Beyond Aero: A Startup Revolutionizing Aviation Towards a Hydrogen-Electric Future

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Introduction

Achieving ICAO's long-term global aspirational goal (LTAG) for international aviation of net-zero carbon emissions by 2050 requires a paradigm shift in aircraft propulsion and energy sources. While established manufacturers invest heavily, particularly in sustainable aviation fuel (SAF), **agile and innovative startups are essential for accelerating the development, maturation, and deployment of disruptive technologies.** These nimble companies often explore novel concepts and architectures, reducing risks associated with technologies that can later be scaled for broader industry adoption. Startups typically operate with a focused mission and can attract specialised talent and venture capital for high-risk, high-reward projects. They face fewer constraints from legacy systems or existing product lines, enabling them to pursue radical innovations like hydrogen-electric propulsion, novel hybrid systems, or ultra-efficient airframes from a clean sheet.

Their efforts provide vital proof of concept, reduce technology costs through iteration, and help establish the necessary supply chains and regulatory frameworks for future sustainable aviation solutions. By focusing on a clean-sheet design approach and leveraging hydrogen's unique properties, Beyond Aero is one of those companies seeking to develop a more efficient future for aviation.

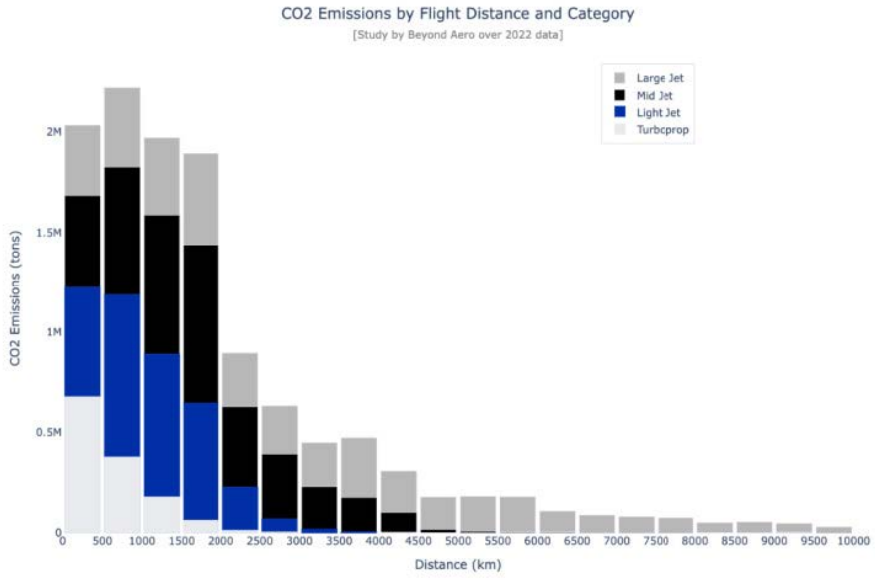


FIGURE 1: CO_2 emissions by Flight distance and Category

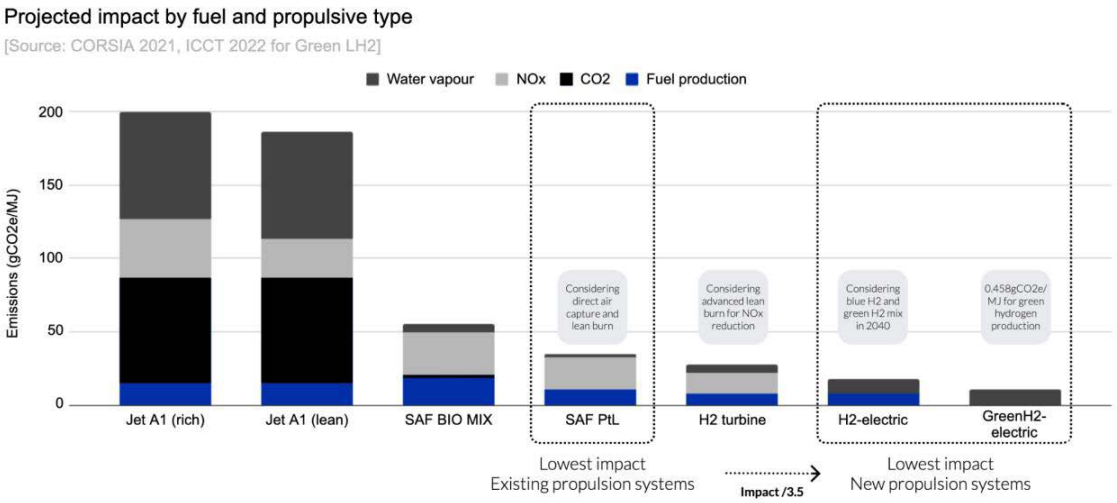
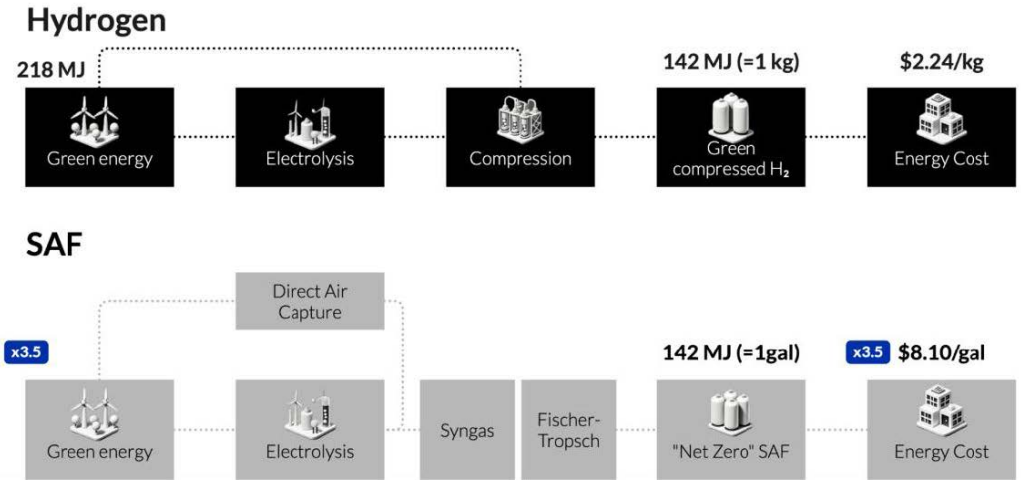


FIGURE 2: Projected impact by fuel and propulsive type.



The emissions challenge and the need for disruption

