ZEROAVIA

The Hydrogen-Electric Cessna Grand Caravan

Zero-Emission, Lower Cost Flight Operations in the Decade Ahead

Contents

The Cessna Caravan is well known for its dependable and efficient performance, and highly trusted by regional airlines, cargo carriers and charter operators worldwide. That trust has been earned - it is the most successful high-wing 9-19 seat-class turbo prop in the world, with more than 2,600 in service today.

While it is recognised that the bulk of emissions come from large, long-haul aircraft, all aviation players face increased scrutiny and pressure to reduce carbon emissions. Research shows that consumers are increasingly making sustainable purchasing decisions, both in terms of the footprint of products they buy and in their travel choices. At the same time, aviation's climate impact is projected to be more in focus as demand grows and other sectors decarbonize.

The time to act is now, but many operators of small aircraft like the Cessna Caravan have limited options for reducing emissions footprints without new platforms. With the longevity of the airframe and the sunk cost in existing fleet, operators and owners have many years of value left in their airframe assets, but face scrutiny on actions now.

Drop-in Sustainable Aviation Fuels provide some relief, but scarcity of supply between now and the end of the decade, and intense competition for these resources from major airlines, makes it improbable that these will have a substantial impact in regional aviation. In addition, while SAF can reduce system-wide carbon emissions, non-CO2 emissions will remain that are currently understood to roughly double climate warming impact and harm local air quality. and these are increasingly understood to have an even larger climate warming impact in aviation than CO2 emissions alone.

For operators of Caravans, typical mission profile and aircraft power requirements make retrofit of new zero or low-emission propulsion types attractive. Unfortunately, battery electric, so successful in passenger road vehicles, is not commercially practical for Caravan, or any commercial aviation, operations due to weight limitations. In addition, the high utilization of the aircraft and requirement for rapid charging at turnaround mean that battery cycling costs are prohibitive.

Hybrid battery and combustion engine solutions have been championed as a result of the fundamental battery-electric system limitations. However, the overall reduction in emissions per passenger would be modest, with the combustion engine ultimately burning fuel and releasing GHG emissions to support the weight of the battery in addition to the airframe and passengers or cargo, particularly at times of peak power demand. Further, this would come with substantially increased operating cost and complexity, which are just not practical to impose upon operators of small commercial aircraft.

Hydrogen-electric powertrains, like ZeroAvia's industry-leading ZA600, can deliver an option for retrofitting aircraft to enable zero-emission flight while also slashing operating costs. With an agreement in place with OEM Textron Aviation, ZeroAvia is well advanced in bringing a certified product for zero-emission Caravan propulsion to market within the next three years.

ZeroAvia's hydrogen-electric powertrain brings state-of-the-art fuel cell and electric motor technology together to create an unparalleled aircraft engine that will deliver improved operating economics without harming the planet. The ZA600 powertrain uses gaseous hydrogen stored onboard in lightweight tanks. Fuel cell stacks then convert the fuel into electricity through a chemical reaction with the only byproducts being water vapor and heat. The electricity is then used to power electric motors, which turn propellers to generate thrust. The system can deliver an electric Caravan with the fuel cell system enabling commercially-relevant range and payload.

This paper outlines why hydrogen-electric propulsion is the future of truly clean flight, and why the Cessna Grand Caravan is the perfect place to start.

Why Hydrogen-Electric?

ZeroAvia is leading the transition to hydrogen-electric aviation – the most environmentally and economically attractive solution to aviation's growing climate change impact.

While aviation currently represents around 2.4% of global carbon emissions (ICCT) and 12% of transport's contribution (ATAG), according to ICSA, aviation could represent 22% of global CO2 emissions by 2050. When non-CO2 emissions are considered, the sector could be between 25-50% of the climate change impact in the middle of the century. Given that the global effort is already behind on overall targets to tackle global warming, the solution for aviation needs to be far reaching and holistic.

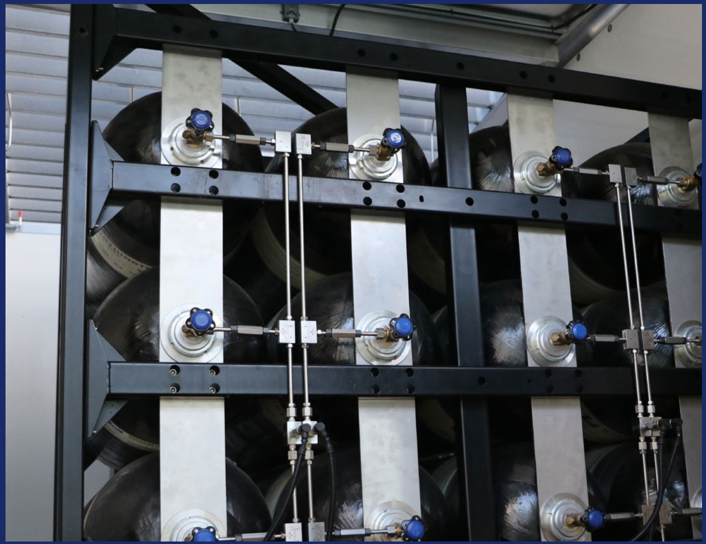
Sustainable Aviation Fuels (SAF) will provide some emissions reduction potential, in the most optimistic case, up to 60% of a given flight (Clean Sky/McKinsey Hydrogen Aviation report). However, there are enormous scalability challenges for biofuel SAF and e-kerosene/ Synthetic Aviation Fuels. Biofuels are a mixed bag, with varying degrees of embedded emissions in their production processes and large land-area requirements with the prospect of competing with food stocks.

