Project 093(B) Collaborative Research Network for Global Sustainable Aviation Fuel Supply Chain Development

University of Hawai‘i

Project Lead Investigator

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University Participants

University of Hawai‘i (UH)

- P.I.: Scott Q. Turn, Researcher
- FAA Award Number: 13-C-AJFE-UH, Amendment 020
- Period of Performance: January 1, 2023, to December 31, 2023
- Tasks:
  1. Establish a collaborative research network for sustainable aviation fuel supply chain development in southeast Asia
     - 1.1 Identify partner universities (and other entities) in the southeast Asian region
     - 1.2 Organize and conduct a sustainable aviation fuel supply chain workshop in Southeast Asia
     - 1.2 Develop a plan for an education and exchange program with collaborating universities in Southeast Asia and with ASCENT Project 093 universities

- FAA Award Number: 13-C-AJFE-UH, Amendment 024
- Period of Performance: March 19, 2024, to September 30, 2026
- Tasks:
  2. Collaborative research network for sustainable aviation fuel supply chain development in southeast Asia
     - 2.1 Develop sustainable aviation fuel research themes of common interest for Association of Southeast Asian Nations countries
     - 2.2 Hold sustainable aviation fuel supply chain workshop in Indonesia

Project Funding Level

Under Federal Aviation Administration (FAA) Award Number 13-C-AJFE-UH, Amendment 020, the ASCENT Project 093(B) Collaborative Research Network for Global sustainable aviation fuel (SAF) Supply Chain Development received $250,000 in funding from the FAA and cost-share funding of $250,000 from UH.

Under FAA Award Number 13-C-AJFE-UH, Amendment 024, the ASCENT Project 093(B) Collaborative Research Network for Global SAF Supply Chain Development received $250,000 in funding from the FAA and cost-share funding of $250,000 from UH.

Investigation Team

University of Hawai‘i

Dr. Scott Turn (P.I.; Hawai‘i Natural Energy Institute)
Dr. Quang-Vu Bach (assistant researcher; Hawai‘i Natural Energy Institute)
Dr. Elmar Villota (postdoctoral fellow, Hawai‘i Natural Energy Institute)

Other Lead Personnel

Washington State University
Prof. Manuel Garcia-Perez (co-P.I.)
Michael Wolcott (P.I.)

Volpe National Transportation Systems Center
Kristin Lewis (P.I. and principal technical advisor)

Massachusetts Institute of Technology
Florian Allroggen (P.I. and research Scientist)

Project Overview

UH will engage universities (and other entities) in southeast (SE) Asian countries and develop collaborative research programs focused on SAF supply chains. These activities will identify information shortfalls and generate fundamental data necessary for the design of engineered SAF production systems. Research activities will include supporting analyses related to the assessment of available feedstocks, supply chains, infrastructure needs, and stakeholder engagement. Planned activities under the program include support of research projects, workshops, and student and researcher exchanges.

The key objectives for this project are as follows:

- Establish a collaborative research network for SAF supply chain development in SE Asia.
- Provide technical support to other ASCENT Project 093 universities and partner activities for which tropical feedstocks are relevant.

Task 1 – Establish a Collaborative Research Network for Sustainable Aviation Fuel Supply Chain Development in Southeast Asia

University of Hawai‘i

Objectives

This task includes three subtasks:

- Subtask 1.1 Identify partner universities (and other entities) in the SE Asian region
- Subtask 1.2 Organize and conduct a SAF supply chain workshop in SE Asia
- Subtask 1.3 Develop a plan for an education and exchange program with collaborating universities in SE Asia and with ASCENT Project 093 universities

Research Approach

UH has led the tropical regional supply chain effort under ASCENT Project 001 since 2015. Activities under this effort have focused on tropical energy crops and agriprocessing residues and urban residues as candidate feedstocks for SAF production. This experience forms the basis for the development of SE Asian SAF supply chains.

Background

Regional supply chain development is informed by crop-science-based evaluations of plants for feedstock production, analyses of crop production potential based on geographic information systems, development of advanced feedstock processing and conversion systems, assessments of the compatibility of biomass and bioderived products with existing infrastructure and logistical resources, and evaluations of biomass-based energy systems based on life cycle and economic approaches. The results of past efforts have provided a baseline of information to be accessed and built upon in developing scenarios of future SAF production along regional supply chains in Hawai‘i and the tropics. Pretreatment and conversion options for materials from potential SAF feedstock crops in the tropics are shown in Figure 1.