While sustainable aviation fuels provide a transitional solution, they continue to depend on combustion and encounter challenges related to feedstock availability and lifecycle emissions. While promising for short distances, battery-electric propulsion is hampered by energy density constraints. Thus, a more comprehensive and disruptive solution is required.

Hydrogen represents a promising viable long-term solution for electric aviation. Its high specific energy density and potential for zero CO_2 emissions (only water) when used in an electric power plant make it a compelling alternative to traditional fuels.

Hydrogen-electric propulsion offers numerous advantages

Hydrogen's significantly higher energy density compared to batteries makes it suitable for longer-range flights, overcoming the limitations faced by battery technology. Additionally, compared to SAFs that produce during combustion NO_x and other pollutants, hydrogen fuel cells emit only water and heat. Furthermore, hydrogen production can be decoupled from fossil fuels.

At the core of Beyond Aero's propulsion system is the proton exchange membrane (PEM) fuel cell. These fuel cells generate electricity through electrochemical reactions between hydrogen and oxygen, featuring no moving parts and emitting only water. The decision to start with gaseous hydrogen is justified by the maturity of the technology: over 25,000 fuel cell electric vehicles are in circulation, and more than 1,000 H_2 refueling stations operating at 700 bars are already in use today, with their numbers growing rapidly.

Beyond Aero aims to achieve a state-of-the-art level of 0.8 kW/kg for its low-temperature proton exchange membrane (LT-PEM) airworthy system, demonstrating the viability of hydrogen-electric propulsion for light aircraft today.