E-fuels require both a source of green hydrogen and carbon-dioxide sourced from the atmosphere, which adds significant further energy and plant costs to the fuel's production. Hydrogen, even liquid form, is predicted by some studies to become five times more cost-effective than Synthetic Fuel in 2050.[1]

[1] https://www.euractiv.com/section/aviation/news/fossil-jet-fuel-price-expected-to- soar-as-eu-taxes-bite/

Hydrogen combustion offers some promise with up to 75% emissions reduction potential, but hydrogen-electric propulsion, such as the ZA600, is predicted by the same report from 2020 to offer up to 90% greenhouse gas reduction across the lifecycle. With advances in technology, and greater understanding, this is thought to be even higher today. Furthermore, the ZA600 engine is far more efficient than the turbine it replaces, roughly twice as efficient, with that efficiency advantage cascading back through the fuel value chain.

Hydrogen has 15-50 times more energy density than the best electric batteries today[2]. This means that, where batteries struggle to deliver payload and range for most commercial applications of an electrified Caravan, fuel cells can overcome that challenge.



[2]Example: a Tesla battery cell holds about 260wh/kg, or 0.9MJ/kg (less if additional pack containment and cooling is included), while Hydrogen provides 120MJ/kg, or approximately 15 MJ/kg inclusive of gas containment and at least 50 MJ/kg inclusive of liquid containment)

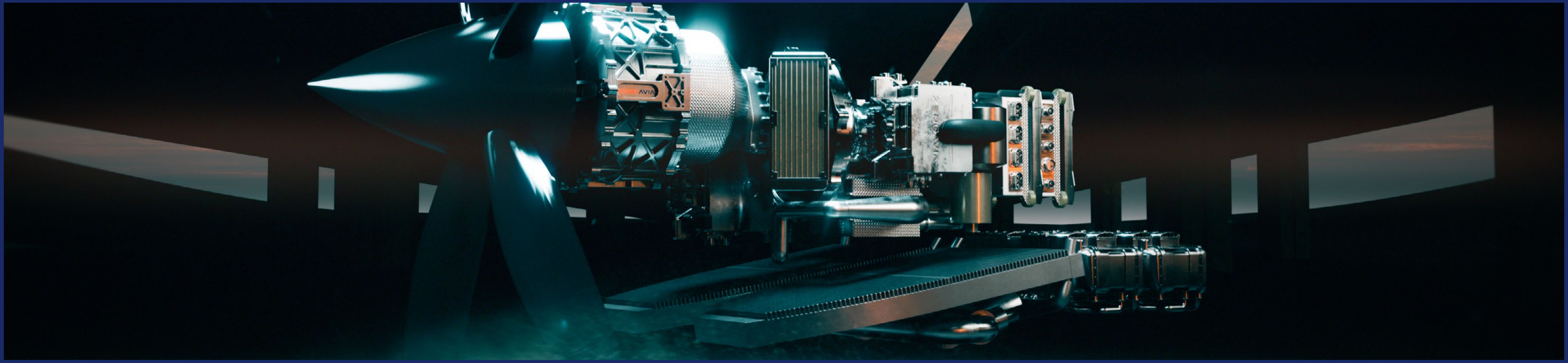
In a high utilization market like aviation, battery cycle life will also drive high replacement costs. While batteries are the right solution for passenger cars, the high utilisation and cycling of aircraft (over 6hrs of operational time per day comprised of multiple flights) and high energy intensity (requiring a lot of onboard energy, at least possible mass) mean they are not well suited despite higher overall energy efficiency. The intensity of use will drive frequent battery replacement and variance in useful energy onboard as battery capacity decays, impacting operations and driving high costs. Batteries also present an infrastructure problem, requiring high power connections to support sub-30 minute turn around for practical commercial operations. This likely entails significant on ground electrical storage with its own conversion efficiencies and costs to manage on one side grid stability and on the other highly intermittent and intense aircraft charging operations. Moving molecules is easier.

Hydrogen is also abundant, as opposed to fossil fuels, and has a specific energy that is 2.8 times higher than traditional jet fuel. The ZA600 will also be >2 times more efficient than the turbine engines it replaces, and due to the lower temperature and pressure conversion processes, will face less wear and tear. All this means significantly lower operating costs for airline operators, as outlined later in this paper.

While hydrogen-electric systems will initially mean reduced theoretical range for aircraft in which they replace combustion engines, ZeroAvia's converted Cessna Grand Caravan aircraft will be able to fly more than 95 percent of the missions flown today (including reserves).

Hydrogen-electric propulsion is plainly the solution to addressing aviation's climate impact long-term, but for Caravan also makes the most business and technological sense of all sustainable aviation solutions.

In the next section, we will provide a technical overview of the system architecture and target component performance of the ZA600 as it approaches submission for certification. Following this, we examine projected aircraft performance for Cessna Grand Caravan aircraft fitted with ZA600 engines and look also at example routes.