In August 2017, the Hawai‘i Natural Energy Institute at UH initiated efforts under a five-year grant from the Office of Naval Research for the Asia Pacific Regional Energy System Assessment. The objective of this 5-year grant was to develop comprehensive energy system assessments that include strategy, policy, regulation, technology options, demonstrations, implementation plans, and training for energy system transitions in select locations throughout the Asia-Pacific region, based on the specific requirements or needs of the targeted jurisdictions and strategic alliances. The first 3 years of this

program laid a firm foundation for continued success built upon the development of solid partnerships with national, regional, and local jurisdictions as well as private and public stakeholders, including utility companies, universities, and other research and international aid and development entities. Relationships developed in SE Asia (i.e., Thailand, Indonesia, and Vietnam) through the Asia Pacific Regional Energy System Assessment were leveraged to facilitate the ASCENT Project 093(B) global supply chain development effort. The Association of Southeast Asian Nations (ASEAN) includes the countries of Brunei Darussalam, Cambodia, Indonesia, Lao PDR, Malaysia, Myanmar, Philippines, Singapore, Thailand, and Vietnam. Universities (and other entities) from ASEAN countries, with the exception of Cambodia and Myanmar, were the initial target participant group in the collaborative research network for SAF supply chain development in SE Asia under this ASCENT project.

