The CAAFI Quarterly

Q2 2017

A Note from the Executive Director

This CAAFI Quarterly newsletter describes the CAAFI activities and events that occurred in April through June 2017. In case you missed it, the second edition of the refurbished CAAFI quarterly reflects an updated newsletter style and new content sections, which were rolled out last quarter. We hope you are enjoying the new look!

In this issue, we review which fuels are currently approved for commercial aviation, and the process through which these fuels get approved. We also explore the efforts currently underway to streamline this process.

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 new segment that highlights and explains relevant topics that impact the SAJF industry, to read about feedstocks on CAAFI's radar.

⇒ 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.

⇒ View "Upcoming Items of Special Note" for pending future activities and events.

What's New?

INL presented on their development of advanced feedstock supply systems as a part of the Seminars on Alternatives to Petroleum (SOAP)-Jet webinar series, which serves as an information-sharing and discussion forum for members of the SAJF R&D community.

Saab Group completed a flight using a 100% rapeseed oil-based SAJF, produced by ARA, in a Gripen single engine fighter jet.

An NREL study demonstrated the possibility (with the implementation of aggressive policy and/or investment scenarios) of a 30% displacement of domestic jet fuel demand with biofuels by 2030 in their Potential Avenues for Significant Biofuels Penetration in the U.S. Aviation Market report.

Singapore Airlines launched their first flight of a three-month long, 12-flight period, in which an Airbus A350-900 will fly on an SAJF blend.

Sweden's largest airport operator, Swedavia, received its first batch of SAJF with the help of the Fly Green Fund, and will use the fuel throughout 2017 at Gothenburg Airport.

CAAFI's Business Team hosted a SOAP-Jet Webinar by John May (Stern Brothers & Co.) and Tom Dickson (New Energy Risk), who discussed innovations to finance large-scale production and deployment of SAJF projects.

CAAFI's R&D and Sustainability Teams hosted a SOAP-Jet Webinar: Industrial Ecology Frameworks for Sustainable Aviation Fuel Development that provided an overview of Industrial Ecology and its specific application to the design of systems for SAJF technologies deployment. Dr. Valerie Thomas of Georgia Tech provided an introduction discussing the theme and utility of Industrial Ecology, while Dr. Laurel Harmon of LanzaTech provided illustrative examples of her company's efforts to develop the circular economy.

Funding Opportunities:

⇒ Biomass Research and Development Initiative (BRDI) funding to support development of bioenergy feedstocks, biofuels, and biobased products.

Additional information on these news items can be found at caafi.org.

Ask CAAFI

Question: What fuels are currently approved for commercial aviation? What is the process for approving jet fuels, and what efforts are being made to streamline this process?

Answer: There are currently five approved sustainable alternative jet fuel (SAJF) production pathways, detailed in ASTM D7566:

- **Fischer-Tropsch Synthetic Paraffinic Kerosene (FT-SPK)**
- **Hydroprocessed Esters and Fatty Acids Synthetic Paraffinic Kerosene (HEFA-SPK)**
- **Hydroprocessed Fermented Sugars to Synthetic Isoparaffins (HFS-SIP)**
- **Fischer-Tropsch Synthetic Paraffinic Kerosene with Aromatics (FT-SPK/A)**
- **Alcohol to Jet Synthetic Paraffinic Kerosene (ATJ-SPK)**

The first SAJF pathway to be approved was FT-SPK in 2009 with a 50% max blend level, followed by HEFA-SPK in 2011 with a 50% max blend level. Two other pathways were approved several years later – HFS-SIP in 2014 with a 10% max blend level, and FT-SPK/A in 2015 with a blend level of up to 50%. The fifth and most recent SAJF pathway to receive ASTM approval was ATF-SPK, which earned qualification in 2016 and has a blend level of up to 30%.

To be qualified for use, SAJF pathways must progress through ASTM D4054 evaluation process, which allows blending agents (synthetically produced hydrocarbons) to be considered by the industry as appropriate for use as jet fuel. The ASTM D4054 Evaluation Process determines a fuel's equivalency to conventional jet fuel and—if it is deemed equivalent—the SAJF pathway is added to the D7566 Drop-In Fuel Specification. The language in ASTM D1655 and D7566 then enable such fuels to be considered identical to petroleum derived jet fuel, allowing them to be used in commercial aircraft.