The ZA600 is a 500 to 750 kW continuous-class hydrogen-electric powertrain and the first commercial product from ZeroAvia. It will deliver zero-emission flight for thousands of 9-19 seat regional turboprops, beginning with the Cessna Grand Caravan variant of the powertrain which will receive supplemental type certification for retrofit and linefit of the popular airframe.

The first ZA600 equipped commuter platform will be ready for service in 2025, fueled by gaseous hydrogen tanks and capable of carrying passengers up to 250 NM plus reserves, The retro-fit arrangement is depicted in Figure 1.

Powertrain Timeline

2025
9-19 seats
300 NM range
First commercial offering

2027
40-80 seats
1,000 NM range

2030
100-200 seats
2,000 NM range

2035
200 seats
3,000NM range

2040
200+ seats
5000 NM range

Figure 1 - Key Components for Retrofit Hydrogen-Electric Cessna Caravan

Hydrogen Tanks
Three lightweight compressed hydrogen tanks are stored in the Caravan's cargo pod, while two are wing-mounted, collectively storing around 70 kg of gaseous hydrogen at 350 bar pressure.

Electric Motor
High-performance direct-drive motor designed in-house delivering exceptional torque and power density.

Fuel Cell SuperStacks
Space efficient configuration configuration of custom PowerCell fuel cell stacks controlled by in-house optimised balance of plant to enable required energy density necessary for certifiable system for 208B Caravan.

Inverters
ZeroAvia's in-house state-of-the-art silicon-carbide inverter technology converts DC generated by fuel cell system to AC to power electric motors.

Offering Improved System Reliability

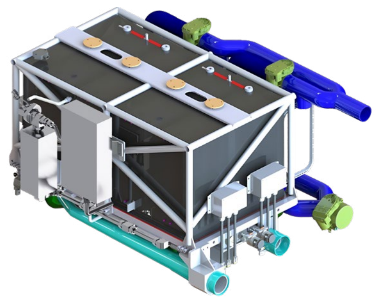
The first question asked around any new aviation system is that of safety. Hydrogen-electric propulsion systems like ZA600 can offer several key safety and reliability benefits. Firstly, the fuel cell systems will operate at nearly around 13-14 times lower temperature than a combustion engine, and also at much lower pressure, with the lower intensity system being less prone to failure. Fuel cells already have 10,000 or more hours of use before significant maintenance events are required, and 20,000 or more hours of operation are achievable. The electric side of the powertrain can also have much lower maintenance costs as it has fewer moving parts than a combustion engine. ZeroAvia has also designed the electric propulsion systems, including the inverters and electric motors, to incorporate additional redundancy to protect against failure.

Cutting Edge Development

Several of the components of ZA600 represent world-leading innovation in fuel cell systems and electric propulsion for aviation; notably the Fuel Cell SuperStacks, the inverters and the electric motor. ZeroAvia's strategy of vertical integration at component level brings whole system thinking to improve performance and fault tolerance and ensure certifiability. The focus on the Cessna Grand Caravan as the launch vehicle for ZA600 has led to rapid integration of these components into a certifiable design with target entry-in-service by 2025.

ZA600 Fuel Cell SuperStack Module

Working with fuel cell stacks provided by leading heavy vehicle supplier PowerCell, ZeroAvia has developed one of the highest power-density multi-stack modules available. The “SuperStack” module is capable of generating 400kW continuously, encapsulates many of the latest aviation fuel cell componentry technologies, and offers an industry-leading scalable power block with specific power in excess of 1.5 kW/kg.



ZA600 Inverters

ZeroAvia has developed a 400kW continuous power inverter which biodirectionally converts high-voltage DC into three phase AC to power the ZA600 motor. Advanced thermal management technologies and integration enable reliable high performance at altitude and successful engine compartment location. The inverters are 98-99% efficient vs. load and speed and operate at 450kW max power.

ZA600 Motor

The ZeroAvia Motor is a 660kW max power, surface permanent magnet based high-efficiency machine with bidirectional operation, specifically designed for direct drive installations mounted to the propeller. Having a stator core divided into 4 sections enhances fault tolerance and allows higher input current from the inverters. The optimized motor cooling allows for very efficient heat transfer within the motor to allow it to run cooler and for longer. The motor offers a max speed of 2500 rpm and high torque (3169 Nm) and power density (5 kW/kg).

ZeroAvia is offering the zero-emission ZA600 powertrain for the Cessna Grand Caravan as its launch airframe, working closely with Textron Aviation towards certification and entry-in-service in 2025.

There are more than 2,000 Cessna Caravan 208b in service or storage globally today, with many having decades of service time left (see Figure 2). The median age of aircraft sits around 15 years. At that age, the airframe has potentially 20-25 years of service remaining.

Figure 2 - Cessna Caravan 208b Airframe Age

The hydrogen tank range and overall system have been designed to capture the overwhelming majority of commercial flying and maximize usable payload.

Crucially, the ZA600 for Caravan is designed to match the existing power requirements and mission profile of the airframe. If cargo operators also run shorter missions, but increased payload is required, the tanks are modular, allowing for removal of fuel capacity to provide additional cargo space or weight.