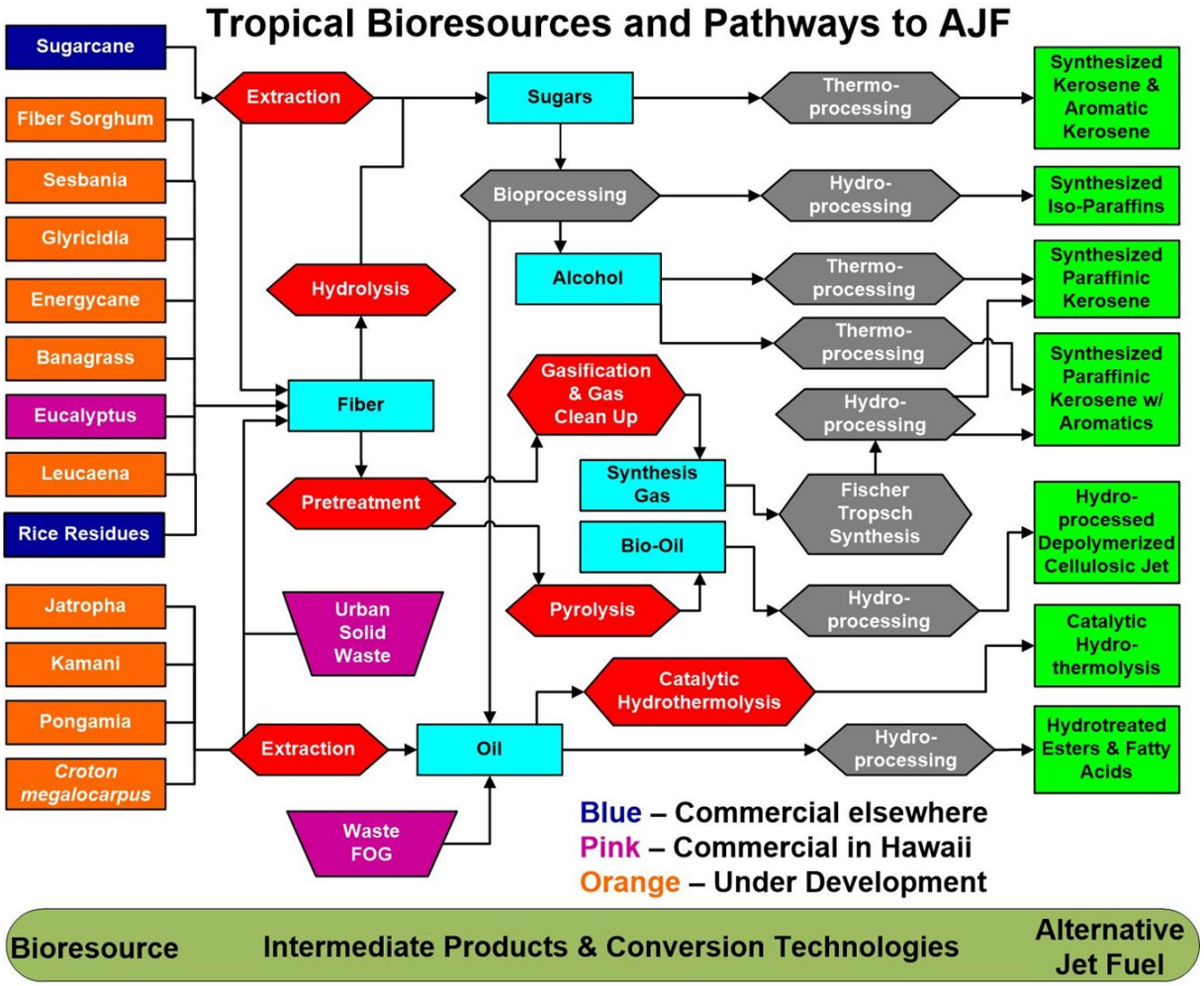

Figure 1. Tropical bioresources and pathways to alternative jet fuel (AFJ)/SAF. FOG: fats, oils, and greases.

Subtasks 1.1 and 1.2

Activities conducted to accomplish Subtasks 1.1 and 1.2 were coordinated in planning the SAF supply chain workshop held in Bangkok in May 2023. The workshop was coordinated with the United States (U.S.) Trade and Development Agency (Commerce Department) as part of their effort to support the SAF business development of U.S. companies in the region. Thailand's National Energy Technology Center and Chiang Mai Rajabhat University were instrumental in the planning process, providing contacts at universities and government agencies throughout the ASEAN region. Staff from the U.S. Embassy in Bangkok and FAA Asia Pacific Office at the U.S. Embassy in Singapore supported workshop planning by contacting and coordinating with government agencies across the region.

The archival literature was reviewed to identify universities and entities from ASEAN countries with either ongoing SAF-related development activities or prior work in biomass resource assessment or biomass supply chains. Based on the results, researchers from 13 universities across the region (i.e., Philippines, Indonesia, Thailand, Vietnam, Malaysia, and Brunei) were contacted to assess interest in workshop participation. Twelve researchers from seven universities attended the SAF workshop in Bangkok, Thailand.

The workshop objectives were as follows:

- Connect stakeholders.
- Foster collaboration.
- Drive innovation in the adoption of SAF.

The FAA-supported section of the workshop was held on May 22–23, 2023, at the Conrad Hotel in Bangkok, Thailand. More than 100 attendees from eight countries participated in the workshop (see Figure 2). Participants self-identified their organization's place in the SAF value chain, as shown in Figure 3.

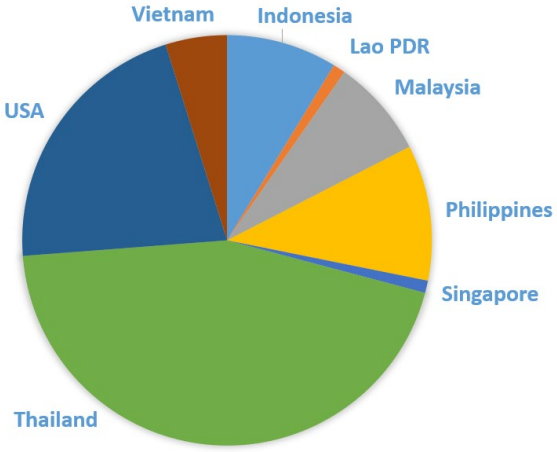

Figure 2. Country of origin of participants at the sustainable aviation fuel workshop.

