ASCENT SAF Research Overview & Update

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ASCENT
AVIATION SUSTAINABILITY CENTER

PRESENTATION OUTLINE

- Introduction to ASCENT
- SAF Research Strategies & Programs
- Examples of Specific SAF Projects
- Questions & Discussion

ASCENT Center of Excellence (COE)

Lead Universities:

Washington State University (WSU)

Massachusetts Institute of Technology (MIT)

Core Universities:

Boston University (BU)

Georgia Institute of Technology (Ga Tech)

Missouri University of Science and Technology (MS&T)

Oregon State University (OSU)

Pennsylvania State University (PSU)

Purdue University (PU)

Stanford University (SU)

University of Dayton (UD)

University of Hawaii (UH)

University of Illinois at Urbana-Champaign (UIUC)

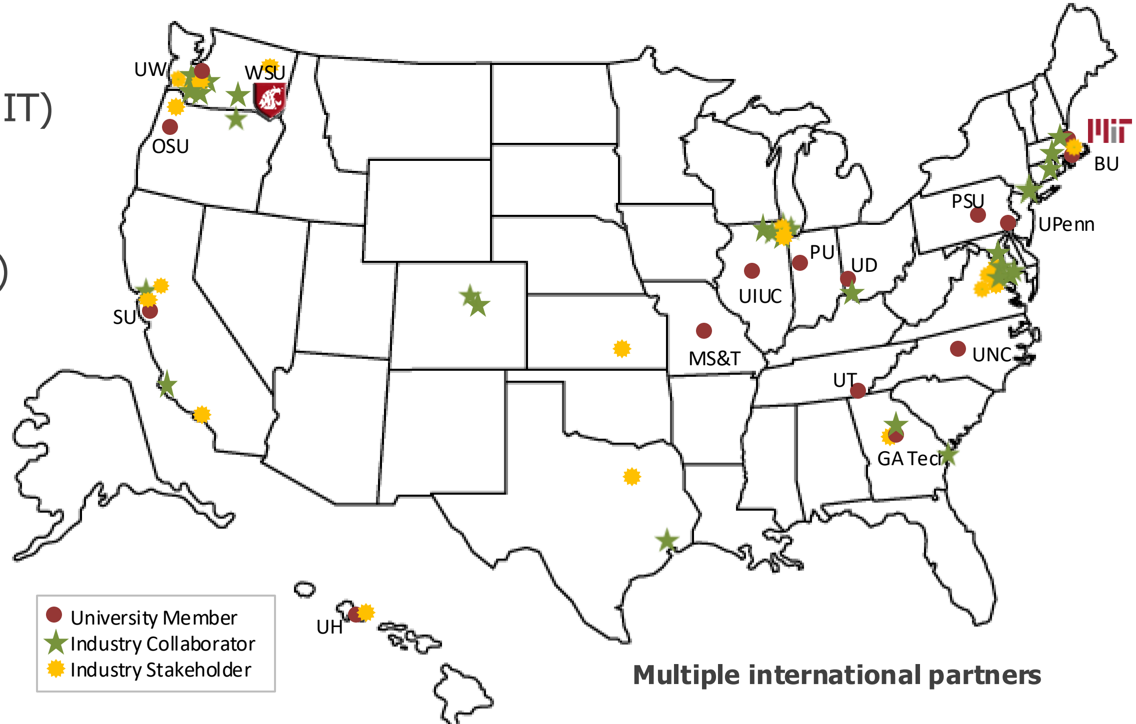
University of North Carolina at Chapel Hill (UNC)

University of Pennsylvania (UPenn)

University of Tennessee (UT)

University of Washington (UW)

For more information: ascent.aero



Multiple international partners

Advisory Committee - >60 organizations:

airports
airlines
NGO/advocacy
aviation manufacturers
feedstock/fuel manufacturers
R&D, service to aviation sector

