TCW Sustainable Insights

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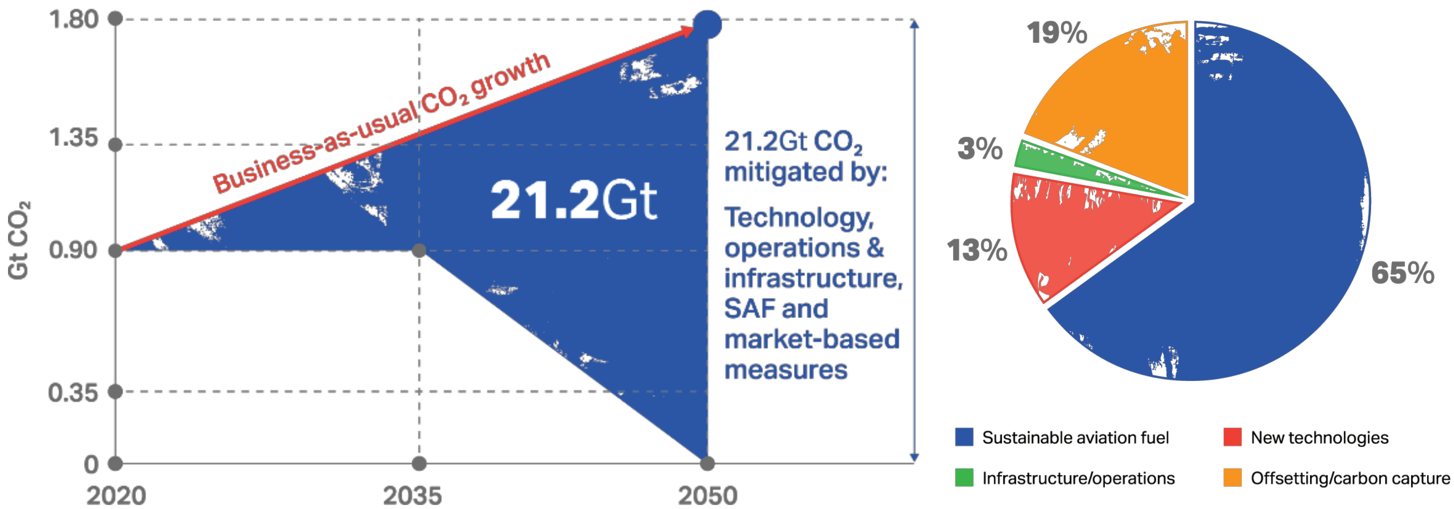
Decarbonizing Aerospace – No Longer Winging It

Aviation contributes 2% of global energy-related carbon dioxide (CO_2) emissions,[1] with commercial aircraft and business jets accounting for 9% of U.S. transportation emissions.[2] In absolute terms, global passenger traffic is expected to double in the next 20 years.[3,4] The aerospace sector has always been acknowledged as a hard-to-abate sector, and recent abandonments of decarbonization targets by some airlines (citing delays in fuel-efficient aircraft deliveries and high costs of green fuels) suggest a broader industry trend. This calls for a realistic discussion on sector-wide decarbonization, considering the complex value chain from fuel producers to OEMs, component suppliers, and airlines. While some segments may advance rapidly, others will require support to scale up and those dislocations present long-term investment opportunities as the industry gradually transforms over the coming decades.

Net Zero: Aviation Carbon Emissions to be Abated by 2050 and Contribution to Net Zero Carbon in 2050



Source: International Air Transport Association - Net zero carbon 2050 resolution

Flight Status Delayed: Sustainable Aviation Fuel

Sustainable aviation fuel (SAF) is an alternative fuel derived from various non-petroleum renewable feedstocks.[5] SAF encompasses bioSAF, made from biomass, and synthetic SAF or Power-to-Liquid (PtL), produced from CO_2 and electricity.[6] As a "drop-in" fuel, SAF can integrate into existing aircraft and airport infrastructure and is typically blended with conventional jet fuel up to 50%, depending on production methods. While 100% SAF usage in commercial flights is not yet permitted, progress is evident, as demonstrated by a test flight from London Heathrow to New York JFK using 100% SAF in late 2023, among other recent successful tests.[7]

The importance of SAF cannot be overstated. The International Air Transport Association (IATA) estimates it will account for a minimum 65% of the carbon mitigation required to achieve net zero emissions by 2050. Despite the industry's apparent eagerness to adopt SAF, production in 2023 accounted for a mere 0.2% of total aviation fuel consumption. The challenge lies in feedstock availability and the cost disparity with fossil jet fuels, where SAF is currently two to six times more expensive.[6] Distribution is another hurdle. According to the International Civil Aviation Organization (ICAO), 83 different airports, largely concentrated in the United States and Europe, have announced a continuous availability of SAF for its operations as of July 2024, a near doubling in three years but not nearly enough to meet the required levels for current stated ambitions among industry players.[8]

