

The SAF Carafe

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Sustainable Aviation Fuel (SAF) Grand Challenge Observations from CAAFI® - the Commercial Aviation Alternative Fuels Initiative

September 15, 2021

On Thursday, September 9, 2021, the U.S. government announced a [SAF Grand Challenge](#). Goals identified include increased government engagement that will enable the U.S. domestic production of 3 billion gallons of SAF per year by 2030, and full replacement of petroleum-based jet fuel (approximately 35 billion gallons per year) by 2050. The Challenge is accompanied by a [Memorandum of Understanding](#) between the U.S. Departments of Energy, Transportation, and Agriculture.

CAAFI appreciates the recognition by the government of the truly “grand challenge” associated with decarbonizing aviation (commercial, business, general, special use, and military), and how SAF will play a predominant role in enabling such to occur in a timely manner. We also value the recognition of the importance of the aviation sector in delivering significant jobs, gross domestic product (GDP), and trade, essential to the health of our economy, as well as providing a means of safe, high-speed, efficient transport of people and goods.

While the aviation industry appreciates all the work that has been accomplished so far through academic, private, public, and joint efforts, CAAFI also recognizes the government’s acknowledgement that much work remains. SAF has been in development since 2006, and has been in commercial use since 2016, but SAF usage has remained very modest as a



result of insufficiently coordinated efforts to address risk, cost, competition with other renewable uses, and overall scale-up.

CAAFI leadership commits to working with the [SAF Interagency Working Group](#) (SAF IWG) that has been tasked with developing the SAF Grand Challenge Roadmap and Recommendations over the coming 6 months. We then look forward to participating in that roadmap's execution. CAAFI believes this will accelerate the ramp-up of SAF production from a very broad range of sustainable feedstocks and conversion processes through supported research, development, demonstration, and deployment efforts, as well as implementation of enabling policy initiatives. CAAFI strongly believes that domestic SAF production can result in significant development of jobs and rural development, while providing other environmental services (e.g., improved air quality, enhanced waste management sustainability).

More information about the Challenge will be released in the coming days and weeks, including the scheduling of industry workshops to inform the SAF IWG roadmap development. The first of those workshops (outside government agency activities that have been ongoing for a couple months), occurs September 16th with various researchers. Please watch your email for announcements of other workshops through the 4th quarter. We'll also be publishing updates via CAAFI's Blog, [The SAF Carafe](#), as well as on our [homepage](#).

Our thanks go out to leadership within DOT, DOE, and USDA for recognizing the vital need to pursue a viable decarbonization strategy for the industry, and then working to actualize this challenge and pending effort across government and industry.

Following are some of the new corresponding producer announcements linked to the Grand Challenge roundtable discussion.

Alder Fuels is launched

- [Honeywell](#)
- [United](#)
- [Alder Fuels](#)

LanzaJet

- Plans to produce 1 B gallons per year of SAF by 2030

Velocys

- [Plans to produce 300 M gallons per year of blended SAF by 2030](#)

Gevo

- [Working with Chevron on SAF](#)

Additional linkage to SAF production scale-up include items related to: [World Energy](#), Fulcrum, BP, Virent, Honeywell, Shell, Neste, Marquis, Green Plains Inc., ADM, Prometheus, Aemetis, and members of the Renewable Fuels Association and members of [Growth Energy](#).

The Auspiciously Quiet Passing of Summer and September Amidst the Cacophony

October 01, 2020

Irrespective of our personal and political views, I think we can probably agree that summer 2020 was one of those “may you live in interesting times” periods. This included significant hurricane formation in the Atlantic basin, hurricane strikes to the U.S. mainland, the hurricane of COVID-19 destruction of life, liberties, and businesses which we take for granted, and the hurricane cacophony of the political season reaching Category 4, ... not to mention wildfires, social unrest, demonstrations, and contempt for the rule of law on which civil society depends. Regardless of the angst, life continues, and we all do our best to cope and thrive.

So, the autumnal equinox came and went without much fanfare this year, and September passed into history ... and I’m happy to look forward. In a similar vein, our CAAFI efforts on sustainable aviation fuel (SAF) development and commercialization continue, irrespective of the cacophony. There were several unique events that occurred this past month that reinforced the need for, value of, and results from the industry’s work on SAF, and point to promising additional collaboration opportunities to accelerate SAF commercialization. I’m happy to share some of those details with you.