The ASTM D4054 Evaluation Process is comprised of three phases:

1. In Phase 1, a task force comprised of a group of specialists (and potentially several companies with similar synthetic fuel production pathways) conduct research on the fuel in Tier 1 (Specification Properties) and Tier 2 (Fit-for-Purpose Properties) testing. The results are synthesized into a Phase 1 Research Report, which undergoes review by participating original equipment manufacturers (OEMs). If the OEMs approve of the preliminary properties of the synthetic blending agent, they make recommendations for any additional verification testing which might be required, and it moves on to Phase 2.
2. In Phase 2, the SAJF candidate goes through identified Tier 3 (Component/Rig) and Tier 4 (Engine and/or Auxiliary Power Unit) testing, the results of which are compiled into a Phase 2 Research Report. After review and approval by OEMs, the SAJF moves on to Phase 3.
3. In Phase 3, the U.S. Federal Aviation Administration (FAA) reviews the OEM approval and submits the fuel to the ASTM balloting process for approval by the broader jet fuel industry representatives involved in ASTM. Once the ballot is passed with a unanimous vote, the SAJF pathway is added to the D7566 standard as a new annex.

The ASTM D4054 Evaluation Process described above has been lengthy and expensive. CAAFI is helping to facilitate several initiatives to streamline this process.

CAAFI works closely with Federal agencies implementing the Federal Alternative Jet Fuels Research and Development Strategy, which lays

out goals to enable efficient SAJF evaluation by advancing certification processes. You can read the full strategy here. CAAFI also supports the FAA's Aviation Sustainability Center (ASCENT) D4054 Clearinghouse concept, which is being positioned to become a one-stop-shop for management of the SAJF testing and data review program.

In conjunction with the interests of the broader SAJF development community, the U.S. Air Force has recently funded an initiative to develop a Generic Annex for incorporation into the ASTM D7566 specification. The Generic Annex specification aims to allow new fuel producers to more quickly produce and sell their fuel without needing to go through the tedious, timely and costly ASTM D4054 evaluation process. However, this generic annex concept will be limited to a low percentage blend (e.g., 10%) and will require more stringent compositional criteria.

The Generic Annex is intended to also remove restrictions on feedstocks and delineation of conversion processes, potentially easing the burden of qualification. CAAFI supports the approach of a Generic Annex concept and has invited CAAFI stakeholders to provide input and feedback on the concept. Finally, the National Jet Fuels Combustion Program (NJFCP), funded by the FAA, is conducting experiments that will relate fuel properties to combustion performance to predict the performance of new SAJF, thus streamlining OEM evaluation and the ASTM fuel approval process.

For more information on the on SAJF certification process, as well as SAJF pathways currently pursuing certification go to caafi.org or contact info@caafi.org.

CAAFI Team Highlights

Business —

⇒ Continued to expand work with prospective alternative fuel producers to facilitate opportunities for airline and other end user engagement, identifying supply logistics needs and informing contract processes.

⇒ Hosted a SOAP-Jet webinar on May 19th in which John May from Stern Brothers & Co., a U.S. investment bank, presented "The Latest De-risking Techniques for Commercial Scale Project Financing in Bio".

⇒ CAAFI leadership continue to work with several firms approaching commercialization, including SG Preston, Shell, ARA (and several of its licensees), NuFuels, LanzaTech, Mercurius, and others. Several new potential producers have also recently approached CAAFI about working with the industry and/or commencing ASTM qualification activities, including entities in the U.S., Canada, and the EU.

Certification/Qualification —

⇒ Convened a June 26th status review meeting on SAJF research report reviews with original equipment manufacturers (OEMs) at the ASTM meeting in Boston.

⇒ Continued development and evolution of the generic SAJF annex with a focus on developing standardized GCxGC test methods for compositional analysis of fuels being produced to the annex. FAA released a solicitation to further develop GCxGC methodology within the ASCENT CoE.

