, 2019) [8]. The jet fuel market in the United States is around

20,000,000,000 gallons per year. Does the potential for SAF is large however, there is no clear technology that exists which can replace traditional jet fuel at that scale. One of the most important factors in understanding whether SAF is commercially feasible is the feed stock. For sustainable aviation fuel this is a large challenge because unlike crude oil, biomass, which is often the precursor to sustainable aviation fuel has a high level of oxygen, which is difficult to deal with as it affects biomass conversion efficiencies and increases the production cost (Yilmaz & Atmanli, 2017) [9].

The aim of this paper is to look at existing opportunities for SAF, and highlight the effort that the industry is taking. This paper also tries to provide a brief summary of existing sustainable aviation fuel technologies and talk about how sustainable aviation fuel could be used to abate a company's Scope 3 business travel emissions.

Overview of Sustainable Aviation Fuel (SAF)

SAF basically describes non-conventional aviation fuel that is produced from biological material such as plant or animal material and non-biological sources such as municipal waste or captured CO2. The chemical and physical characteristics of SAF are essentially identical to traditional jet fuel. According to the U.S. Energy Information Administration in 2017, the market for jet fuel is dominated by large petroleum-based refineries that produce approximately 24,000,000,000 gallons of jet fuel per year in the US. The global consumption is about four times as much as the US. Domestic jet fuel consumption is expected to increase by more than 40% from 2016 to 2040 as projected by the US EIA. This increase is expected because the demand is expected to far out with the projected energy efficiencies that the airlines can obtain. The airline industry relies heavily on fossil fuels and the cost of jet fuel is one of the highest percentage of total cost of an airline as well as emissions. Rising jet fuel prices and carbon reduction targets are a driving factor for the aviation industry to look for alternative drop in fuels (Ryerson & Hansen, 2013) [10].

There is no singular approach or technology that will allow the aviation industry to achieve a sustainable zero emissions flight. Even if electric or hydrogen powered planes become practical in the future for short and medium haul flights SAF deployed at scale will be required to decarbonize long-haul flights across the industry. Mode switching such as with trains and buses, can generate less CO_2 per passenger mile than planes alone, and shipping freight by rail has the potential to reduce emissions (Nelldal & Andersson, 2012) [11]. Airlines would be required to work with rail and bus operators to integrate services specially for short to medium connections. However, the carbon savings of these advances will likely only result in a small percentage reduction in the overall airline emissions at least until there are groundbreaking new technologies.

This implies that SAF is the key to decarbonize air travel at scale today and in the long run, specially in the medium to long haul flights that account for a majority of emissions. SAF can, in theory, reduce lifecycle emissions up to 99% depending on the technology feed stock and transportation, and it does not require any major changes to the airport infrastructure or the aircraft (Chiaramonti, 2019) [8]. It is important to note that tailpipe emissions are largely equivalent between SAF and traditional jet fuel. However, when inspecting SAF over the entire life cycle and accounting for all of the emissions associated with the fuel, including production methods and feedstocks, SAF is significantly better than traditional jet fuel. The key distinction between the two is the traditional jet fuel releases new carbon into the atmosphere whereas SAF releases carbon from sources that would have introduced additional carbon anyway when they degrade such as residual biomass, waste cooking oil, waste crop residue, etc. According to the ASTM, SAF can be blended into conventional fossil kerosene to varying degrees as it is considered as the same physical product. This means that SAF is technically compatible with all fuel delivery and airport fuel options and does not require any new investment and delivery or fueling infrastructure. There are four main pathways to producing SAF that have the capability to produce at scale: hydro processed esters and fatty acids (HEFA); alcohol-to-jet (AtJ); gasification/Fischer-Tropsch (gas/FT); and power-to-liquid (PtL) (Gutiérrez-Antonio *et al*., 2018) [12]. According to CORSIA, the % life cycle greenhouse gas emission reduction compared to traditional jet fuel is 73%–84% for HEFA, 85%-94% for AtJ and gas/FT and almost 99% for PtL (CORSIA Default Life Cycle Emissions Values for CORSIA Eligible Fuels, 2019). This demonstrates that no matter what the source of producing the SAF, it will always be better than traditional jet fuel from a life cycle perspective.

How can SAF enable Scope 3 Business Travel emissions reductions?