The **Bioeconomy Initiative Forum**

(<https://www.energy.gov/eere/bioenergy/events/bioeconomy-initiative-forum>) held virtually on September 14-15. Discussion topics were broad but targeted, and reinforced our Federal

Partners interests in all things Bioeconomy, including SAF. Several specific affirmations of focus were made, with three specifically targeting SAF:

- 1) AAF IWG:** Our colleagues at DOE/USDA/DOT formally announced the establishment of a new interagency work group under the auspices of the [Biomass Research and Development Board \(BRDB\)](#). This new IWG, entitled the [Advanced Aviation Fuels Interagency Working Group \(AAF IWG\)](#), will be dedicated to coordinated research and development (R&D) for SAF. As you know, with CAAFI being a public private partnership, we have been collaborating closely on SAF development with multiple agencies. This IWG announcement is the latest progression of such collaboration, which we have been pursuing as a follow-up to the completion of our Farm-to-Fly 2.0 effort. The AAF IWG will support a number of goals including: 1) sharing of information and key findings among federal agencies and coordinating activities; 2) ensuring that R&D efforts reflect the critical needs of commercial, business, and military aviation; 3) developing best practices to foster the success of fuel supply development for the commercial, business, and military aviation sectors; and, 4) developing a revised Federal R&D roadmap on advanced aviation fuels.

CAAFI welcomes the decision by BRDB to establish the IWG. This coordination function will make SAF a priority area of the overall federal effort to stimulate the development of the Bioeconomy and support rural development. CAAFI pledges to work to support the goals of the AAF IWG and the overall mission of the BRDB to implement a federal strategy to develop biofuels, bioproducts, and biopower through the Bioeconomy Initiative. CAAFI Strategy and Implementation Advisor Nate Brown, of the FAA’s Office of Environment and Energy, will co-lead the group with long-time CAAFI collaborators Bill Goldner (USDA) and Zia Haq (DOE) starting this fall.

- 2) Sustainable Aviation Fuel, Review of Technical Pathways report:** This SAF Review (<https://www.energy.gov/sites/prod/files/2020/09/f78/beto-sust-aviation-fuel-sep-2020.pdf>) was released in September. Closely related to the above, this report highlights the data analysis and conclusions that DOE reached with regard to SAF. This document, as well as an updated version of the [2016 Federal Alternative Jet Fuel R&D Strategy](#), will be used as the basis for creating an updated and ongoing roadmap to help guide integrated Federal Agency strategy on SAF development and commercialization.
- 3) Summary of recent DOE funding announcements:** As a timely indication of BETO's continued commitment to SAF, the Department of Energy earlier in the summer [announced](#) their intent to award [\\$97 M to 33 R&D projects](#) to accelerate the bioeconomy from the FY2020 Multi-Topic Funding Opportunity Announcement (FOA). Of those, seven projects, awarded \$23M, were focused on SAF. Additionally, the [DOE Office of Science made an earlier award of \\$68M](#) to several entities aimed at making bioenergy feedstock crops more productive and resilient. Of particular interest to SAF production concepts, [six of those projects \(three each award\)](#) are focused on pennycress and camelina development, for a combined award of \$24M. These projects should be accretive to the work of folks

like [Global Clean Energy Holdings](#) and [CoverCress](#) (and their work with the [NIFA/AFRI CAP project IPREFER](#)) who are diligently working to make sustainable

seed-oils a major opportunity for renewable fuel and bioproduct production, including SAF. (Come back for my next blog for more information about these opportunities).

The **ICAO Stocktaking Seminar on aviation in-sector CO2 emissions reductions** took place on September 08-11. These sessions provided summaries of the breadth of activities occurring around the world that are fostering the development of aviation efficiency improvements via Technology, Operations and SAF, coincident with the aviation industry's commitment to carbon neutral growth from 2020, and the longer term aspiration of achieving a 50% reduction in net CO2 emissions from 2005 levels by 2050. ICAO's own observations can be found [here](#), but I was encouraged by the broad recognition from across the world of the need and role for SAF to deliver the significant reductions in CO2 emissions for which we are striving. In a timely news release, the **oneworld** airline alliance announced a commitment from its 13 airlines to achieve net-zero carbon operations by 2050, also clearly highlighting the importance of SAF to enable such reductions.