⇒ Engaged the FAA ASCENT-funded D4054 Clearinghouse to manage the evaluation of two new candidate fuels: Shell IH^2 and IHI Hydrocarbon HEFA. The D4054 Clearinghouse will provide a "one-stop shop" for testing and data review for candidate AJF producers.

⇒ The U.S. Navy conducted a T700 engine test with Applied Research Associates' (ARA) Catalytic Hydrothermolysis (CHJ) fuel for compliance with the OEM Tier 4 testing requirement. ARA will complete its Phase 2 and final research report upon receipt of the U.S. Navy test report.

⇒ OEMs completed Phase 1 review of the LanzaTech Phase 1 research report for the ATJ-SPK process. OEM recommendations require some revisions to the report, but do

not require Tier 3 or 4 testing. LanzaTech will revise its research report and submit it for final OEM review prior to balloting a revision to Annex A5 to add ethanol-derived ATJ to the currently approved isobutanol-derived ATJ.

⇒ Virent Synthesized Aromatic Kerosene (SAK) is undergoing Step 2 screening and will be submitted to the OEM review process later this year.

⇒ Boeing prepared a second draft of the research report for High Freeze Point HEFA (HFP-HEFA) and it was submitted to OEMs for Phase 1 review.

Sustainability —

⇒ Worked to draft an expansion of the "Environmental Sustainability Overview" to include social and economic sustainability and developing new content for caafi.org.

⇒ Co-hosted SOAP-Jet "Industrial Ecology Frameworks for Sustainable Aviation Fuel Development" webinar with the R&D Team on June 16th.

R&D —

⇒ Continued to engage emerging pathway technologies and companies, holding three more information gathering calls with Anellotech, Tyton, and Proton Power. The team has now spoken with 12 companies and is currently drafting a summary of the conversations.

⇒ Co-hosted SOAP-Jet "Industrial Ecology Frameworks for Sustainable Aviation Fuel Development" webinar with the R&D Team on June 16th.

SAJF Deployment Projects

Appalachian Region: The following efforts by Virginia and surrounding states commenced during this quarter:

◊ **Virginia –** CAAFI has convened a core team from interested parties in the region to consider the use of woody biomass for fuel production. They are currently evaluating options for funding several developmental projects, through the use of established funding mechanisms. The team also discussed potential brown field development sites, consulted U.S. Department of Agriculture (USDA) Rural Development in Virginia and Washington, DC for facility planning, and is anticipating relevant U.S. Forest Service solicitations by the end of the year.

◊ **Georgia –** CAAFI and Appalachian Regional Commission (ARC) leadership determined that Georgia team / ARC engagement will be directed toward Appalachian areas where poultry waste management is the primary focus.

Farm-to-Fly 2.0 (F2F2) highlights:

◊ **South Florida –** After completing its one-year Rural Business Development Grant (RBDG) contract and developing an implementation method for commercialization in Q1 to benefit fuel process developers and the citrus processing industry, the team executed a sugar beet processing test at a citrus facility on June 14th. The team also created a work plan to analyze facility potential to rapidly process beets and provide animal feed and low-cost sugars. A USDA Value Added Producer Grant (VAPG) is being pursued to commercialize the beet processing capability at the facility.

◊ **Vermont –** Initiated implementation of a $150K VAPG for initial stage conceptual design for a GSR Solutions heterotrophic/mixotrophic algae process. The team has identified a potential high protein cattle feed co-product to supplement the existing feedstock and middle distillate fuel focus. CAAFI initiated dialogue with Dairy industry representatives Newtrient and their University advisory Board members Michigan State University and Cornell University to establish the basis for a research partnership and potentially a joint BRDI R&D grant proposal during the period.

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.

Upcoming items of special note:

Please check the CAAFI website on a regular basis for more detail on pending activities.

Miscellaneous events hosted by CAAFI collaborators for planning purposes:

- The BIO World Congress on Industrial Biotechnology is scheduled for July 23-26 in Montreal.

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.