Hydrogen safety and infrastructure

Concerns about hydrogen safety, often stemming from historical events, are addressed through modern safety measures and rigorous testing protocols. Extensive studies in space launch systems, military aviation, and fuel-cell vehicles have demonstrated hydrogen's safety when handled properly. For instance, NASA has safely managed massive quantities of liquid and gaseous hydrogen for decades in its space programs, including during the Apollo and Space Shuttle missions, with an exemplary safety record. In military aviation, the U.S. Air Force's Hydrogen Aircraft Program in the 1950s successfully operated experimental aircraft like the Martin B-57B using hydrogen fuel without safety incidents, proving that hydrogen could be safely integrated even into demanding flight environments. More recently, thousands of hydrogen fuel-cell vehicles have been deployed globally — from passenger cars to buses — covering millions of kilometers without major safety issues, often achieving higher safety ratings than conventional gasoline vehicles. These real-world examples across high-risk industries show that with the right protocols and technologies, gaseous hydrogen can be managed safely. Hydrogen's properties, such as rapid evaporation and low detonability, make it safer than conventional fuels in many aspects.

Robust infrastructure and logistics for green hydrogen are important and must be accelerated. Low-carbon electrolytic hydrogen production, transport, and on-site storage are crucial for a sustainable hydrogen ecosystem. Hydrogen refueling stations at airports, both fixed and mobile, to facilitate safe and swift adoption will also be a key enabler. . By equipping key business airports with hydrogen refueling capabilities, hydrogen-electric aircraft can be enabled to serve a significant portion of global missions. For example, Beyond Aero signed partnership agreements with key airport operators, such as Groupe ADP (Aéroports de Paris), which operates some of Europe's largest airports for business and commercial aviation, and Edeis, a major player in regional aviation.

The clean-sheet design approach

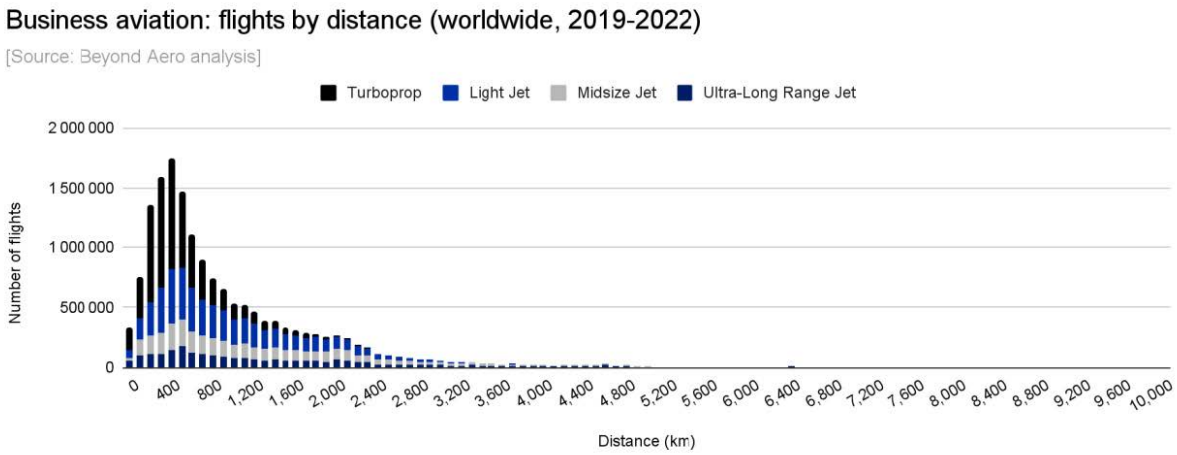
Retrofitting existing aircraft provides a short-term solution, but a truly optimised hydrogen-electric aircraft requires a design specifically tailored to the distinct properties of hydrogen. This includes integrating gaseous hydrogen storage systems, thermal management, and electric engines in a manner that maximises performance and efficiency.

A clean-sheet design also has the advantages of enhancinge weight distribution, aerodynamics, and overall performance. This approach can also facilitate the incorporation of new design and manufacturing technologies, as well as maintenance-oriented requirements.