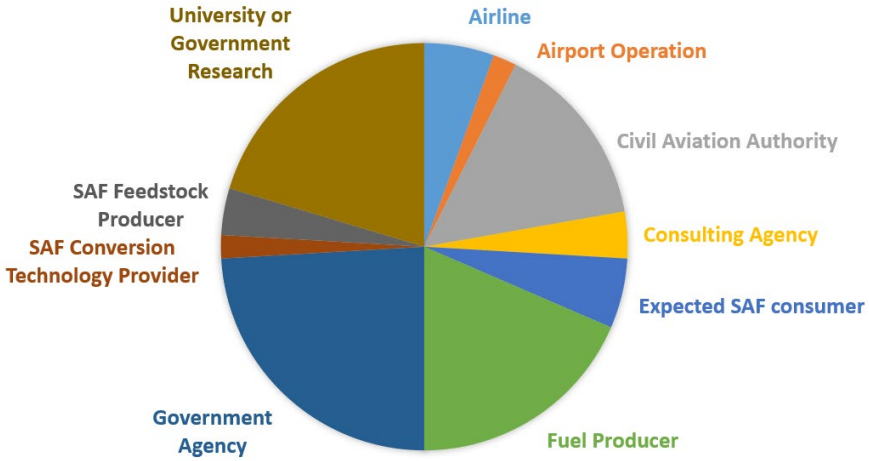

Figure 3. Organizations of sustainable aviation fuel (SAF) workshop attendees.

The two days of the workshop were organized as shown below:

Day 1, Morning
- Workshop overview and introduction
- Keynote address: International Civilian Aviation Organization
- Civil aviation authority perspectives
- Energy policy perspectives on SAF

Day 1, Afternoon
- Panel on SAF production: Upstream considerations/logistics
- Update on the Commercial Aviation Alternative Fuels Initiative
- Summary and close out of Day 1

Day 2, Morning
- Recap from Day 1
- Keynote address: SAF sustainability criteria
- Agricultural industry: Feedstocks for SAF production
- Airport fuel system operator perspectives

Day 2, Afternoon
- University research in support of SAF development
- Panel discussion: Way forward
- Summary and close out of Day 2

Participants who gave presentations were provided with five motivational prompts:
- Tell us about your organization (e.g., private/public, size, authority, etc.).
- What role will your organization play in the transition to SAF use in your country?
- How will your organization plan for the expanded use of SAF?
- What barriers will need to be overcome for SAF deployment in your country?
- What tools and resources are needed to overcome those barriers?

Workshop participants identified common themes that need to be addressed across the region, as summarized below:
- Sustainable funding models and strategies are needed for the aviation industry's transition to SAF.
- There is a lack of discussion on sustainability and economic viability of feedstocks.
- Investments in research and development are required to diversify feedstock options and promote sustainable alternatives that do not compete with food supplies.
- Infrastructure development is crucial for the production, storage, and distribution of SAF.

Workshop recommendations included the following:
- Explore and establish supporting policy (e.g., the use of incentives and carbon credits) to promote SAF production and adoption.
- Raise awareness and develop education initiatives to inform stakeholders, including the public, about the benefits and importance of SAF.

Participant feedback identified the sessions on civil aviation authorities' perspectives, energy policy perspectives on SAF, and the agricultural industry feedstocks for SAF production as the most useful.

Subtask 1.3
A meeting was held with the Dean of Education Programs and the Deputy Director of Research Programs at the East-West Center (www.eastwestcenter.org) adjacent to the UH campus. The purpose of the meeting was to inform the Dean and Deputy Director about ASCENT Project 093(B) goals and activities and to explore opportunities to integrate East-West Center educational and research networks and infrastructure with the ASCENT Project 093(B) goals of recruiting and educating SE Asian postdoctoral fellows and visiting scholars. UH faculty members that are actively engaged in research on ecosystem services and transportation networks have been recruited as mentors for the ASCENT Project 093(B)-supported postdoctoral fellows and visiting scholars.

Milestones

- Identified partner universities for the SAF research network.
- Selected a venue and support organizations for the SE Asia SAF workshop.
- Held the SAF supply chain workshop in SE Asia.

Major Accomplishments

The major accomplishment of the project was holding the highly successful SAF supply chain workshop in Bangkok, Thailand, on May 22–23, 2023. The workshop established ASCENT Project 093(B) as a leader in supporting the development of global SAF supply chains in the ASEAN region. Participants expressed great interest in FAA support for a similar workshop in 2024.

Publications

None.

Outreach Efforts

Organizing and conducting the SAF supply chain workshop in Bangkok, Thailand, provided outreach and education to the SAF supply chain stakeholder community. Presentations were made by Dr. Prem Lobo and Dr. Scott Turn during the workshop. Electronic communications were made with all the workshop participants, either directly or through in-country partners.