Capacity	Range	Tailpipe CO2 Emissions	Shaft Power	Entry In Service
9 - 12 PAX / 855 kg+	250-300 nm	0 g/nm	533 kW	2025

The hydrogen-electric engine will have a theoretical range penalty due to lower overall energy density when compared to the stock engine. However, as we will see in the next section, the overwhelming majority of scheduled flights across the world today using the Caravan platform can be replaced with the alternative propulsion system, while preserving payload.

With the full retrofitted powertrain system and hydrogen tank capacity, the remaining weight for the aircraft stands at 855 kg. With assumed passenger weight of 95 kg, this allows for 9-passenger flights at maximum range.

Wing-mounted hydrogen tanks preserve internal space for passengers and cargo, at the expense of a ~5 percent drag penalty.

Operational knots true airspeed (KTAS) will be marginally lower than the traditional combustion-engined aircraft, but with minimal impact on typical Caravan routes and schedules.

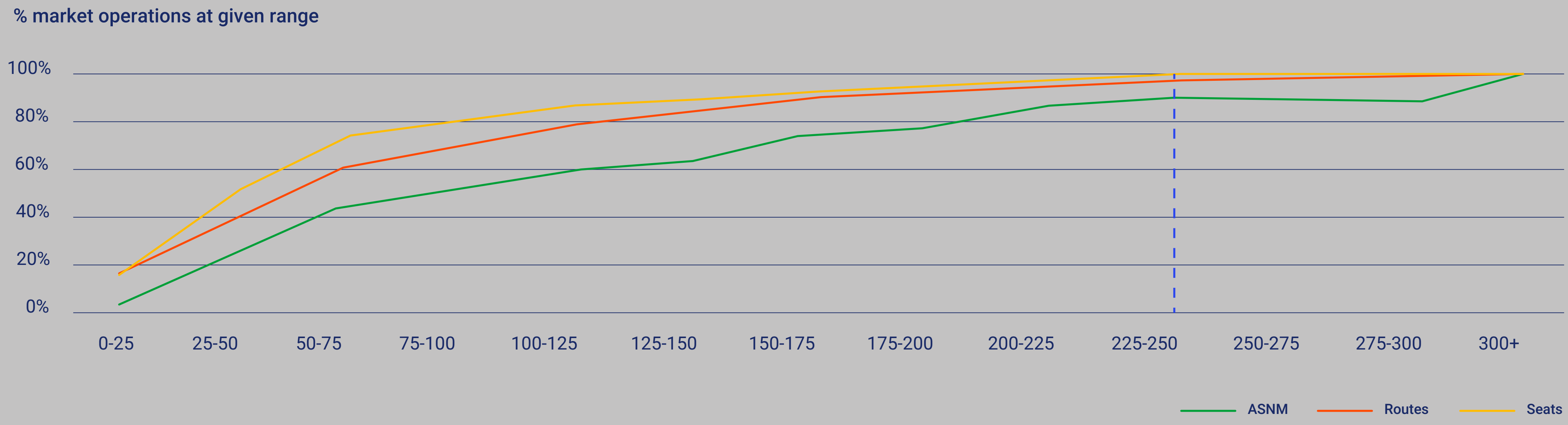
The hydrogen-electric propulsion system will offer Caravan operators significant maintenance and fuel savings and the opportunity to explore new routes and expand their businesses.

The hydrogen tank range of ZA600 has been designed to capture the majority of commercial flying and maximize usable payload. The ZA600 is designed for the mission profile of the airframe, enabling Cessna Grand Caravan operators to switch to zero-emission, hydrogen-electric aviation and maintain range for 95% of missions flown today.

The ZA600 system for Caravan targets entry-in-service in 2025 with a 250 nautical mile range plus reserves, carrying 9 passengers or just under 900 kg in cargo weight.

This opens up a range of existing routes in flight today, as detailed in Figure 3.

Figure 3 - Range distributions of key ZA600 Airframes



In addition, NASA's report[3] into the impacts of zero-emission flight on regional air mobility in the US finds that any reduction above 40% in operating costs will generate a "huge expansion" in demand for flights, presenting new opportunities for operators.

However, even replacing the existing routes flown offers substantial opportunities for emissions and cost savings (as we will see in the next sections).

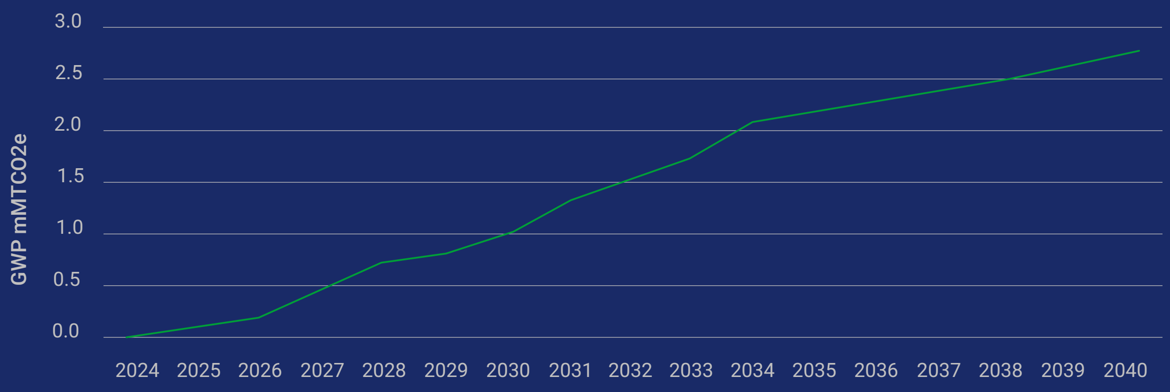
[3] https://sacd.larc.nasa.gov/wp-content/uploads/sites/167/2021/04/2021-04-20-RAM.pdf

Emissions Savings

As one of the first zero-emission aircraft to fly commercially, even as a smaller aircraft, the Cessna Grand Caravan and its operators will garner headlines for efforts to tackle climate change. The attention will be justified. Converting Cessna Caravan 208b to hydrogen-electric propulsion can position Caravan operators as leaders in the global race to decarbonize aviation.

