

A Note from the Executive Director

This CAAFI Quarterly newsletter describes the CAAFI activities and events that occurred April through June 2018.

In this issue, we get to know the CAAFI R&D team tri-chairs and talk about CAAFI R&D Team efforts to engage companies with emerging technologies.

I also want to make sure you're aware of the following upcoming items:

- **CAAFI's General Meeting, December 4-6, Washington, DC** (Visit the [registration site](#) for details and to register.)
- [ABLC Global 2018, November 6-9, San Francisco, CA](#)

We appreciate questions, comments, and suggestions at any time. Enjoy!

Steve Csonka and the CAAFI Team

Quick Links

⇒ Check out "[What's New](#)" for a brief review of noteworthy SAJF news from the last quarter, including funding opportunities.

⇒ Go to "[Ask CAAFI](#)", a segment that highlights and explains relevant topics that impact the SAJF industry.

⇒ See "[CAAFI Team Highlights](#)" for a snapshot of CAAFI work teams' projects and progress last quarter.

⇒ Jump to "[SAJF Deployment Projects](#)" for a summary of select deployment projects around the United States.

What's New?

[The U.S. Dept. of Energy sought nominees for Biomass Research & Development Technical Advisory Committee by June 30.](#)

[Cathay Pacific announced a plan to fly all of its new Airbus aircraft home to Hong Kong using a 10% alternative jet fuel blend, using ASTM-qualified hydroprocessed fermented sugars to synthetic isoparaffins \(HFS-SIP\) produced by Total.](#)

[LanzaTech's first commercial facility began operations.](#)

[Shell Aviation and SkyNRG announced agreement for long-term collaboration on SAJF deployment.](#)

[CAAFI's Assistant Director Chris Tindal attended the Fulcrum Sierra Biorefinery Groundbreaking.](#)

[A consortium made up of Fetola, the World Wide Fund for Nature South Africa, and SkyNRG will launch a Waste to Wing project that will determine the feasibility of using waste biomass to produce sustainable alternative jet fuel \(SAJF\) in South Africa.](#)

[Red Rock Biofuels announced Groundbreaking on first commercial facility and ordered FT Reactors and Catalysts from Velocys.](#)

[The Port of Seattle and 13 airlines announced their partnership to create a work plan for providing sustainable alternative jet fuel \(SAJF\) to all airlines at Seattle-Tacoma International Airport \(Sea-Tac\).](#)

[USDA and DOE Announced New Funding Opportunities.](#)

[Air Canada saved 160 tonnes of carbon on Earth Day through innovative biojet fuel project at Toronto Pearson Airport.](#)

[Co-processing provision approved and added to ASTM 1655 Annex A1 enabling renewable feedstocks in jet fuel.](#)

[Ethanol was added as an approved feedstock and the allowable blend levels for ASTM approved ATJ-SPK were raised to 50%.](#)

[Global Bioenergies and SkyNRG announced their intent to collaborate on ASTM certification of new SAJF pathway \(isobutene-to-jet\).](#)

[UK added alternative jet fuel into RTFP scheme for reducing GHG emissions.](#)

Additional information on these news items and additional funding opportunities can be found at caafi.org.

Ask CAAFI

Question: How is CAAFI engaging with emerging companies, and what early-stage pathways should SAJF stakeholders be aware of?

Answer: In the fall of 2016, CAAFI Executive Director Steve Csonka asked the R&D team leads to take on the role of liaison with early-stage fuel producing companies that had contacted CAAFI and expressed interest in producing AJF. The R&D team leads have since engaged with 14 companies to find out about current efforts in development and perspectives on the jet fuel certification process and commercialization progress. Here is a summary from that engagement.

Feedstocks:

The companies are pursuing various feedstock categories, including algae, cellulose, lipids, sugars, oilseeds, tall oil residue, and sugars. Most of the companies were only pursuing one feedstock category, with only a couple continuing to explore multiple feedstocks or planning to migrate from food-based to non-food based feedstocks.