ASCENT Mission

FAA
Environment & Energy

ICAO - International Civil Aviation Organization

NOISE

AIR QUALITY

ENERGY

ASCENT Support & Coordination

Federal Aviation Administration

Transport Canada

NASA

Environmental Protection Agency

Defense Logistics Agency - Energy

U.S. Dep't of Energy

U.S. Dep't of Agriculture

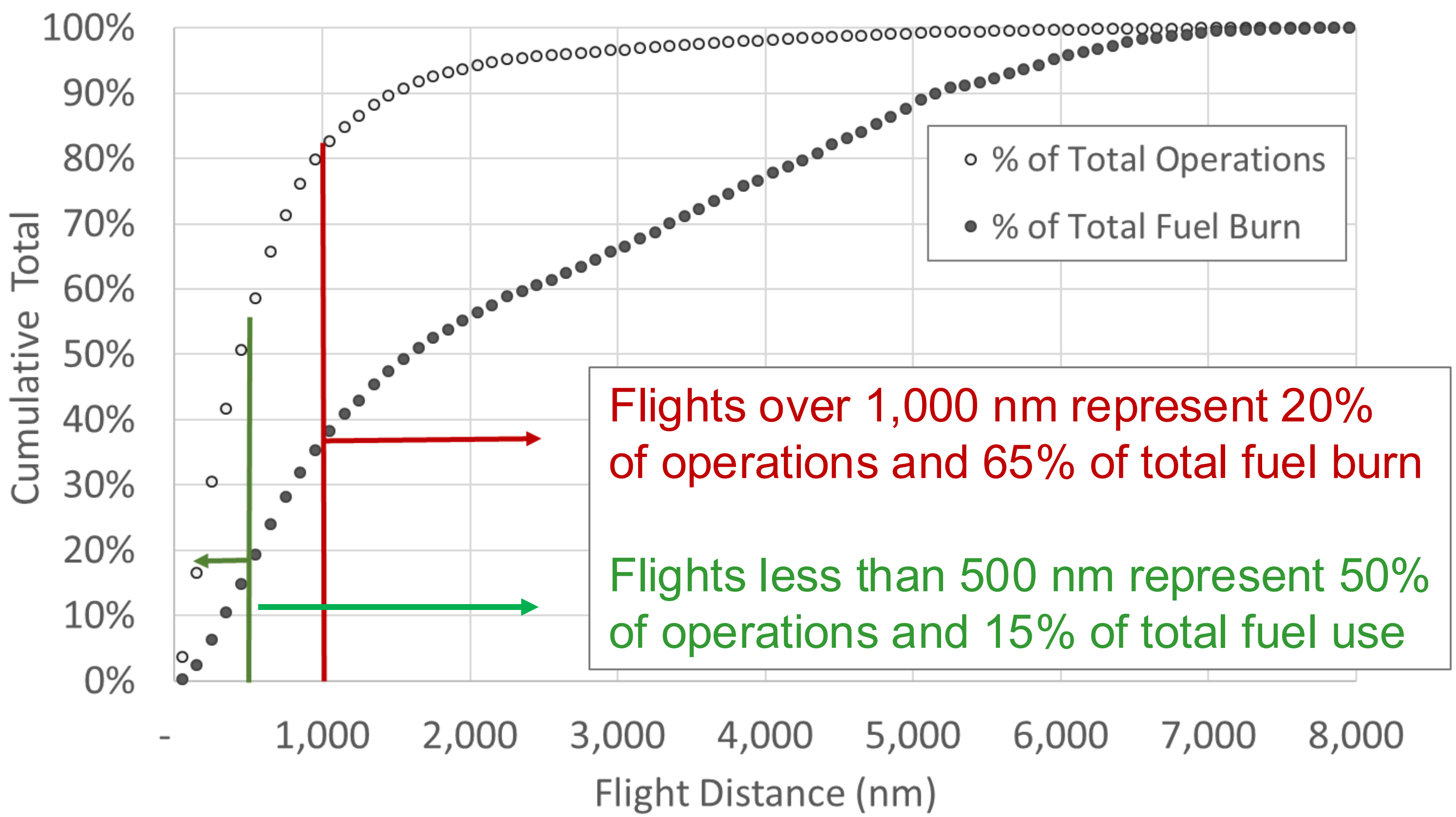
Air Force Research Laboratory

FAA COE research requires 100% cost share. This has led to significant collaboration among universities, industry, and international research programs