Cumulative emissions savings to 2040, for the projected converted Cessna Caravan market, is 2.22 million metric tons CO2 equivalent (mMTCO2e). That is higher than the US State of Rhode Island's annual home heating emissions.[4]

Figure 4 - Cumulative emissions savings across projected Cessna Caravan market replacement with ZA600 product to 2040



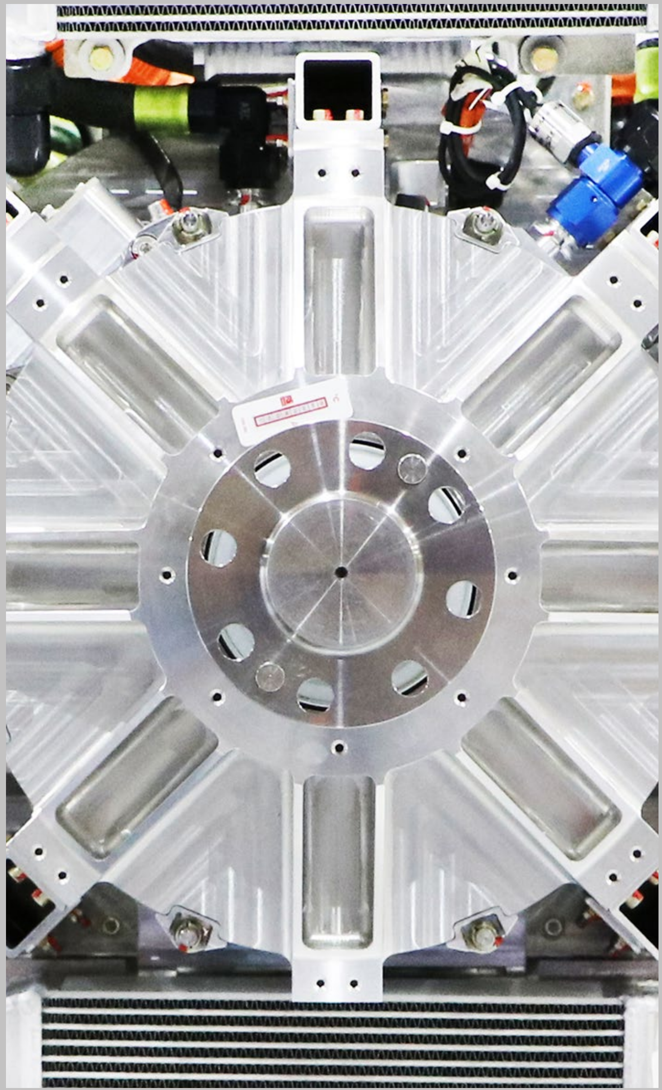
This represents a 78.7% reduction from jet fuel emissions and a 41% reduction from a typical 30% blended SAF bio mix fuel (see Figure 5 on the next page). For SAF, emissions from NOx and CO2 (captured for production) are reduced, while emissions due to water vapor are increased, compared to conventional jet fuel.

[4] https://dem.ri.gov/sites/g/files/xkgbur861/files/programs/air/documents/ghg-quick-facts17.pdf

Of all practical options for reducing climate warming and clean air impact of Cessna Grand Caravan operations, hydrogen-electric propulsion is by some margin the furthest-reaching solution. As we will also see, it offers major operating cost savings as well. Together, this amounts to strong motivation for airline and cargo operators to convert Caravans in service or to switch to the platform with line-fitted engines at the time of fleet replacement.

Figure 5 - Cumulative emissions across projected Cessna Caravab market replacement with ZA600 product to 2040

Critically for the adoption of zero-emission solutions in aviation, hydrogen-electric propulsion offers significantly improved operating costs. It is therefore attractive for both the environmental and commercial impact, making speedy adoption and high demand from operators a high likelihood.



ZA600 offers Caravan operators the opportunity to potentially half operating costs on the most advantageous routes (see Figure 6), and substantially reduce on the vast majority.

The operating cost savings are driven by two primary factors which we will explore in the next page - lower cost of hydrogen as a fuel, and engine maintenance savings.

Fuel Savings

The price of jet fuel is expected to double in next 25 years, with on-going risk of market shocks on feedstocks and fossil fuels.