Technologies:

As with feedstocks, the conversion technologies that the companies were pursuing varied and included HTL, IH2, ATJ, pyrolysis, thermochemical, thermal deoxygenation, gasification, catalytic, HEFA, and HFP-HEFA. Though most companies have picked one

technology to pursue, at least one company expressed interest in exploring other pathways while continuing its current focus.

Scale and Products:

Almost all of the companies we spoke with are at a pre-commercial scale. There are two exceptions. One is producing renewable diesel commercially overseas and another has built commercial-scale turnkey plants for their clients. The companies in pilot stages are producing, or are planning to produce, the following primary products: green crude oil, ethanol, BTX, jet fuel, biochar, gasoline, wood vinegar, high octane gasoline blendstocks, and biodiesel. Co-products included biofertilizer, naphthalenes, indanes, and high molecular weight compounds.

Jet Fuel:

Half of the companies we spoke with are producing or have produced jet fuel. Many of the companies saw a potential future with jet fuel, but currently see aviation fuels as a secondary priority to producing road transportation fuels, due primarily to inequities produced by policy incentives. A few companies license their technology and cannot make the decision of what will ultimately be produced, but were interested in offering jet fuel as part of the product slate of their technology. Other companies expressed interest in learning more about the aviation fuel market, while at least one company we spoke with claimed their intended jet fuel might be used neat. The inclusion of jet fuel in LCFS is generally viewed as very positive in helping to make the business case for jet fuel.

Key Identified Challenges:

Key identified challenges can be classified under three categories: investment, economics, and the certification/qualification (CQ) process. In terms of investment challenges, companies are looking to connect with interested financial partners. We were also told that end-users are not demanding greater SAJF production due to the challenges of producing SAJF cost-competitively with petroleum-derived jet fuel (though the inclusion in LCFS may alter the

equation). ASTM and the CQ process were consistently identified as a matter of concern and uncertainty: two key points that persisted included a general interest in receiving guidance on the process and concern over the feasibility of making the quantity of fuel necessary to go through the process.

R&D-specific Challenges:

Though many companies claimed to have no current R&D and/or technical challenges, the following themes did emerge from the discussions: ensuring product quality and limiting variability; including maximizing yields, siting for scaling-up to commercial production, and developing second generation sugars in feedstock supply; and optimizing the conversion process (mixing biomass and catalysts at large scale).

Conclusions to Date:

The companies with emerging SAJF pathways which we spoke with are not actively looking for assistance with R&D. The companies expressed the desire for assistance with financing/investment and ASTM approval. While many companies expressed interest in producing jet fuel, the economic viability of jet fuel production and the challenging cost and timeline for ASTM approval were seen as barriers to entry to producing AJF.

The R&D Team tri-chairs are:

Dr. Michael Lakeman (Boeing) – Dr. Lakeman is Regional Director of Biofuels Strategy at Boeing Commercial Airplanes where he is responsible for helping to enable regional commercialization projects for sustainable aviation fuels, and performs due diligence on emerging biofuel feedstock technologies. Michael has over a decade of experience in plant and algae science and years of first-hand experience in the biofuel industry. He received his PhD from University of Washington. [Note: Dr. Lakeman is currently on leave from Boeing and CAAFI]

Dr. Stephen Kramer (Pratt & Whitney) - Dr. Kramer manages Combustor Technology at Pratt & Whitney. Dr. Kramer has over 21 years of experience at Pratt where he has been involved with the development of combustors for Pratt's current military and commercial jet engines. His previous experience was as a consultant in the field of combustion and fuels.

He has over 25 patents and has won several P&W leadership awards. He received his BS, MS, and PhD in Chemical Engineering from Brigham Young University.