SAF Research Strategies & Programs

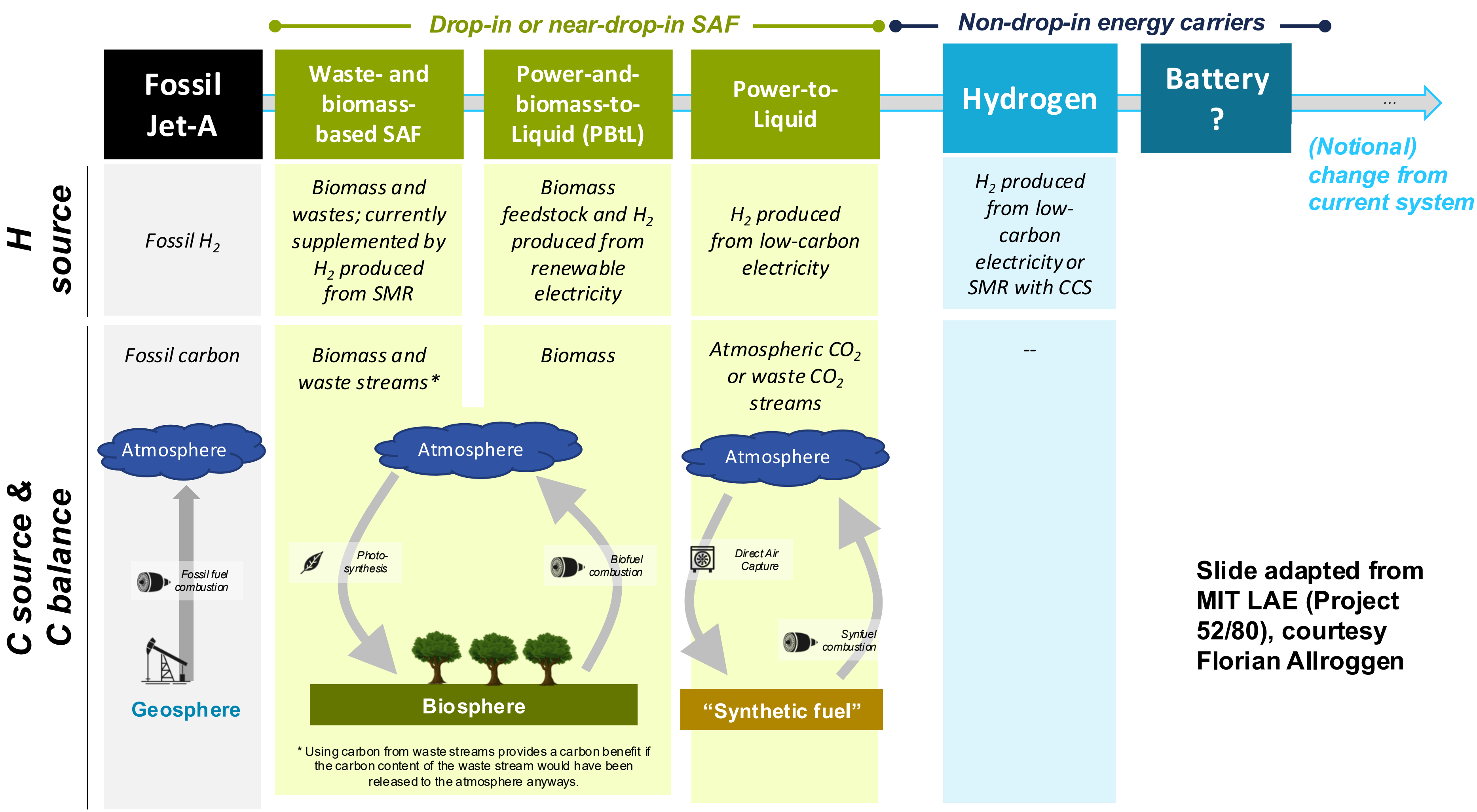
Global Jet Fuel Use

- Global jet fuel use is driven by long-haul aviation
- SAF only option through 2050 for long distances