A presentation describing the workshop, its goals, and its outcomes was presented at the 3rd ASEAN International Conference on Energy and Environment held in Bali, Indonesia, on August 23–25, 2023.

Awards

None.

Student Involvement

None.

Plans for Next Period

This task is complete.

Task 2 –Collaborative Research Network for SAF Supply Chain Development in SE Asia

University of Hawai'i

Objectives

This task includes two subtasks:

- Subtask 2.1 Develop SAF research themes of common interest for ASEAN countries
- Subtask 2.2 Hold SAF supply chain development workshop in Indonesia

Research Approach

Subtasks 2.1. and 2.2

A snapshot of jet fuel consumption and development plants for SAF in SE Asia is shown in Figure 4. Across the region, annual jet fuel consumption approaches 25 million metric tonnes. Planned and operating SAF annual production capacity is less than 3 million metric tonnes.

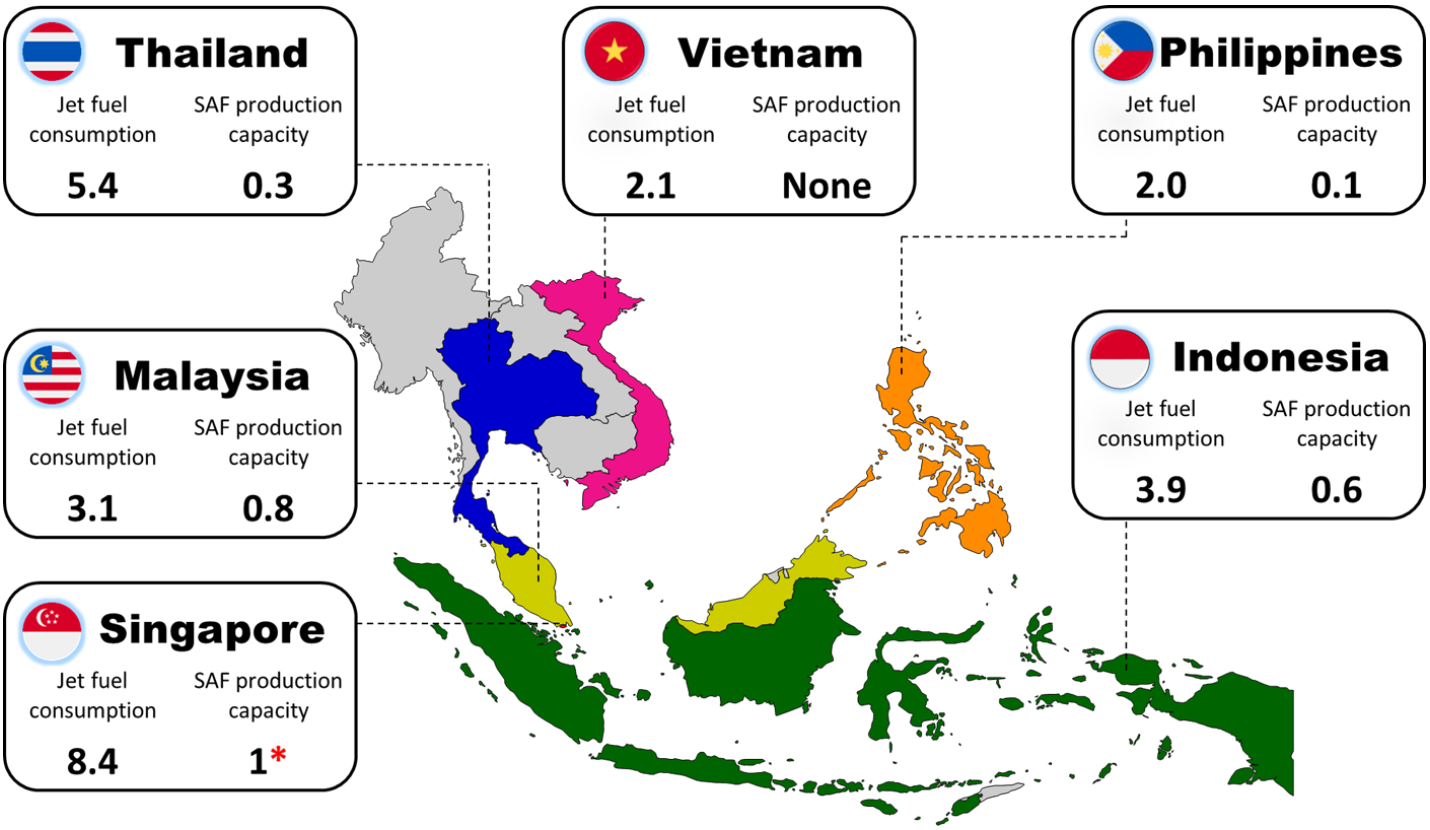

Figure 4. Summary of jet fuel consumption (U.S. Energy Information Administration, 2019) and planned sustainable aviation fuel (SAF) production capacity (Argus Media, 2024) in southeast Asia (* facility currently in operation). Units = million metric tonnes.