The business case: starting with business aviation

Beyond Aero's initial product is a high-end clean-sheet, hydrogen-electric light jet, called BYA-I. While business aviation represents a small percentage of overall aviation emissions, it is the most CO_2-intensive per passenger. It is an ideal market for introducing disruptive technologies that can be later scaled to larger aircraft, addressing more and more CO_2-emitting markets.

Furthermore, business aviation has a history of pioneering innovation. By introducing hydrogen-electric propulsion in this segment, costs can be driven down and the way can be paved for mass-market affordability in regional and commercial aviation. Beyond Aero estimates that 80% of business aviation flights are within the range of their hydrogen-electric aircraft, making it a viable and practical option.



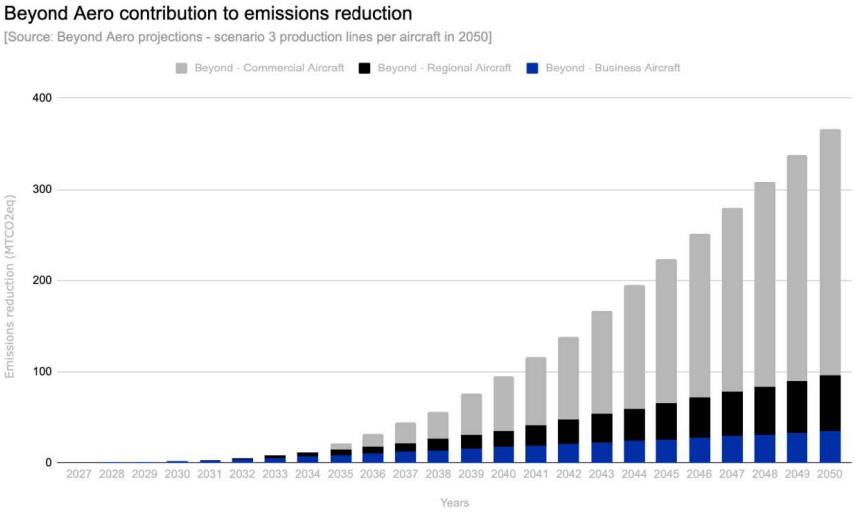
A hydrogen-powered business jet could offer cost-effective operations with lower maintenance costs (due to the lack of a combustion engine, and fewer moving parts) and competitive operating costs compared to traditional jets,. Customer feedback indicates a strong desire for a more sustainable way of flying, with many delaying orders to wait for a better option.

Scaling up: a three-step plan

A three-step plan for scaling-up hydrogen-electric technology is suggested:

- **Step 1:** Pioneering development and certification: Develop, certify, and bring to market the first aircraft, establishing a new paradigm for efficiency and comfort. This initial aircraft will fund the development of larger platforms.
- **Step 2:** Mastering scale for regional aviation: Based on the same architecture, develop a scaled-up powerplant for a 70-passenger regional aircraft, certified under EASA CS25 and FAA FAR25 regulations.
- **Step 3:** Maximizing climate impact for commercial aviation: Develop a 150-passenger commercial aircraft, leveraging the acquired knowledge and technology, to address the largest source of aviation emissions.

Beyond Aero's long-term target is to deploy a high-tech hydrogen-electric fleet by 2050, contributing to the reduction of hundreds of megatons of CO_2 emissions.



Startup advantage and innovation

Newer startups benefit from their agility and freedom to explore innovative solutions without the constraints faced by established players. These companies can shorten cycles from concept to flight validation and adopt an agile approach that includes extensive testing. This can enable them to bring disruptive innovations to maturity more quickly and cost-effectively.

Other industries, such as smartphones, electric cars, and space launchers, have demonstrated the ability of startups to drive technological disruption. Aviation is next and a startup can successfully scale clean-sheet hydrogen-electric aircraft to market by 2050.

Conclusion

Beyond Aero is dedicated to transforming aviation through electrification and digitalisation. By concentrating on hydrogen-electric propulsion and a clean-sheet design approach, the company is paving the way for a more efficient aviation future. Aerospace start-ups have characteristics that could position them strongly to play a crucial role in decarbonising the aviation industry and aligning it with global climate goals.. Beyond Aero's efforts will support the ICAO's environmental objectives and expedite the transition to a cleaner, more sustainable aviation ecosystem.