Data analysis conducted by the U.S. DOT Volpe Center using the Aviation Environmental Design Tool (AEDT)

Energy Carriers for Aviation – A Typology

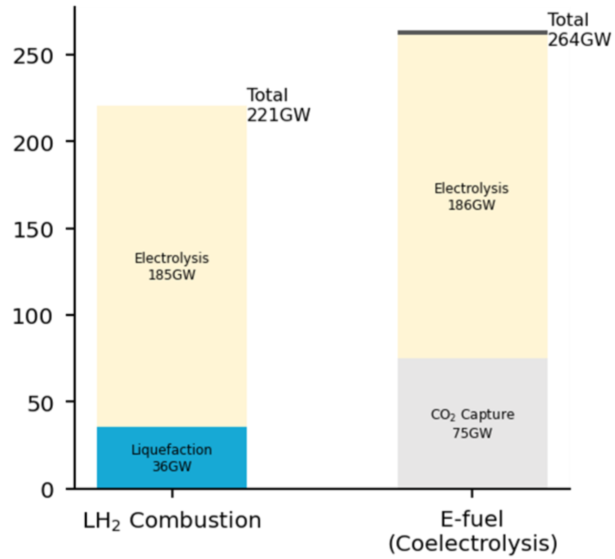


Slide adapted from MIT LAE (Project 52/80), courtesy Florian Allroggen

Airports as Energy Hubs: Global picture

- Replacing jet fuel with cryogenic hydrogen would require considerable electricity to electrolyze water and compress it to a cryogenic state
- Power-to-liquids would require comparable energy as cryogenic hydrogen, but without requiring infrastructure changes

Electric power consumption of fuel production [1]
broken down by process step, in GW

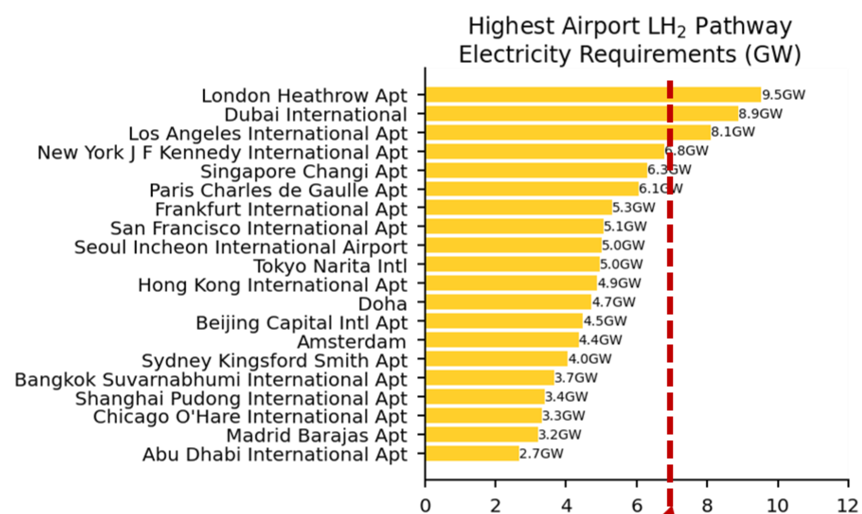


[1] Values are annual average power demand.

For comparison:
U.S. power generation capacity (2019): 1.2 TW
Cumulative global PV capacity (2019): 627 GW

Graphic and data courtesy of MIT from ASCENT Project 52

Electric energy consumption of fuel production
in GW, by airport



Capacity of largest existing nuclear power station

Preliminary Results from Ongoing Research in ASCENT Project 52 for flights greater than 1,000 km