Scope 3 emissions are notoriously hard to abate since they mostly occur in the value chain of the company and are usually beyond the control of the business. Decarbonizing Business Travel is even harder as it entails decarbonizing the aviation sector which is one of the hardest to abate. This requires a systemic approach and leadership across the entire value chain with SAF being a critical tool. Other than companies providing a demand signal to SAF producers and airlines, they must also be willing to be for the added cost of SAF. This demand signal along with regulatory changes can enable SAF to scale rapidly. However, the problem of accounting still exists as there is no credible way for companies to take credit for their SAF purchases. Borrowing from existing approaches, these are a few ways SAF purchases could be accounted for within a corporate footprint:

1. Independent disclosure

Companies can chose to disclose their SAF purchases separate from their inventory and show the potential carbon reduction in their Scope 3 emissions. This approach, however, is not allowed under the Greenhouse Gas Protocol (Ranganathan *et al*., 2001) [14] and companies would not be able to claim direct reductions in the Scope 3 emissions. Thus, this approach might not be suitable for SAF reporting.

2. Carbon Offsets

Carbon offsets are emission reductions mechanisms measured in metric tons of CO2e that are obtained from funding projects that remove greenhouse gases from the atmosphere. The accounting methodology follows published guidance and is part of a voluntary market where carbon offsets are tracked and retired through valid registries. Carbon offsets need to demonstrate their additionality which means that the emissions reductions would not have occurred in absence of the funding that was received from the sale of the offsets (Kollmuss *et al*., 2010) [15]. This is a credible way to track and report on emissions reductions. However, tracking SAF using offsets is not the correct approach as the purpose of offsets is to fund projects for carbon removal whereas SAF is about repurposing existing carbon to convert it into aviation fuel. Despite the requirement for funding, SAF purchases should not be considered as carbon offsets.

3. Carbon Inset

Carbon Insets are concept related to carbon offsets, but it focuses on reducing emissions within a company's own value chain or operations rather than purchasing offsets from external projects. Examples include use of renewable fuels, or renewable energy purchased by an upstream supplier. This approach is also not correct for tracking SAF as the fuel is not consumed in the company's supply chain. The fuel is used by the airline which then provides a service to the company so SAF could be used as an inset by the airline rather than the company wanting to reduce business travel emissions.

4. Energy Attribute Certificates (EACs)

EACs are market based certificates that convey the environmental benefit of renewable energy to a buyer. These are mature instruments that have been used to track the benefits of renewable energy in the US and Canada as Renewable Energy Certificates (RECs), in Europe as Guarantees of Origin (GOs), and Internationally as International Renewable Energy Certificates (IRECs). They are established mechanisms within the Greenhouse Gas Protocol as a way to reduce a company's Scope 2 emissions. EACs have been critical in helping scale renewable energy by providing carbon reduction benefits and tracking to corporate buyers (Holt *et al*., 2011) [16]. Since SAF has a similar concept to renewable energy where the feedstock provides the environmental attribute, EACs can be used to track and report on SAF purchases in Scope 3 emissions.

EACs are the most promising of the four approaches detailed above as they have what is required for SAF. Moreover they have shown the benefit of having such a system for renewable energy. EACs have generated funding for renewable energy projects. They are already incorporated into existing reporting mechanisms so corporate buyers can take credit for purchasing SAF. EACs facilitate building new renewable energy projects because of corporate buyers. Presently, no such system exists for tracking and claiming credits for SAF but there are industry players working on a solution. In any case, EACs present a viable approach to ensure SAF gets accounted for within a company's Scope 3 emissions and serve as a credible way to reduce carbon emissions from business travel.

Conclusion

The aviation industry's contribution to global carbon emissions presents a significant challenge. Coupling that with the growth expected from business travel would lead to a drastic increase in GHG emissions. The reliance on fossil fuels for jet fuel exacerbates this issue, which necessitates a shift towards sustainable alternatives. Sustainable Aviation Fuel (SAF) is a promising solution which has the potential to drastically reduce lifecycle emissions compared to traditional jet fuels. Despite complexities surrounding feedstock availability and production scalability, SAF offers an immediate and viable pathway for airlines to meet regulatory requirements and corporates to meet their sustainability goals. Benefits of SAF are: immediate action - as SAF is compatible with existing fueling and aircraft infrastructure. Scalability - SAF production can grow provided enough funding. Aviation value chain - SAF can offer credible carbon insets for the airline industry.

Moreover, the integration of SAF into corporate strategies can facilitate the reduction of Scope 3 emissions associated with business travel, although the current lack of standardized accounting methods poses challenges. The exploration of mechanisms such as Energy Attribute Certificates (EACs) may provide a framework for companies to credibly track and report their SAF usage, thus enabling them to contribute meaningfully to climate change mitigation efforts. As the industry evolves, continued collaboration between airlines, fuel producers, and corporations will be essential to unlock the full potential of SAF in achieving a more sustainable aviation sector.

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