According to IRENA predictions, green hydrogen production costs could reach levels of $0.65/kg H2 by 2050 in the best locations, while reaching levels of $ 1.15/kgH2 in less optimistic cost assumptions.[5] Some see that cost trajectory even more optimistically. Average cost of green hydrogen is set to fall to $1.50/kg by 2030 as electrolyser capacity ramps up 50-fold, according to Rethink Energy, in what it labels a “conservative estimate.”ò

According to a report from McKinsey and Clean Aviation, hydrogen, even in liquid form, is predicted to be five times more cost-effective than Synthetic Fuel in 2050.7

Hydrogen-electric engines enable further fuel savings through their higher efficiency (2-3 times more efficient than combustion engines). ZeroAvia’s Cessna Caravan engine will be twice as efficient as the turbine it replaces, halving the energy needed to fly a given mission.

Maintenance Savings

Engine maintenance savings are driven by longer time between overhauls (TBOs) and generally less onerous maintenance events.

Fuel cell systems operate at significantly lower temperatures and pressures than internal combustion engines, and therefore represent lower intensity systems with less degradation. As is now well understood thanks to the proliferation of electric road vehicles, electric propulsion systems are less prone to component breakdown than internal combustion engines. ZeroAvia calculates that the electric side of our powertrain can have 10 times lower maintenance costs than a conventional engine. Fuel cells are already at 10,000+ hours of use before significant maintenance events are required. ZeroAvia projects that 20,000+ hours are achievable. This compares highly favorably to the 1800-3600 hours between major maintenance, repair and overhaul (MRO) events for conventional engines.

Combining both fuel and maintenance, ZeroAvia estimates potential cost savings of between 30 and 50% depending upon route type.

[5] https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2022/May/IRENA_Global_Hydrogen_Trade_Costs_2022.pdf?rev=00ea390b555046118cfe4c448b2a29dc
[6] https://rethinkresearch.biz/articles/market-dynamics-to-drag-green-hydrogen-to-1-50-kg-by-2030/
[7] https://www.euractiv.com/section/aviation/news/fossil-jet-fuel-price-expected-to-soar-as-eu-taxes-bite/

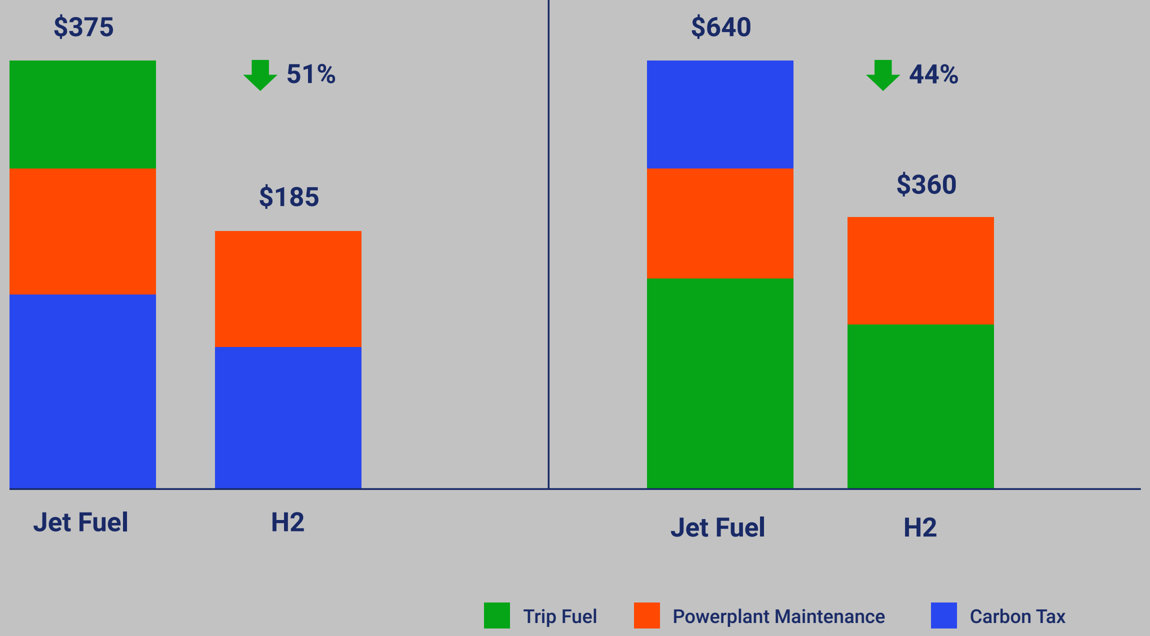
Figure 6 - Conventional vs. Hydrogen-Electric Engine: Sample Route Comparison

125 nm

	Jet Fuel	H2
Flight Time (mins)	51	51
Max Passengers	9	9
Available Seat Miles	1,125	1,125
Block Fuel (kg)	174	25

250 nm

	Jet Fuel	H2
Flight Time (mins)	100	100
Max Passengers	9	9
Available Seat Miles	2.250	2.250
Block Fuel (kg)	278	48



Assuming annual utilisation of 1000 FH & 1500 Fc at maximum payload, in 2005 economics. Hß price = $3.95 per kg Jet fuel price = $1.21 per kg. Carbon price = $106 per ton COß. No inflation assumed.

HyPerHour - Derisking Adoption

ZeroAvia is signing agreements with operators based on its HyPerHour model - providing hydrogen-electric propulsion on a fixed hourly cost, as well as a smaller percentage upfront investment in the powertrain and retrofit. HyPerHour agreements will most often involve hydrogen fuel supply and maintenance, thus de-risking early adoption for customers by providing surety of fixed operating costs for zero-emission propulsion. These fixed agreed costs will represent long-term savings when compared against future jet fuel costs as described above.