Hydrogen Use in Aviation

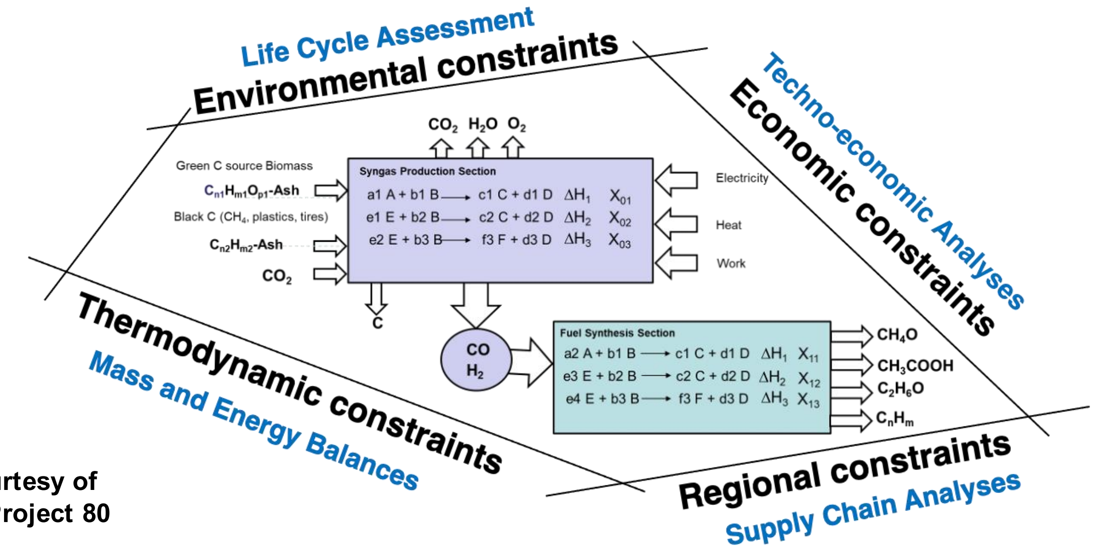
MIT and WSU through A001 and A052 have been examining potential paths for using renewable electricity in aviation

Hydrogen is the key to unlocking the potential of SAF

- Using renewable hydrogen for fuel production would provide an immediate reduction in carbon footprint of aviation and enable the use of sustainable aviation fuels (low carbon fertilizers and fuel production)
- There are considerable waste and biomass resources in the U.S. that could be sustainably produced, at lower costs than either cryogenic hydrogen or power-to-liquids, and that would use today's infrastructure
- Makes logical sense to use these resources now and to leverage our current infrastructure. Could also use biomass with power-to-liquids.
- In the future, if we need more jet fuel than can be provided from waste and biomass resources, then power-to-liquid fuels could be a viable solution. It could be produced from renewable electricity via hydrogen as an intermediary while enabling us to use our existing infrastructure

Analysis: Novel SAF Production

A080 will evaluate costs and lifecycle GHG for hydrogen, power-to-liquid (PtL) fuels, and how they can be integrated with biomass technologies



Graphic and data courtesy of WSU from ASCENT Project 80

- Address recent interest in both green hydrogen and PtL concepts for aviation
- Intense electricity demand must be factored into lifecycle and techno-economic evaluations
- Provide recommendations for alternative uses and future directions as resource availability changes with time

Testing/Certification/Qualification: Beyond 50%

- Current ASTM D7566 specifications limit most pathways to 50% by volume blending with conventional jet fuel
- Need to ensure fuels are drop-in compatible with existing and legacy systems
- Developing new ASCENT project(s) to isolate fuel properties that constrain blend volumes and develop fuel evaluations that support higher blend limits

ICAO Fuels Task Group (FTG) and Long-Term Aspirational Goal Task Group (LTAG-TG)