The **Virtual 2020 Business Aviation Global Sustainability Summit** was held on September 14 and 15th, to highlight the interest of the business aviation community in fostering greater availability of SAF. The [summit featured participation from key industry leaders](#), and highlighted the use of SAF by several corporate flight departments. Guest speakers included House aviation subcommittee chairman Rick Larsen (D-Washington) and ranking Republican Garret Graves (Louisiana), as well as Acting Undersecretary for Transportation Policy, Joel Szabat. This Summit was planned and executed by the [SAF Coalition](#). A summary of the event can be found [here](#), and video links to the four summit sessions can be found on CAAFI's News [site listing](#).

Culminating Boeing's 2020 ecoDemonstrator activity, airline partner **Etihad flew their 787-10 from Seattle to Charleston, SC, [using a 50,000 gallon load of 50/50 blend of SAF](#)** produced by World Energy and supplied by EPIC Fuels. This blend level validates the ability to produce D7566 compliant SAF at the highest blend level allowed by the specification (as opposed to some fuels being produced at lower levels like 30/70). Taken together with World Energy's recently improved 75% reduction in carbon index for this HEFA fuel, Etihad was able to achieve a reduction of 37.5% of net CO2 emission on a full flight basis! All of this year's ecoDemonstrator flights, validating four projects to reduce emissions and noise and to enhance passenger and crew health, were flown on SAF blends. This final Etihad flight coincided with at least the third usage of SAF by Etihad for new aircraft delivery flights.

Finally, I'll note some other interesting tidbits from the summer:

Commercial and Policy Announcements:

- Neste announced they are supplying fuel to American, JetBlue and Alaska at SFO, and announced a new deal with Signature Flight Support to supply fuel to SFO and London Luton for business aviation usage.
- Phillips 66 announced their intent to convert the Rodeo refinery to renewable fuel production including SAF, while Total made a similar announcement on their intentions with the Grandpuits refinery.
- Gevo fuel will be supplied by Avfuel to additional airport FBOs including Atlantic, and ACI Jet.
- The government of Sweden has decided to implement a GHG reduction mandate for jet fuel starting in 2021 at -0.8%, growing to -27% by 2030.
- In the UK, the government has announced the [formation of the Jet Zero Council](#), a partnership between industry and government to bring together ministers and chief executive officer-level stakeholders to drive the ambitious delivery of new technologies and innovative ways to cut aviation emissions. Aviation Minister Robert Courts, announcing their pragmatic approach to the challenge of aviation emission, said: "... through innovative technologies, such as sustainable fuels, hybrid and eventually electric planes, we will build a cleaner, greener and more sustainable future for all."
- Bryan Sherbacow, CCO of World Energy, also indicated we should watch for further reductions in the Carbon Index of their HEFA-SPK, from the currently scored level of minus 75% (CARB and RSB validation), to minus 100% or greater in the new year, based on continued supply chain optimization! Go SAF optimization!

So, being fully aware of humanity's mortality, and my own specifically, I've never been a fan of talking about being glad that time has passed. However, I will say that I'm not anxious for a September 2020 repeat, but I am looking forward to better days for aviation, for SAF, and for a more sustainable future for us all. I find myself regularly needing to take an extra five minutes at lunchtime (when weather cooperates, which it did wonderfully here in Ohio in September), to simply sit in quiet contemplation on the front porch with the sun shining brightly on my face, being thankful for what I do have, recognizing things can always be worse, but recognizing and anticipating that they can be much better. I truly hope you are all able to also find your sunshine moments, and I hope this autumn affords you many such opportunities.

