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Can Aerion's Supersonic Jet Be Green? A Carbon Neutral Fuel Tie-Up Hinges On Regulatory Reform And Image As Much As Technology

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An artist conception of the AS2 supersonic business jet on takeoff. AERION SUPERSONIC

When Aerion Supersonic announced July 8 that it would explore using synthetic jet fuel made by Carbon Engineering, a Canadian company developing technology to suck carbon dioxide out of the atmosphere, the underlying message was that the company is committed to making a supersonic business jet that potential customers can claim is environmentally responsible. Aerion has pledged to make its administrative, manufacturing, materials and supply chain processes carbon neutral, but its aircraft is the centerpiece.

Aerion says the AS2 will take flight in late 2024 or early 2025 as a nearly silent Mach 1-plus transport capable of hauling a dozen passengers in luxury on intercontinental business missions. There are environmental reasons for flying a clean, green bizjet but potential owner operators are perhaps even more keen to avoid the specter of being seen as insensitive elites rocketing around the globe at the time-saving speed-of-sound.

Gene Holloway, Aerion's Chief Sustainability Officer, likes to cite the 2019 "Google Camp" gathering in Italy as a useful example. Last summer, Google's founders invited a group of grandees including former President Barack Obama, Prince Harry, Leonardo DiCaprio and Katy Perry to the Sicilian seaside for a week-long discussion (nee fete) on climate change. Attendees arrived in 142 business jets and several yachts.

"There was no end of ridicule," Holloway observes. "I think [bizjet] users are becoming much more sensitized to this. This [an alternate-fuel AS2] helps them say, 'I used my business jet but in a way not unfriendly to the environment."

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So Aerion will work with Carbon Engineering to assess the potential of using of a sustainable synthetic jet fuel produced by the latter to power its airplane.

“We have a supersonic jet powered by fuel made from air. It’s intriguing,” Holloway says. “This will be the first jet specifically designed to operate with [synthetic/biofuels]. That’s unique in the market.”

Not surprisingly the market, like all of commercial and business aviation, is up in the air due to the global pandemic. Aerion has recently “re-prioritized” its engineering workflow and path to critical design review of the AS2 (slated for 2021) but has not laid any employees off, as it transitions from headquarters in Reno, Nevada, to new digs and a manufacturing facility in Melbourne, Florida.

These moves come following a report that major Aerion investor Boeing and Spirit AeroSystems have halted engineering work on the AS2. Aerion’s Holloway declined to comment. Boeing said by email only that it remains an investor in Aerion and referred any further comment to the former.

A rendering of the Aerion AS2 business jet crossing snow-capped mountains at supersonic speed. AERION SUPERSONIC

In the meantime, Aerion and Carbon Engineering plan to move forward to realize a “supersonic jet powered by fuel made from air.”

Carbon Capture & Flight

Vancouver-based Carbon Engineering counts Microsoft co-founder Bill Gates among its investors. CE specializes in direct air capture (DAC) of carbon. Since 2017, the company has been removing tons of carbon from the atmosphere at a pilot plant in Squamish, B.C.

DAC is a liquid chemical process that begins with a fan pulling air past a mixture which reacts with CO2 in the air, extracting a significant percentage. Subsequent chemical reactions reduce CO2 from the prevailing 400 parts per million per unit of air to zero. Extracted carbon is then pressurized into a liquid and can be pumped underground, where it mineralizes into rocks over time.

The major elements of Carbon Engineering's Direct-Air-Capture CO2 removal process. CARBON ENGINEERING

Conveniently, combining DAC with the Fischer-Tropsch process (which converts a mixture of carbon monoxide and hydrogen into liquid hydrocarbon) yields liquid fuel that can be plugged into today's transportation infrastructure. That's the stuff that CE and Aerion think could work in the AS2.

“They’re interested in our fuel because it has the smallest potential impact on their engine design and a very low carbon intensity," Carbon Engineering CEO Steve Oldham says.

The low carbon intensity to which Oldham refers is the product of a virtuous cycle wherein CO2 removed from the air via DAC improves overall atmospheric carbon. When converted into fuel and used in any vehicle, the carbon is returned to the atmosphere as CO2. But the (largely electrified) DAC process then captures it again to make more fuel, continually re-using existing CO2. Little or no new carbon emissions are thus created, according to CE.

While conventional jet fuel has a carbon intensity on average of just under 90g CO2/MJ (megajoule), CE estimates that synthetic fuel made from atmospheric CO2 using its process will come in at around 10g CO2/MJ.

The possibilities of using an air-to-fuel (A2F) synthetic to power airplanes extends beyond Aerion, Oldham says.

“We’re talking with the aviation sector as a whole about an even nearer term solution ... how capitalizing on the use of alternative fuels in combination with carbon removed from the atmosphere [by DAC] can combine with traditional fossil fuel use to provide a way to decarbonize aviation with a very limited impact on existing infrastructure.”