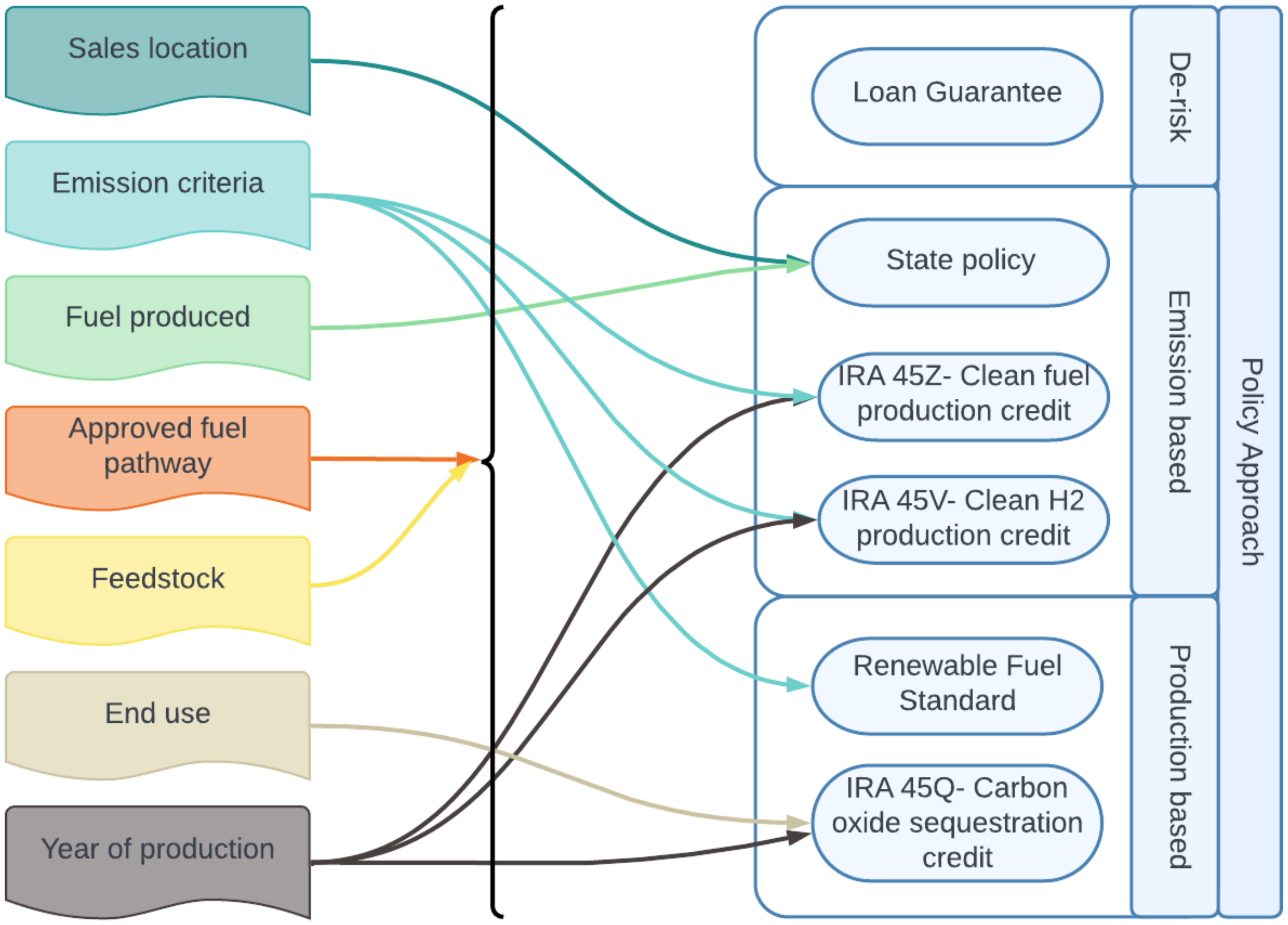
- FTG worked across five subgroups with a focus on maintaining the fuels-related sections of Annex 16 Vol IV (CORSIA).
- LTAG-TG worked to inform 41st ICAO Assembly in October 2022 on feasibility of a long-term global aspirational goal for international civil aviation CO_2 emissions reductions.
- LTAG-TG Fuels Sub-Group focused on fuel production and lifecycle GHG emissions projections out to 2070.