The SAF supply chain development workshop was organized and held on July 10-12, 2024, in Bali, Indonesia, to support and coordinate ongoing SAF development activities across the region. The workshop was co-organized by the FAA through ASCENT, the Indonesian Directorate General for Civilian Aviation, the Energy Technology Center of Thailand, and UH.

The workshop registered 95 participants from Malaysia, Indonesia, Philippines, Thailand, Singapore, Vietnam, the U.S., and the European Union and included representatives from agricultural commodity groups, airlines, airport operations, civil aviation authorities, consulting groups, fuel producers, government energy and transportation agencies, SAF conversion technology providers, feedstock producers, university and research organizations, and aircraft manufacturers. Data on attendees and their organization are presented in Figure 5 and Figure 6, respectively.

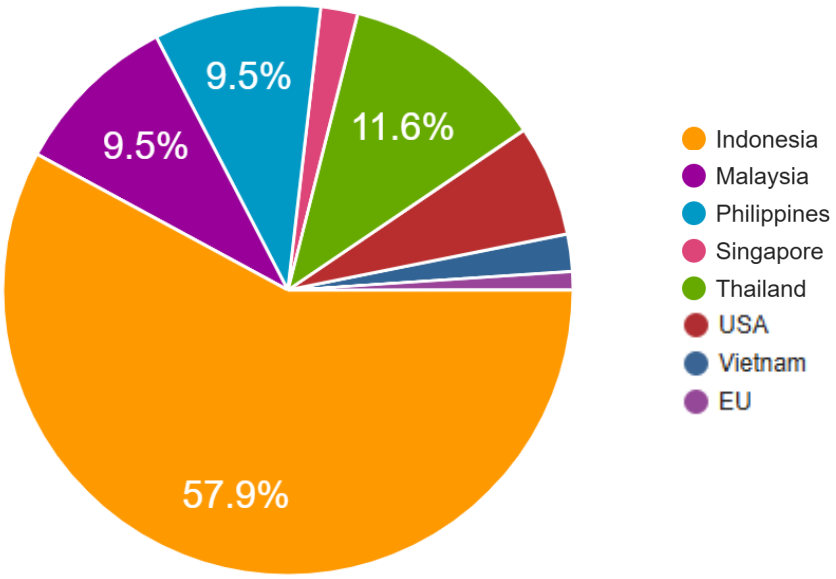

Figure 5. Country of origin of participants at the 2024 sustainable aviation fuel workshop in Bali.