Regards,

Steve Csonka

Executive Director, CAAFI

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Celebrating National Aviation Day

... and commenting on how Sustainable Aviation Fuel (SAF) is tied to future sustainability, and success, of the enterprise

OpEd by Steve Csonka, Executive Director of CAAFI, the Commercial Aviation Alternative Fuels Initiative

Washington, D.C., AUGUST 19, 2020 – Today is National Aviation Day in the U.S., a recognition instituted by FDR in 1939, honoring the birthday of Orville Wright, but also creating awareness of, and celebrating the progress and vision associated with, the aviation industry. Today, that industry has become so much more than most envisioned 81 years

ago, while having the potential to be even more impactful for future generations. Civil aviation in the U.S. drives more than \$1.85 trillion in annual economic activity, and creates livelihoods for more than 11 million workers; an industry that “punches well above its

weight” in measures like balance-of-trade and value-per-environmental-impact when compared with other industrial sectors. [Worldwide, the impact of aviation is huge](#), and likely touches all of us in some very meaningful ways. So, aviation is truly something to celebrate today, and to anticipate for tomorrow. I encourage you to do so with your family, or at least to reach out to someone you know who works in the industry, and let them know you appreciate what they’re doing for the benefit of society.



As they have done regularly, in 2016, our colleagues at NASA created [this poster to mark National Aviation Day](#). It is a nearly perfect representation of the pull that aviation had on me and so many of my peers in our formative years. Yes, the inspiring vehicle designs depicted have changed since my youth in the 60’s, but the visceral draw is no less – escaping the “surlly bonds of earth” ... higher, faster, farther. At that age, I had no idea that that also meant mastering mechanics, materials, aerodynamics, controls and physics – forging an assemblage of extremely advanced technologies suitable to serve mankind’s reach for flight – all superfluous to a 9-year-old, but still creating wonder for me today as I am able to now fully appreciate the genius-at-work inside the shiny vehicle. I hope to pass some of that wonder on to my unborn granddaughter, or the school children I might mentor, as the poster elicits... and hope you do, too.

Today, additional motivations for the future of aviation include cleaner, quieter, safer, more efficient, more affordable, and more sustainable ... the specific focus of the unique plane designs shown in the poster which NASA continues to develop with industry. Such progress will enable continued sectoral growth and access to this wonderful technology for our progeny, as well as other developing markets and economies around the world who have actually yet to benefit directly from our progress.

Several things have happened in the past couple weeks that bring things full circle for me, and in more than just a colloquial sense. The NASA poster also depicts soaring birds, and when you consider their capabilities, it reminds us that what we still have perhaps much in nature to attempt to emulate for human aviation. I clearly recall the barn swallows that used to circle my tractor as I mowed fallow fields on the farm of my youth, stealthily hunting the insects attempting to escape the approaching demise of the brush-hog. Swallows are magnificent fliers, wheeling around in tight arcs with incredible dexterity in changing direction to catch their fleeing insect prize. They often whirled within arm's reach of my perch on the tractor, and created a desired distraction to the drudgery of row-pass upon row-pass. This past weekend, after not experiencing such a spectacle for the past 42 years, I found myself being visited by three chattering, wheeling swallows while mowing the field adjacent to my current home. For the duration of their 45 minutes feeding frenzy (and the remainder of my morning chore), the tedium vanished, and I was transported back to my youth as so effectively depicted by NASA's poster. It was quite the pleasant diversion

from mind-numbingly current issues associated with politics, COVID, and my concerns about the current survival challenges pressing the aviation industry, and partially prompted me to pen this piece.

Anyway, long story short, that earlier barn-swallow wonderment led to wonder-of-flight exploration, to pursuit of a private pilot's license, to short-lived aircraft ownership, to two aerospace degrees, and to 35 years of work in the aviation industry focused on the nexus of advanced technology, societal macro-economic drivers, and policy. I believe in the value of the sector. For the last eight years at [CAAFI](#) I have been focused on assisting the aviation enterprise with the development and commercialization of Sustainable Aviation Fuel (SAF) to address one of those current challenges I previously mentioned, the future sustainability of aviation as driven by public sentiment to continue lowering the carbon footprint of flight.