Dr. M. Gurhan Andac (GE Aviation) - Dr. Andac is the Engineering Leader for Aviation Fuels and Additives at GE Aviation. His past responsibilities have centered on gas turbine combustor aerodynamic design, fuels, and additives, encompassing the military, commercial, marine, and industrial platforms. He has extensive fuel testing and evaluation experience, and is deeply immersed in fuels certification, qualification, and specification development arenas. He holds MS and PhD Degrees in Mechanical Engineering from the University of Southern California.

CAAFI Team Highlights

Business —

- ⇒ Continued to expand work with prospective alternative fuel producers and airlines to facilitate opportunities for airline and other end user engagement, identifying supply logistics needs and informing contract processes.
- ⇒ CAAFI leadership continue to work with several firms approaching commercialization, including SG Preston, ARA (and several of its licensees), Velocys, LanzaTech, and others.
- ⇒ Continuing to foster on the expansion of engagement of the latest two NIFA/AFRI/CAP projects, [SPARC](#) and [SBAR](#).
- ⇒ CAAFI is creating a Commercialization Engagement Framework to assist future SAJF producers with business maturation leading to airline engagement for the purpose of achieving offtake agreements.

Certification/Qualification —

- ⇒ ATJ-SPK (Ethanol): The revision to D7566 Annex A5 to add ethanol as a feedstock was incorporated into D7566-18, published in April 2018. This version of the specification also incorporates the increase to the maximum blending level allowable for ATJ-SPK fuels in Annex A5 to 50%, from 30%.
- ⇒ HFP-HEFA (Green Diesel): The OEMs have completed their review of the Phase 1 version of

the research report, but additional investigation of the feedstock quality and composition is currently underway. Additional fit-for-purpose testing and rig testing (combustor, fuel nozzle spray, APU cold/altitude starting) have been recommended. The FAA will collaborate with the OEMs to conduct the required rig testing under the CLEEN 2 R&D program.

- ⇒ ARA CHJ: ARA provided responses to the OEM comments to the Phase 1 research report and is now preparing the Phase 2 final research report. The U.S. Navy has completed their engine test and is in process of issuing the associated report. The OEMs will work collaboratively with ARA to advance this conversion pathway to ASTM ballot as soon as ARA provides the Phase 2 research report.
- ⇒ Refinery Co-processing: The co-processing provision was incorporated into Annex A1 of ASTM D1655-18a, published in April 2018. The Annex includes co-processing of fats and oils feedstocks. A new task force, formed at the request of Fulcrum will now work on adding FT crude feedstocks to the annex.
- ⇒ Virent Hydrodeoxygenation: The OEMs have completed their Step 3 review of the Synthesized Aromatic Kerosene (HDO-SAK) research report and have submitted their comments and Tier 3 and 4 test requirements to Virent. Virent is now reviewing the comments and arranging for the required Tier 3 and 4 testing.
- ⇒ Shell/CRI has submitted their initial batch of test fuel from their IH² demonstration facility to the D4054 Clearinghouse at UDRI and Tier 1 and 2 testing has been initiated. Shell is also working with the FAA to provide additional fuel for testing under the ASCENT National Jet Fuel Combustion Program (NJFCP) to provide data that will help develop streamlined rig testing concepts that may be used to pre-screen candidate alternative jet fuels.

Sustainability —

- ⇒ Continued to participate in the ICAO CAEP AFTF.

R&D —

- ⇒ Continued to engage companies with emerging alternative jet fuel pathways.
- ⇒ Hosted two SOAP-Jet webinars on May 4th. Dr. Bill Anderson presented [The Creation and Role of the USDA Biomass Research Centers](#) and Donald Wyse and Nick Jordan presented [Forever Green Initiative: Developing New Perennial and Winter Annual Crops to Enhance Minnesota's Soil and Water Resources](#) on June 15th.