ZeroAvia is building a global support network of Retrofit and Maintenance Centers to ensure the smooth entry into service, and in-service support, of our powertrain products. Through partnering with established aviation maintenance providers, ZeroAvia will be leveraging existing aviation skill sets and also upskilling the aviation workforce to prepare for the transition to new clean aviation technology.

ZA600 Retrofit:

The retrofit will require the removal and replacement of the conventional aircraft turbine and fuel system components, in order to make way for the new zero-emission powertrain. Each step of the retrofit will be supported by ZeroAvia experts and carried out by ZeroAvia approved centers

The removal of the conventional turbine engine is a common procedure carried out as part of overhaul maintenance intervals, although additional supporting electrical and mechanical system components will be required to be removed, alongside the fuel system and supporting fuel subsystem components.

The installation will require preparation of the airframe to house, mount and attach the new subsystems, such as the electrical motor, inverters, hydrogen tanks, and fuel cell stacks. Once installed the systems can then be inspected and tested to ensure the full powertrain system functions as expected.

ZeroAvia customers will be supported throughout the retrofit process and through maintenance inputs once in service through our planned global service support network, dedicated customer support team and in-house design team experts. With the replacement of the combustion engine with fuel cell and electric propulsion systems, less maintenance is expected due to the lower temperature, pressure and fewer moving parts.

1. **The turbine engine** is removed along with the associated furl systems and structures
2. **The aircraft** is preprared for the new engine including mounting structures, pipework, electrical harnesses and avionics
3. **ZeroAvia's hydrogen-electric powertrain** is installed
4. **Hydrogen tanks and aerodynamic fairings** are installed

The aircraft is inspected and tested before returning to the customer.

Hydrogen Fuel Production and Airport Refuelling

In addition to developing the world's first certified zero-emission propulsion system for commercial aviation, ZeroAvia is working to deliver low cost, low carbon, resilient and reliable hydrogen to remove emissions from airport ecosystems and provision fuel for hydrogen-electric flights.

ZeroAvia is approaching this challenge by both demonstrating and rolling out refueling infrastructure for early adoption, as well as partnering with major energy companies such as Shell, Fortum and Masdar, and leading airports, ensuring operator and lessor confidence in the refueling ecosystem as flight routes are planned.

The company envisages Caravan operations relying on either a "Distributed Production" hydrogen infrastructure model with proven flexible mobile refuelers, or "Plug and Play" services, with centralized production supporting scale-up and network coverage. With the Caravan requiring around 70 kg of hydrogen per mission, hydrogen supply and refueling infrastructure can be established relatively easily.

1. Plug and Play

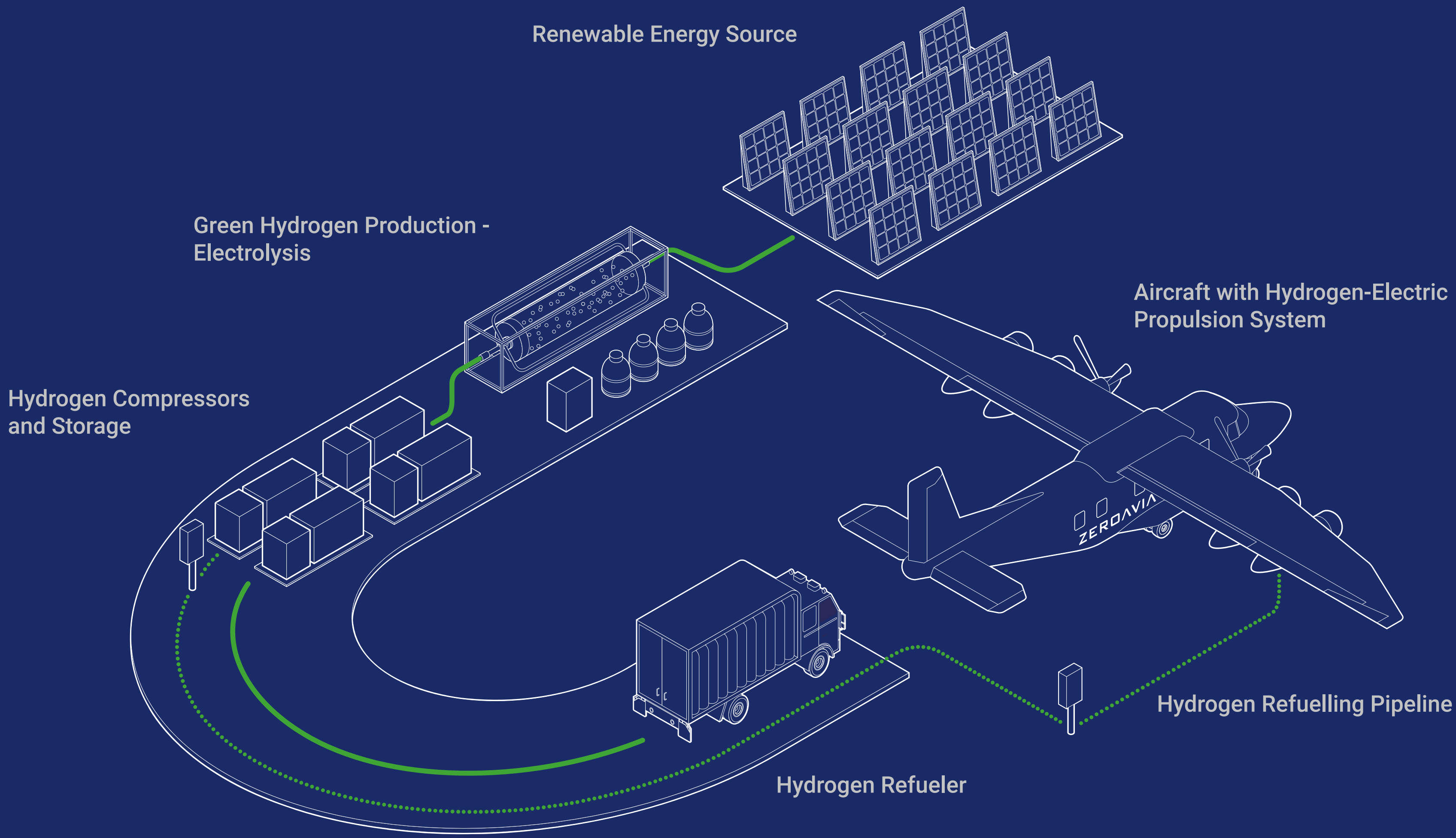
- 3rd party hub provides green H2
- ZeroAvia mobile refueler transports and dispenses to the aircraft
- Most suitable for smaller airports / smaller aircraft fleets / early deployment
- Complements future distributed production system
- ✓ Limits infrastructure investments
- ✓ Flexibility to deploy / support network expansion quickly - launch customers or adding airport nodes
- ✓ Re-deployable infrastructure, enabling continued network expansion