Airframing the Conversation: Decades-Long Incremental Improvement and New Innovation

The aviation industry continues to leverage lightweighting as a crucial method for enhancing fuel efficiency, with the use of composites playing a central role due to their superior strength-to-weight ratio compared to traditional materials like aluminum. This shift towards materials such as carbon fiber, fiberglass, and Kevlar began in the 1970s and remains a focal point of innovation, with composites accounting for 50% of structural weight in current generation airframes.[9] Engineered-component suppliers within the aerospace industry play an important role, contributing to lightweighting through various innovations such as enhancing efficiency to enable reductions in the size of actuators to replacing complex hydraulic systems with simpler, lighter electric alternatives. Additionally, the lightweighting of aircraft cabins and the optimizing of seating densities contribute to additional efficiency gains.

Beyond lightweighting, there's a growing interest in rethinking airframe design, which has seen little fundamental change since the 1950s. Some progress has been made with aircraft wingtip devices such as winglets and sharklets to minimize vortex effects, reduce drag, and increase fuel efficiency by up to 6% but the industry has begun exploration of new aerodynamic concepts altogether. Breakthroughs with canard-wings, blended wings, and strut/truss-braced wings, hold the promise of substantial efficiency gains and compatibility with next generation and alternative propulsion systems.[10]

Progress With Propulsion: We Are Fans

Current generation engines boast a 20% improvement in fuel efficiency compared to their predecessors, along with substantial reductions in air emissions such as nitric oxide and nitrogen dioxide (NOx) and CO_2, enhanced noise reduction, and overall gains in reliability.[11,12,13] The next two decades are expected to see further fuel efficiency improvements of 15-25%,[6] driven by advancements in aerodynamics, engine design, such as open fan architecture, and materials technology, including composite fan blades and ceramic matrix composites. Engine manufacturers are also actively developing the next generation of propulsion technologies. Hybrid-electric engines offer a dual propulsion system that combines combustion and electric power for maximum thrust during takeoff and optimized efficiency during cruise flight. For short-haul flights, fully electric propulsion is nearing advanced testing stages, with plans for electric aircraft seating up to 19 passengers in the late 2020s and regional aircraft in the 2030s. Hydrogen propulsion, in both fuel cell and direct combustion forms, is also under exploration, with the industry aiming to introduce a hydrogen-powered large commercial aircraft by the mid-2030s.[2]

Airlines: Making the Hardest Connection Yet

Most major airlines have committed to substituting 10% of their jet fuel with SAF by 2030. Despite long-term contracts being in place, current production levels indicate that many airlines are lagging behind this target. To address this shortfall, stakeholders across the industry – including low-carbon fuel producers, manufacturers, technology developers, and airports – are collaborating through initiatives like the SAF coalition in the U.S., with similar groups emerging internationally.[14] This collective effort aims to expedite the development and deployment of SAF, recognizing that its widespread adoption depends on the relocalization of supply chains to support the necessary systemic shift.

Decarbonization gains via airframes and engines materialize with airlines lowering average fleet age through the procurement of next generation aircraft. However, fleet renewal plans have encountered obstacles due to substantial delivery delays caused by supply chain disruptions post-pandemic and recent governance and safety concerns among key industry players. As a result, retrofitting existing fleets with efficiency-enhancing measures is becoming less of a backup plan and more of a necessity. An often-underestimated player is the aircraft leasing sector, which plays a crucial role providing access to newer, more efficient aircraft in supply-constrained environments.

Airlines are adopting a range of operational and efficiency measures which, while individually may seem minor, collectively contribute to notable improvements in greenhouse gas (GHG) abatement. These include pilot incentive programs for more fuel-efficient flying and taxiing, enforcing stricter operational weight limits, maximizing aircraft load factors, and electrifying ground support equipment. Software is playing an increasingly vital role in operational decarbonization, with optimized air traffic management and flight route optimization software being used to minimize fuel burn and avoid areas where high-climate-impact contrails may be most likely to form.[15]

Turbulence Needs to be Expected

The initial optimism surrounding the decarbonization of the aerospace sector has been tempered by the realization of the extensive systems transition required for such a hard-to-abate industry. An ongoing reassessment of strategies is to be expected: decarbonization will necessitate a comprehensive overhaul of intricate value chains, with varying rates of progress across different companies and industry segments. The need for companies to scale up or pivot in response opens up long-term investment opportunities by pinpointing the firms best positioned to succeed in these competitive and dynamic environments. ■

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