The Increasing Importance and Potential of Electricity for CORSIA Eligible Fuel Production

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Introduction

In an era marked by increasing awareness of climate change and the urgent need for sustainable practices, the aviation industry faces significant challenges in reducing its carbon footprint. Traditional jet fuels necessitate the exploration of alternative and less carbon-intense fuel options.

One of the most innovative and environmentally friendly methods for producing Sustainable Aviation Fuels (SAF) is through the use of decarbonized electricity. This approach, often referred to as Power-to-Liquid (PtL), leverages renewable electricity to convert carbon dioxide (CO_2) and water (H_2O) into synthetic fuels. By integrating electricity generated from renewable sources such as wind, solar, and hydro, this process mitigates the reliance on fossil fuels and creates a virtuous circle where CO_2 is recycled rather than added to the atmosphere.

Another critical application of decarbonized electricity in traditional fuel production facilities is the production of green hydrogen to produce Lower Carbon Aviation Fuels (LCAF) and/or lower the carbon intensity of SAF. Green hydrogen can be produced through the electrolysis of water using renewable electricity, resulting in a low carbon-intense hydrogen source. This green hydrogen can then be used in refinery processes, such as hydrocracking and hydrotreating, which traditionally rely on hydrogen derived from natural gas.

This article delves into the recent developments at ICAO to integrate electricity sourcing considerations for the production of CORSIA Eligible Fuels (CEF), exploring their environmental benefits.

Benefits of using decarbonized electricity as an energy source for CEF production

There are multiple benefits to promoting the scale-up of decarbonized electricity as an energy source for CEF production.

1. Reduced Land Use

One of the most significant environmental advantages of electricity-based Sustainable Aviation Fuels (SAFs) is their reduced land use requirement. Unlike biofuels, Power-to-Liquid (PtL) fuels are produced through a process that converts CO_2 and H_2O into synthetic hydrocarbons using renewable electricity.

Renewable electricity can be generated from various sources, including wind turbines and solar panels, which

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can be installed in areas with low environmental impact, such as deserts, marginal lands, offshore locations, or even on rooftops. This flexibility in energy sourcing can minimize the land footprint of PtL fuels compared to traditional biofuels.

2. Decarbonization Potential

SAFs with a significant renewable electricity input offer substantial decarbonization potential, making them a crucial component in the aviation industry's efforts to reduce greenhouse gas emissions. The PtL process utilizes renewable electricity to power the conversion of CO_2 and H_2O into synthetic fuels, effectively recycling atmospheric carbon. This closed-loop system can achieve significant reductions in emissions, with some studies from the World Economic Forum suggesting that PtL fuels could reduce greenhouse gas emissions between 85-100% compared to conventional jet fuels[3].

3. Complementarity with Carbon Capture and Storage (CCS) Technologies

Electricity-based SAFs are highly complementary with Carbon Capture (CC) technologies, creating a synergistic system that optimizes resource use and enhances emission reductions (often referred as Carbon Capture and Utilisation - CCU). The PtL process can utilize CO_2 captured from industrial sources, such as cement plants or steel mills, or directly from the air through Direct Air Capture (DAC) technologies. By integrating CC with PtL, the aviation industry can promote a circular economy where captured carbon is converted into valuable fuels, thereby reducing overall emissions and contributing to a more sustainable future.

Leveraging on a more abundant and cheaper renewable energy

The transition to electricity-based Sustainable Aviation Fuels (SAFs) is closely tied to the availability and cost-effectiveness of renewable energy sources. As the world increasingly shifts towards cleaner and more sustainable energy solutions, the abundance and affordability of renewable energy present a significant opportunity for the aviation industry to reduce its carbon footprint.

According to the International Energy Agency (IEA), renewables accounted for nearly three-quarters of the total increase in power generation in 2024 (Figure 1). Solar PV was the leading contributor, with an increase of approximately 480 TWh—the highest of any source and significantly surpassing the previous year's growth. Globally, solar PV generation has been doubling roughly every three years since 2016.

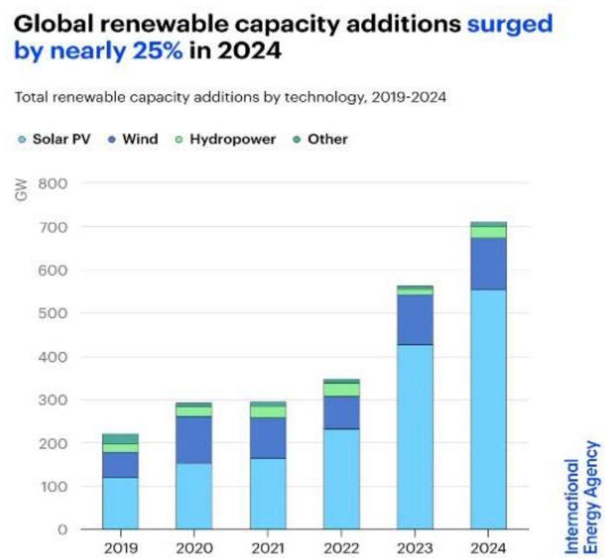

FIGURE 1: Total renewable capacity additions by technology, 2019-2024 (IEA, 2024)[4]

In 2023, 81% of newly added renewable energy capacity was more cost-effective than fossil fuel alternatives, according to a report by the International Renewable Energy Agency (IRENA). This trend, driven by decades of cost reductions and technological improvements in solar and wind energy, underscores another compelling economic and environmental benefit of renewable energy.