Subgroup	Task Number	Task Title
ILUC	S.01.01	Computation of induced land use change emissions for SAF for use in CORSIA
	S.01.02	Low ILUC risk practices
	S.03	Co-processing of esters and fatty acids in petroleum refineries – just ILUC calculation
	S.04.02	Methodology refinements – ILUC
Core LCA	S.01.03	Feedstocks classification
	S.02	Computation of default core LCA emission values for SAF for use in CORSIA
	S.03	Co-processing of esters and fatty acids in petroleum refineries – methodology for conducting LCA and default core LCA values
	S.04.01	Methodology refinements – core LCA
Emission Reductions	S.04.03	Methodology refinements – Emission Credits
	S.11	Double counting
	S.12	ILUC Permanence
All FTG	S.05	CORSIA Package Updates
Sustainability	S.06	Sustainability criteria
	S.07	SCS Requirements
Technology and Production	S.08	Technology evaluation
	S.09	Fuel Production Evaluation
	S.10	Guidance on Potential Policies and Coordinated Approaches for the Deployment of SAF

Data and Analysis for ICAO Fuels programs – Working Group 5 (WG5)

- FAA and ASCENT P01 / Volpe / ANL Team providing key data and leadership to determine how **SAF and Lower Carbon Aviation Fuels (LCAF) are credited within CORSIA**
- Continue to develop **core life cycle emissions values** for SAF and LCAF
- **Sustainability criteria** being developed for LCAF based on the list of SAF criteria – have also revised the SAF criteria
- Monitor **Sustainability Certification Schemes** approved by the ICAO Council and posted on the CORSIA Eligible Fuel website
- Maintain **harmonized Techno-Economic Analysis tools** for comparison of fuels costs and biomass need – **ICAO Rules of Thumb**
- Maintain **global production database** to assess progress towards industry goals

Policy & Support Analysis



ASCENT/FAA SAF Program Focus

Testing

ensure safety

- Test fuels
- Improve testing methods
- Conduct evaluation
- Streamline approval

Analysis

economic and environmental

- Lifecycle emissions
- Cost reduction
- Supply potential
- Supply chain opportunities

Coordination

support SAF integration

- Public-private partnership – *CAAFI*
- U.S. interagency cooperation
- International cooperation – *ICAO*

SAF Project Examples

SAF Production

A001- SAF Supply Chain Assessment

Develop tools to assess the economic and environmental sustainability of SAF production in support:

- ICAO/CORSIA (FTG & LTAG)
- CAAFI & Regional supply chains

A093- Global Supply Chain Evaluation

A100 – US/Canada Cross Border SAF Supply Chain Assessment

Work with international partners to make these tools globally relevant.

A052-Electrification Strategies

A080- H2 Use in SAF Production

Assess the role and potential of electrification strategies for SAF production.

SAF Testing/Certification/Qualification

A031- Clearing House Alternative Jet Fuel Test and Evaluation to Support the ASTM International Approval Process

In collaboration with industry, conduct combustion testing of novel drop-in jet fuels to ensure they are safe for use and conduct research to improve the certification process

A025- Rapid Infrared Fuel Prescreening
A065A/B- Rapid Prescreening Approaches

Examine novel methods for fuels prescreening to reduce the time and cost to ensure novel jet fuels are safe for use

SAF Property Database

A033- Alternative Fuels Testing Database Library

Establish a foundational database of information about current and newly emerging SAF

A090- World Fuels Survey

Assess and catalog fuels produced globally

SAF - Fuel/Engine Compatibility – 100% SAF

A066- Evaluation of High Thermal Stability Fuels

Testing high thermal stability fuels for emission reduction

A67- Impact of Fuel Heading on Combustion and Emissions

Evaluating fuel heating to optimize combustor efficiency

A073- Combustor Durability Evaluation with use of SAF

Conduct experiments to understand changes in combustor and turbine life with use of Alternative Jet Fuels with fuels that lack sulfur content and have reduced soot emissions.

A088- Fuel Compatibility with Non-metallic Materials

Develop a method to rapidly assessing the compatibility of candidate SAFs with non-metallic materials.

A089- Compositional Effects on Dielectric Constant

Examine how hydrocarbon composition affects the dielectric constant of a fuel, a key fuel property that aircraft use to determine the amount of fuel onboard an aircraft.

QUESTIONS