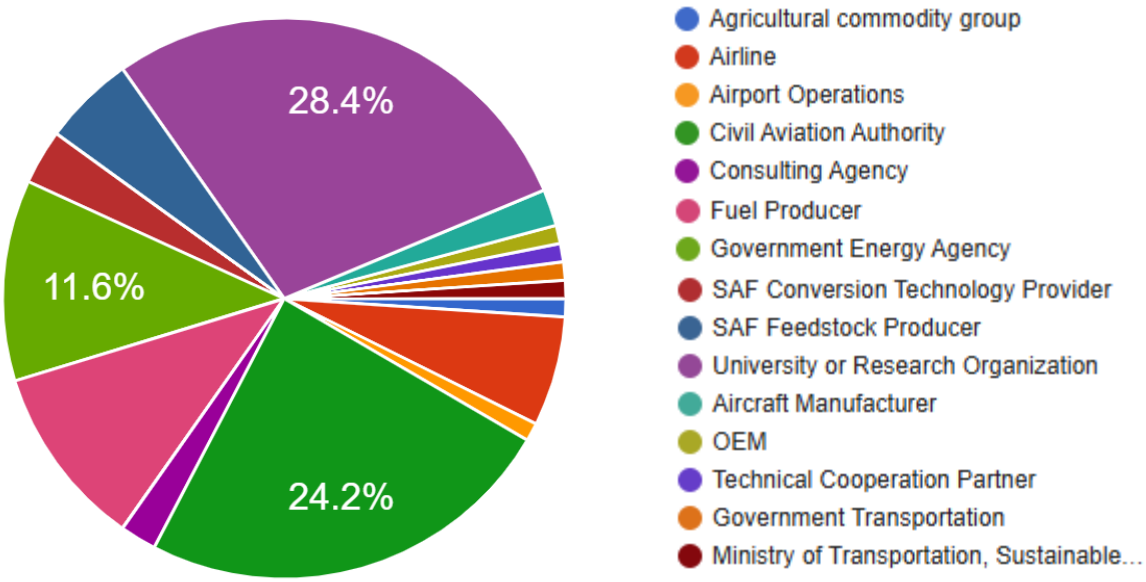

Figure 6. Organizations of sustainable aviation fuel (SAF) 2024 workshop attendees.

The workshop agenda included sessions on perspectives of civil aviation authorities, energy policy, SAF fuels/airports/airplanes, airline perspectives, feedstocks, feedstocks production and logistics, SAF conversion technologies, climate finance, SAF policy development, and university research. The first two days of the workshop were organized as shown below:

Day 1, Morning
- Workshop overview and introduction
- Civil aviation authority perspectives

Day 1, Afternoon
- Energy policy perspectives on SAF
- SAF Fuels: Airports and Airplanes
- Airline Perspectives on SAF
- Summary and close out of Day 1

Day 2, Morning
- Recap from Day 1
- Keynote address: Feedstocks for SAF: The Realm of Possibilities
- SAF Feedstocks: Production and Logistics
- SAF Conversion A-Z

Day 2, Afternoon
- Keynote: Climate Finance Options for SAF
- Development of SAF Policy
- University Research Activities
- Summary and close out of Day 2

Participants who gave presentations were provided with five motivational prompts:
- Tell us about your organization (e.g., private/public, size, authority, etc.).
- What role will your organization play in the transition to SAF use in your country?
- How will your organization plan for the expanded use of SAF?
- What barriers will need to be overcome for SAF deployment in your country?
- What tools and resources are needed to overcome those barriers?

An evaluation of workshop effectiveness was provided by 50 attendees who participated in an exit survey on the workshop content and organization. Participants found sessions on feedstock production and logistics, SAF policy development, energy policy, and SAF conversion technologies to be the most useful, demonstrating the value of an inter-agency approach to moving the SAF agenda forward.

The survey also queried participants on important research questions that needed to be addressed in order to advance SAF production in the region. Suggestions coalesced around common themes of (1) feedstock diversification and supply chains, (2) conversion technology advancement, and (3) environmental/sustainability certification. Cross cutting themes included funding, finance, and long term economic, social and environmental impacts of SAF implementation/utilization. This information was used as motivation in a four-hour session for university and research organization participants where they were encouraged to workshop on (1) specific research questions to include in a proposal, (2) funding sources, and (3) approaches to collaboration between their organizations for proposal development.

Central Luzon State University (CLSU) in the Philippines is undertaking a national biomass resource assessment in support of SAF development efforts. Dr. Elmar Villota, a postdoctoral fellow at UH, is coordinating with CLSU faculty and staff to serve as a resource person. Results from the draft report will be presented to Philippines Department of Energy staff in the fourth quarter of 2025.

UH personnel have initiated a study to quantify the occurrence of non-standard coconut in post-harvest supply chains. The Philippines would be the initial study area and contacts in Indonesia have been made to gauge interest there.

Milestones

- Identified partner universities for the SAF research network.
- Held the SAF supply chain workshop in SE Asia. This effort required identifying co-organizer groups for the SAF workshop in Bali, Indonesia, finalizing the workshop terms of reference, selecting and contracting a venue for the workshop and support organizations, and holding the SAF supply chain workshop in SE Asia.