For the aviation industry, leveraging on this abundant and cheaper renewable energy would help promoting the production of electricity-based CEFs. Moreover, the integration of renewable energy with aviation fuel

3 https://www.weforum.org/publications/clean-skies-for-tomorrow-delivering-on-the-global-power-to-liquid-ambition/
4 https://www.iea.org/data-and-statistics/charts/total-renewable-capacity-additions-by-technology-2019-2024

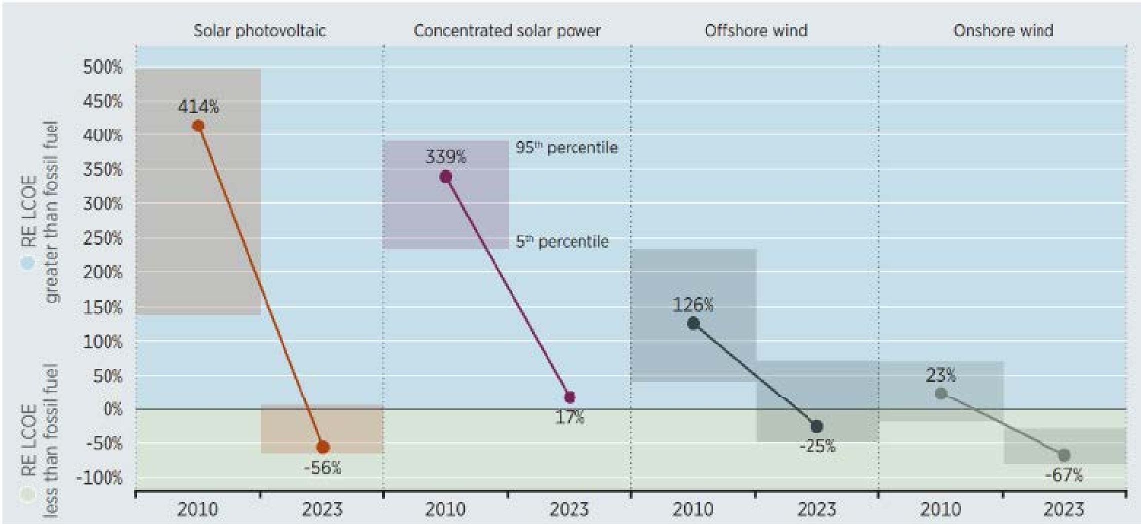

FIGURE 2: Change in global weighted average LCOE for solar and wind compared to fossil fuels, 2010-2023 (IRENA)

production processes can create a more resilient and sustainable energy system. By utilizing excess renewable electricity during periods of high generation and low demand, the aviation industry can help balance the grid and optimize the use of renewable energy resources. This synergy not only supports the decarbonization of the aviation sector but also contributes to the broader transition towards a low-carbon economy.

Why environmental integrity is important when considering a significant use of electricity for CEF production

Knowing the source of electricity is crucial when considering a significant use for CEF production.

The primary goal of using electricity as an energy source for sustainable aviation fuel production is to leverage on its decarbonization potential. If the electricity comes from non-renewable sources, such as coal or natural gas, the environmental benefits are negated. Ensuring that the electricity is sourced from renewable energy, like wind, solar, or hydro, is essential to achieve genuine decarbonization.

Moreover, If the electricity is sourced from areas where renewable energy projects have led to deforestation, the overall environmental impact can be severely negative. Deforestation not only releases stored carbon into the atmosphere but also destroys habitats and reduces biodiversity.

All those considerations have led the ICAO Committee on Aviation Environmental Protection (CAEP) during the CAEP/13 cycle to develop a set of electricity sourcing criteria to avoid unintended consequences when considering a significant use of electricity for CEF production.

Recent developments in the CORSIA framework

For electricity, it is not feasible to physically track the electricity procured for CEF production from a specific electricity generator to CEF production. As such, CORSIA's chain of custody consideration cannot be applied. A set of electricity sourcing criteria has therefore been developed to replicate chain of custody considerations. They are to be applied to all CEF to the extent necessary to (1) obtain a technology-neutral assessment method, and (2) to avoid untenable system-level impacts, e.g. for grid stability or grid-wide emissions. This approach will apply to CEF production processes with increased levels of electrification and has five pillars:

1. **Sourcing arrangements**. Contractual arrangements to identify source of electricity when CEF production is not powered via a direct connection to the electricity generator.
2. **Deliverability**. Defines the sourcing points (facilities) from which the procurement of electricity is possible (ensures connection and addresses grid congestion issues).
3. **Temporal matching**. Timescale over which the generated electricity must match the electricity consumed by the CEF producer (addresses temporal electricity availability).
4. **Additionality**. The degree to which electricity generation capacity is added to a grid in response to demand for CEF production (addresses potential displacement effects in the grid).
5. **Sustainability Requirements**. They aim at avoiding negative sustainability impacts such as deforestation or Induced Land Use Change (ILUC).

The introduction of this comprehensive set of electricity sourcing criteria should represent a significant step forward in enhancing the robustness of the CORSIA framework. By addressing the challenges associated with physically tracking electricity, these criteria would ensure that the environmental and operational integrity of CEF production is maintained. Finally, it will help avoid potential displacement effects within the grid and ensure that the addition of new electricity generation capacity is responsive to the demand for CEF production.