SAJF Deployment Projects

◇ **Virginia and Multistate South Central Atlantic Coast Region F2F2** – CAAFI assisted the University of Tennessee Knoxville (UTK), and Virginia Farm to Fly focals, non-profits Virginia-based Commonwealth Center for Advanced Logistics Systems (CCALS) and the Center for Natural Capital (NatCap), with multiple proposal efforts in VA and the multi-state south central Atlantic region. Specifically:

- UTK, in concert with CCALS member University of Virginia, Virginia Tech, University of Washington and NatCap, proposed an initiative to the Biomass Research and Development Initiative (BRDI). The proposed initiative would analyze hardwood development in the region, which could have a significant impact on Dulles Airport and other United Airlines hubs in the northeast, the Tidewater region of VA and federal government facilities, and possible Southwest Airlines operations in Nashville. Awaiting a decision as of June 30.
- A “Go Virginia” program proposal covering multiple regions in VA is under consideration. In order to improve chances for this option to mature, CAAFI, CCALS, and NATCAP conducted a meeting with planning region consultant Genedge in Martinsville, VA to discuss various strategies to engage the regions.
- The University of Virginia, Virginia Tech, North Carolina State University and Clemson University jointly sent a Letter of Intent (LOI) to NIFA for its AFRI Sustainable Agriculture Systems grant. The proposed project will

substantiate the suitability of the three south central Atlantic coast states (Virginia and the Carolinas) to offer processors, such as Red Rock and Velocys, the best opportunity for an east coast facility in the region, to contribute to NIFA's 25-year fuel supply strategy. The LOI process has already engaged airlines who have a stake in the region or can easily access pipeline pumping stations that feed northern east coast hubs and other delivery nodes of interest. The LOI includes a strong supply chain development, education and extension component to foster supply chain acceptance.

◇ **Vermont F2F2** - A coalition from the University of Vermont and Cornell University renewed efforts to collaborate to examine added manure based dairy product based largely on options identified in the Newtrient (consortium of dairy cooperatives) catalog.

- Options covered include fuel (jet and diesel), biochar and fertilizer from multiple process options and includes process option producing fuel and other co-products as defined and developed in prior USDA Rural Development Rural Business and Value Added Producer grants.
- The team now includes multiple founding members of the "farm to fly 2.0" leadership.

◇ **Georgia and South Florida Support Sustainable ATJ commercialization feedstock development -**

The first half of 2018 featured the addition of ethanol as an approved feedstock for the production of synthetic paraffinic kerosene (SPK) via the alcohol-to-jet (ATJ) pathway in ASTM D7566 Annex A5. This approval was the result of ethanol derived ATJ-SPK production and testing led by LanzaTech. LanzaTech also received approval to proceed with the design of a facility to produce jet fuel from ethanol using grant funding from the Department of Energy, to be located at its Freedom Pines facility in Soperton, Georgia.

- During the second quarter of 2018, to ensure the success of this opportunity, Georgia Tech, in partnership with LanzaTech, CAAFI, USDA ARS and other universities and regional interests in the Southeast initiated collaboration on efforts to assist in the development of a Southeastern supply chain to initially provide ethanol to LanzaTech's Freedom Pines facility and ultimately form the basis for long-term, year round sustainable supplies that contribute sustainable feedstocks to meet USDA's 25 year national goals.
- The team will be meeting during the 3rd quarter to further define specific goals and mechanisms to progress short-term to 2020 and longer-term 25 year regional support opportunities.

◇ **Connecticut F2F2** - In late May, CAAFI and the Connecticut Center for Advanced Technology (CCAT) held meetings to consider reopening discussions around the conversion of the South Hartford Materials innovation and Recycling Authority (MIRA) facility to fuel production following a failure of the initial proposal for converting the facility to power generation. The planned rethinking of the Hartford facility enjoys operator support.

If you are aware of other scenarios that could be appropriate for a regional development effort, please let us know. For more information, see [CAAFI's State Initiatives](#) page.

Please check the [CAAFI website](#) on a regular basis for more detail on pending activities.

Email peter.herzig@dot.gov with any ideas for CAAFI Quarterly items of interest, caafi.org news suggestions, or inquiries about subscription to the CAAFI Membership group.