As demand grows, plug and play solutions will transition to distributed production.

2. Distributed Production

- ZeroAvia produces (on-site via electrolysis), transports and dispenses green H2 to aircraft
- Most suitable for larger airports, also potentially serving broader hydrogen users such as heavy ground transportation
- Primary model for airport fixed infrastructure
- ✓ Ability to drive down costs through scale and smart management
- ✓ Strengthens the value proposition for all parties
- ✓ Leverages outside capital – ZeroAvia demand aggregates

Figure 7 - ZeroAvia's distributed production, storage and refueling infrastructure



Hydrogen Airport Refueling Ecosystem (HARE)

ZeroAvia has already developed a fully functioning microcosm of potential refueling operations. The Hydrogen Airport Refueling Infrastructure (HARE), developed as part of the HyFlyer projects in conjunction with the European Marine Energy Center (EMEC), has demonstrated green hydrogen production through to airside fueling.

The company is building an updated version of the HARE in both California and Gloucestershire, UK, to power testing and demonstration flights. The next generation will include proprietary software and battery buffer designed to optimize the production cost of hydrogen through an algorithm which can decide when to channel the renewable power generated into the electrolyzer (green hydrogen production), battery storage or sell it back to the grid.

Refueler

Electrolyser

Rotterdam

Rotterdam the Hague Airport, ZeroAvia and Shell are collaborating on a concept of operations for hydrogen in airports and demonstration flights to European destinations by the end of 2024, gearing up for commercial passenger flights by 2025.

This specific collaboration will focus on serving the first hydrogen flight from Rotterdam, including operation at the airport, developing on-the-ground infrastructure and operations to satisfactorily pilot distribution, storage, and dispensing of hydrogen for aviation, leading towards decarbonizing the whole airport ecosystem.

Edmonton International Airport

ZeroAvia and Edmonton International Airport are working together to develop hydrogen infrastructure at both the main airport and Villeneuve Airport. The partnership will leverage EIA’s on-site solar farm to produce green hydrogen for refueling demonstration flights before building towards initial flight operations.

Conclusion

With hydrogen-electric powertrains coming to market for the Cessna Grand Caravan, this iconic airframe will be the first zero-emission commercial aircraft in the world.

Several factors are aligning to make early adoption for operators attractive: reduced operating costs, readiness of hydrogen fuel supply infrastructure, government incentives, and public and investor pressure to reduce aviation emissions.

ZeroAvia is leading the way in helping operators and lessors take advantage, with nearly 2,000 powertrains under pre-order and already establishing production to meet demand.

Caravan operators can benefit from adopting hydrogen-electric propulsion in the following ways:

- True zero-emission flight and fuel - tackling 95 per cent of the climate change impact of flight
- Lower and more stable fuel costs - low-carbon hydrogen on track to beat jet kerosene and SAF; overall powertrain system energy efficiency will be double meaning optimized use of fuel
- Lower maintenance costs - smaller turbine engines range from 1,800 to 3,600 hours between major service or overhaul; a hydrogen-electric powertrain promises more than 10,000 hours of flight between major servicing events
- Lower noise and improved ground air quality - replacing engine combustion and exhaust with negligible noise of fuel cells and electric systems leaves only propulsor noise, while removal of all tailpipe emissions removes impact on airport community air quality

Connect with us to explore how we can work with you, starting with:

- Detailed route studies for existing and future operations with hydrogen-electric propulsion
- Fleet longevity analysis for retrofit and new aircraft opportunities
- Assessment of refueling needs and provision opportunities
- Modeling operating cost and environmental benefits of zero-emission propulsion

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