Major Accomplishments

The major accomplishment of the project was holding the highly successful SAF supply chain workshop in Bali, Indonesia, on July 10-11, 2024. The workshop established ASCENT Project 093(B) as a leader in supporting the development of global SAF supply chains in the ASEAN region. Participants expressed great interest in FAA support for a similar workshop in 2025.

Publications

None.

Outreach Efforts

Organizing and conducting the SAF supply chain workshop in Bali, Indonesia, provided outreach and education to the SAF supply chain stakeholder community. Electronic communications were made with all the workshop participants, either directly or through in-country partners.

- Presented (Dr. Manuel Garcia-Perez and Dr. Scott Turn) information on SAF production and ASCENT global engagement to students from Taylor University in Malaysia at the request of the U.S. Grains Council on October 13, 2023.
- Presented two lectures (February 15 and May 16, 2024) as part of the ASCENT Project 093b Latin America training course organized by Washington State University.
- Presented on ASCENT Project 093b activities at the ASCENT review meetings in Honolulu, Hawai‘i (April 2024) and Alexandria, Virginia (October 2024).
- Participated (Dr. Scott Turn) in the Asia Pacific Air Transport Forum in Bali, Indonesia, and attended the release of Indonesia’s SAF road map at the Bali Airshow in September 2024.
- Held meetings with the Indonesian Directorate General for Civil Aviation (January, July, and September 2024) to discuss SAF development in the region and preparation and timelines for the release of Indonesia’s SAF road map.
- Participated in the 2025 Philippines SAF Forum #1 and subsequent feedstock availability working group meetings on agricultural residues and non-standard coconut, February 28 to March 4, 2025.
- Visited Universitas Sumatera Utara (USU) in Medan, Indonesia and Hasanuddin University (UNHAS) in Makassar, Indonesia during the week of April 14, 2025, accompanied by Dr. Wendy Aritenang, the Senior Technical Advisor to the Indonesian Directorate General for Civil Aviation. Visit focused on common interests in *Aleurites moluccanus*, a tree species that bears a nut containing 60% oil.
- Participated in the 1st Philippine SAF Policy Development Roundtable Discussion on June 23, 2025. This meeting included stakeholders from the Philippines government, agricultural commodity producers, airlines, and petroleum refiners. UH made a presentation entitled, "Stakeholder Needs: Building the SAF Ecosystem."
- Presented on ASCENT Project 093b activities at the ASCENT review meetings in Knoxville, Tennessee (April 2025).
- Participated in the My Aero Sustainable Aviation APAC Symposium in Kuala Lumpur. Meetings with personnel from Petronas, the Malaysian oil company, indicated that they remain interested in partnering with UH/FAA to co-host future SAF workshops for southeast Asia in Malaysia. (July 2025)
- Attended the southeast Asia SAF Forum, "From Waste to Wings: Thailand's Role in Sustainable Aviation Fuel (SAF)," in Bangkok, Thailand and made a presentation entitled, "SAF Perspectives in ASEAN." (July 2025)
- Initiated a study to quantify the occurrence of non-standard coconut in post-harvest supply chains. The Philippines would be the initial study area and contacts in Indonesia have been made to gauge interest there.

Awards

None.

Student Involvement

None.

Plans for Next Period

- Draft and submit a manuscript for publication in the journal *IOP Sustainability Science and Technology.* A report was prepared describing the 2024 workshop in Bali, Indonesia, and detailing its outcomes. This report will be used to draft the manuscript.
- Pursue a study to quantify the occurrence of non-standard coconut in post-harvest supply chains. The Philippines would be the initial study area and contacts in Indonesia have been made to gauge interest there.

- Explore interests in establishing core values of carbon intensity for SAF produced from *Aleurites moluccanus*. Participants from Indonesia and Hawai'i will be the initial focus group.
- Continue efforts to develop regional projects for southeast Asian universities currently involved with SAF development work.

References

Argus Media, 2024. Global SAF Map. https://view.argusmedia.com/global-saf-capacity-map.html

U.S. Energy Information Administration, 2019. International Energy Statistics. https://www.eia.gov/international/data/world