Opportunities for claiming neutral or negative emission status potentially arise from CE sales of carbon credits for each ton of CO2 it takes out if the atmosphere. While no carbon credit market currently exists in the U.S. and the outlook for carbon credit legislation awaits the results of the November elections, firms that invest in the sequestration (carbon removal and burial) which CE will begin doing at scale at a new plant in Texas' Permian Basin in 2023 could lay claim to a kind of neutrality by supporting DAC.

Carbon Engineering's direct air capture pilot plant in Squamish, B.C., Canada. CARBON ENGINEERING

Surprisingly, Aerion says it has not really considered this. Instead, it's looking to balance

AS2 CO_2 emissions by planting 100 million trees in a massive reforestation effort. Holloway says this is more "proactive" than simply buying credits from CE or another carbon recycler (Canadian/Japanese-backed LanzaTech for example).

But alternative fuels are key. "We hope to inspire others to move to solve the carbon problem through our example," Holloway affirms. “This [CE synthetic fuel] is one of those technologies that begins to reverse some of the CO_2 footprint.”

Making the AS2's non-afterburning General Electric-developed Affinity engines work on a 100% A2F load of fuel presents no insurmountable problems, Aerion's Holloway says though the lack of natural aromatics (which make rubber seals swell/seal) that are present in fossil fuels creates issues for the aircraft's fuel system. Aerion is investigating different sealing materials and possibly adding small amounts of fossil fuel to the A2F.

The company is also considering the possibility of pre-positioning synthetic or other biofuels at FBOs to which the AS2 will fly worldwide. Given a likely lack of availability of such fuel in many locations, Aerion is even considering standing up its own company-owned FBOs to service the AS2, a bit of vertical integration not unlike that seen in other luxury goods sectors.

“They’d have this type of fuel available any time a customer comes in," Holloway says, "whether one of our customers or, as others shift to this fuel, another customer comes in.”

And the jet itself will be capable of flying on non-alternative fuels. Like a "flex-fuel" Chevy, the AS2's design requirements are such that the jet can either fly on 100% petroleum jet fuel or on 100% synthetic fuel with no aromatics.

However the supersonic transport may be ready to fly before any CE synthetic fuel actually reaches the market.

Regulation & A Market

“I’ve never hid the fact that our fuel will be more expensive than fossil fuels, just as biofuel is, so we’re reliant on carbon policies that emphasize [use of] lower carbon fuels,” Steve Oldham says.

For A2F those policies don't exist. When Congress created the renewable fuel standard (RFS) program to reduce greenhouse gas emissions and expand the nation’s renewable fuels sector in the early 2000s (Energy Policy Act of 2005, Energy Independence and Security Act of 2007) it very carefully, strictly wrote the legislation so as not to encourage inappropriate use of biomaterials – like essential foodstocks - to make fuel. Air was not one of the fuel stocks it considered.

“I like to tell people, how hard can it be to insert two words - ‘and air’ - into a piece of legislation?" Oldham quips. "That’s what we would like to add the RFS.”

Until that happens – and CE is lobbying for it in the U.S. and other countries – A2F won't be cost competitive.

Without such incentives in place, CE has no immediate plans to even open a scaled synthetic fuel production plant. The company has actually considered siting a plant next to Aerion's new Florida facilities, both Oldham and Holloway confirm, but until end user costs can be made equivalent to fossil fuels, it won't happen.

That leaves Aerion without the near term prospect of a Carbon Engineering synthetic fuel supply despite the two companies' formal cooperation. Does that make their announcement more a symbolic one?

“It demonstrates that there is a [potential] market for our fuel,” Oldham contends.

Aerion's Holloway maintains that observers who understand commercial aviation recognize that the agreement provides lead-time for technological and market development.

The AS2 ready for Carbon Engineering A2F synthetic fuel at a notional Fixed Base Operation (FBO)... [+] AERION SUPERSONIC

The planned first flight of AS2 (2025) is not far off, however. Will it be made with 100% synthetic fuel or a biofuel?

The short answer is neither unless there's a dramatic change in carbon incentives. Supplying enough CE synthetic for fuel for a test program less than five years away is unlikely even if the regulatory landscape suddenly shifted.

Gene Holloway thus describes a flight test program (reckoned to be 4,000-5,000 hours with five aircraft) wherein the first series of AS2 flights are fossil fuel-powered, setting a baseline for performance, required fuel calibration and later moving to biofuel blends, 100 percent alternative fuel and, at some point, 100% A2F.

The results of alt fuels flight testing will be made available to all for the good of the industry and environment Holloway says.

For now, it's likely wise to consider the tie-up between Aerion and Carbon Engineering as a technological and market signal. Liquid fuels remain superior to electrification from an energy density, portability and weight standpoint, and will for the foreseeable future.

Decarbonization of commercial aviation through inputs to existing infrastructure makes compelling economic and technical sense. Signs point to the world likely finding out soon that the perceived environmental benefits of battery electrification aren't what they're cracked up to be as well.

But as Aerion's well-heeled prospective customers might admit, a dash of positive perception can't hurt.

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