Another unique, related story played out last week, one I suspect is similar to my own and hundreds of others similarly struck with the "aviophile" condition. [Robert DeLaurentis](#), self-described "Peace Pilot" / "Zen Pilot," completed a transformational journey, "the Pole-to-Pole Peace Mission," flying in the "Citizen of the World," a highly modified Gulfstream Twin-Turbo Commander 900. This was a [polar circumnavigation of the planet](#), encompassing 26,000 nautical miles, visits to 23 countries and 6 continents, including an 18 hour solo segment over the South Pole. Roberts's intent was simple - "to encourage and inspire." Mission accomplished, Robert! Furthermore, he was also performing science along the way. Oh, and the additional tie to this piece ... he flew the mission using a SAF blend, acquired in part from Gulfstream Aerospace Corporation, via World Fuel Services and World Energy's Paramount, CA SAF production facility. Gulfstream has been using SAF in their own operations since 2016, and are now also offering that fuel to select customers at their Long Beach facility. DeLaurentis used SAF to lower the environmental impact of his flight, so as not to detract from the overall benefits of the endeavor. SAF can do the same thing for all of civil aviation, and in fact we've already started doing so.

Some observers, both inside and outside the industry, continue to push back on the need to improve aviation's sustainability. Let me simply say that we have to acknowledge the fact

that the policy makers and the public have concluded the need for improvement. This has been the case since the Kyoto Protocol was signed in 1997, has been the topic of focus at every U.N. Framework Convention on Climate Change (UNFCCC) meeting since, drove the case for the European Union (EU) Emissions Trading Scheme (ETS) which monetizes carbon for our industry, formed the basis for the Paris Accords, and is now responsible for the continued outgrowth of financially impactful legislation. Most people are unaware, but there already exists the first SAF blending mandate in Norway, with pending proposals to do the same across Scandinavia and much of Western EU. Funds that were provided to the industry to weather COVID impacts in some countries have sustainability commitments attached. In the same way that the industry has had to improve its performance on noise and criteria air pollutants (now with an increased focus on particulate matter) for the last four decades... we need to now stay in front of regulation on greenhouse gases. The aviation industry itself recognized this in 2008 with voluntary commitments that were the precipitators of the International Civil Aviation Organization's (ICAO) Carbon Offsetting and Reduction Scheme for International Aviation (CORSA) agreement which enters into effect on January 1st 2021. And the lead-up to the industry commitments themselves were the basis for founding CAAFI in 2006 to work on behalf of the industry to foster the development and commercialization of SAF.

SAF are partially synthetic drop-in jet fuels made from bio-based or other circular-economy feedstock sources, using industrialized biochemical and thermochemical processes. On a

gallon-per-gallon basis, today's SAF blending components typically reduce net CO₂ emissions by 50-80% versus conventional jet fuel. In several cases in development, the SAF will actually deliver negative carbon index scores, meaning that its production can remove more greenhouse gases from our environment than it will release during in-flight combustion. SAF are safe for use today, and have been used continuously at select airports (e.g. LAX) since 2016. There are greater than 350 million gallons per year in offtake commitments from multiple airlines representing a greater than \$6 Billion outlay, and all of the SAF output from the first several planned production facilities has been committed. Stay tuned for further announcements along these lines later this year, as they continue to be made on a regular basis.

The challenge that we have with SAF today, and why we are only uploading SAF at less than 0.1% of total jet fuel usage, is that they are more expensive than the depressed price of petroleum-derived jet fuel. They are also disadvantaged versus renewable diesel production. So, this is the primary focus that CAAFI and others have right now; fostering the development of feedstocks, supply chains, conversion processes, and byproducts to enable lower-cost production and facilitate airline uptake. It's a challenge, but we continue to make progress, especially with assistance from DOE and USDA on the development of technologies and feedstocks, and from FAA on a wide range of activities from fuel qualification through supply chain analysis. In some cases, state and national governments are also deploying policy elements that help close the price gap. So, we're making slow progress.

However, there is a bottom line message I want to emphasize with this writing, especially about news items that detract from this fundamental concept:

SAF usage will immediately start to lower the net GHG footprint of aviation. We don't need to wait for unique technologies to work their way into the fleet. We don't have to modify fuel distribution infrastructure. We simply need to stand-up the facilities to produce the fuels, in an accelerated fashion from the build-out described above. We know how to make them, we know they can be sustainable, and their use is impactful! In fact, we know some of these fuels will be carbon negative! With the right policy approach, we can see a

significant ramp-up in production from a broad range of renewable and circular-economy resources.

Now the concerns:

1. **Advanced aircraft technology:** I'm a fan of advanced technologies being incorporated into future aircraft, and the industry needs them, but we can't force their usage before they are technically viable and demonstrated at commercial utilization readiness levels. We have seen examples from each of the major manufacturers of the intolerable impact on multi-billion dollar investment activities, due to redesign or backtracking, remanufacture, rework, retest ... in cases where technology implementation went forward prematurely. Although things like fully electric aircraft might work now for personal aircraft, and perhaps in another 15 years for a small regional commuter, fully electric large aircraft are not realistically viable for another 30 years. About 80% of world-wide aviation fuel burn is associated with aircraft larger than the commuter or regional level. For these larger aircraft, fully electric technology levels associated with energy or power production and utilization per unit weight or volume is off by a factor of 50. And the associated enabling systems are in their infancy. What's more, the certification basis does not exist. So, let's all be pragmatic - look in detail at 12 of the most discussed "next generation" commercial aircraft designs - 11 of them are hybrid-power aircraft, meaning, if successful, they will still burn jet fuel with a turbine to create primary power aboard the aircraft for subsequent conversion to electric propulsion. SAF enables this first use of the

next generation of hybrid propulsion technology to deliver net GHG reductions. Let's not forego spending on SAF R&D, demonstration and deployment right now in the pursuit of future sustainability improvements that will not see entry into service for another 30 years. Let the advanced technologies come to the market when they are ready and justified, but pursue SAF now.

2. **Hydrogen:** The best use of renewable hydrogen in our industry is for the creation of SAF, and this will likely be the case for at least the next 30 years. Hydrogen is critical to synthetically create SAF from renewable and circular-economy resources - the C₇ to C₁₇ family of pure hydrocarbons we know and love as jet fuel. SAF production requires a fair amount of hydrogen depending on the production process (say between 1-4%+ of the mass of the feedstock used). Let's produce sustainable hydrogen and use it in that fashion, rather than as a fuel itself. The case for using something other than a turbine and hydrocarbon fuel, won't be made until we see fully-fledged new aircraft designs that demonstrate double digit operating cost reductions versus the models pending and in-production now. We would also need someone to determine how to pay for the more costly refineries and infrastructure switches required by hydrogen. Let's be pragmatic and stay focused on SAF, produced with renewable hydrogen, as the near-term solution.

3. **Power to Liquids:** Finally, there's been a lot of discussion about power-to-liquid fuels (P-t-L). These are SAF that are synthetically produced from hydrogen and carbon monoxide using renewable power, to deliver fuel with very low carbon indices. The hydrogen is proposed to be stripped from water or biogas, and the carbon monoxide is ripped from carbon dioxide, in some cases sourced from the atmosphere via Direct Air Capture. Again, I'm a technologist, and I appreciate the technical elegance, but I don't appreciate the even higher price point of such fuels. Some estimates predict these fuels will only perhaps equal today's (already high) production price of bio-derived SAF by **2035**. Again, let's not forego spending on nearer-term SAF at the expense of pushing out progress. For those countries who believe they have no biomass resources to spare, then fine, spend away, but don't expect near term reductions in GHGs from your airlines' fleets. For the remaining majority of us, let's use those agricultural residues, forestry residues,



municipal solid waste, animal waste, sanitary waste-water treatment, industrial effluents, purpose grown lipids, etc. to produce the first few tens of billions of gallons of SAF. Then, when the time and technology are right, let's look to P-t-L to form the basis of a second round of production expansion.

Finally, if you haven't spent much time thinking about SAF, the Business Aviation community, through the [SAF Coalition](#) (which includes CAAFI), today released a second SAF Guide, entitled [Fueling the Future](#), intended to serve as an educational and informational resource about the practicalities of SAF development, industry adoption, and pending expansion of supply and use, primarily from the perspectives of the business aviation community. It also reinforces the industry's global commitment to sustainable aviation fuels as a key component to enabling the global industry meet its long-term goal to address climate change by halving carbon emissions by 2050 relative to 2005 levels.

Take a look at the Guide, and with consideration of the above, move SAF into your consciousness and lexicon with respect to your vision of the future of aviation. And, perhaps, fold up a few paper airplanes with the kids after dinner tonight, let them know about the significance of National Aviation Day. Tell them about people with vision like Robert DeLaurentis, and that aviation has a sustainable future in its flight plan, and potentially in theirs, and that SAF will likely play a key role.

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