Farm to Fly

Sustainable Aviation Biofuels from US Agriculture

Executive Summary

Unlike ground transportation, which has modal alternatives and potential for electric power, there is no ready substitute for aviation. Development of a 'drop in' biofuel produced from regionally-appropriate feedstocks and supply chains is a high priority for the airline industry—a biofuel that is competitively priced, environmentally acceptable, and that meets global performance and safety certification. With smaller volumes (aviation comprises only 10% of the liquid fuel market for US transportation), fixed points of distribution, and relatively few buyers with whom to collaborate on market development, aviation represents a manageable scale to create new supply chains for sustainable biofuels. The majority of these new supply chains will originate from agricultural feedstocks, including vegetable oils, biomass, and algae. Linking the technologies, policies, and economic and sustainability criteria from agriculture-to-aviation is the goal of '*Farm to Fly*.' This five-year project is proposed to be led by Washington State University (WSU) and Oregon State University (OSU) in partnership with a national network of land grant universities (the Sun Grant Association) and federally funded laboratories working together to further establish a biobased economy. Supporting the private sector supply chain, goals include the first introduction of commercial aviation biofuel in Seattle during 2012, with subsequent expansion across the country at volumes exceeding 1% of total market by 2016.

Aviation Biofuel Proof-of-Concept

The aviation industry has been compelled to seek viable petroleum alternatives because of fuel's increasing proportion of overall operating costs, its unpredictable pricing, and the possibility of global carbon emission limits. Boeing has emerged as a leader, and with DARPA-funded partners, has produced synthetic paraffinic kerosene that meets or exceeds certification requirements from several feedstocks (tropical oilseeds, temperate oilseeds, and algae oil). Without modifying flight equipment, Boeing completed test flights using petroleum/biofuel blends in four locations around the world, utilizing aircraft equipped with four different jet engines produced by all three of the major manufacturers. The Department of Defense has also tested these advanced biofuels, and both the Air Force and Navy have procured pilot-scale quantities for further testing. Thus, this first refining technique has proven technically feasible in converting a variety of plant-derived oils into a certified biofuel equivalent. The recently approved ASTM D7566 - 09 Standard Specification for Aviation Turbine Fuel Containing Synthesized Hydrocarbons has paved the way for a biofuel standard likely in early 2010. However, the economic and environmental feasibility has yet to be demonstrated on a commercial scale.

Assuring the Market for an Aviation Biofuel

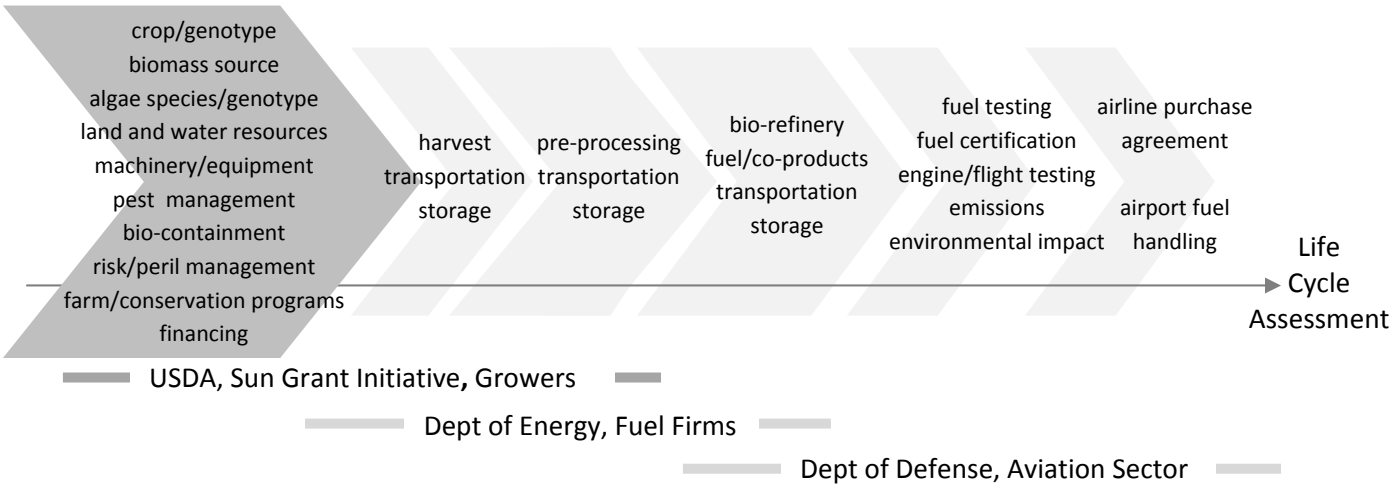
The Commercial Aviation Alternative Fuels Initiative (CAAFI) has been an important collaborative in developing viable biofuels for aviation. Principal stakeholders from across the aviation sector have been involved, including federal agencies (Federal Aviation Administration), trade associations (Airports Council International – North America, Aerospace Industries Association, Air Transport Association), the private sector (Boeing, US Airways), and others. Their major contributions to date have been to foster inter-agency cooperation, develop pathways for fuel certification, and compile and integrate the research and development roadmaps necessary to commercialize aviation biofuels.

The Sustainable Aviation Fuel Users Group (SAFUG) includes Honeywell's UOP (a major participant in the DARPA – funded synthetic paraffinic kerosene 'ecofining' process) and Boeing as supporting members, but importantly, it also includes commercial airline companies that collectively exceed 15% of global aviation fuel demand. Recently, the Air Transport Association (ATA) has led a collaboration of fuel buyers among the commercial airline companies to explore the feasibility of off-take agreements, pricing schemes, and risk allocation as a means of assisting the launch of the new biofuel.

Developing the Biofuel Supply Chain

Early generation biofuel feedstocks such as corn for ethanol or soy for biodiesel are under close scrutiny. These feedstocks are also key sources of food and are produced from generally high-input agricultural systems and supply chains. Thus, both the life cycle net energy balance and environmental benefits from such first generation biofuels have been questioned. Apart from these existing supply chains, CAAFI has authored a research and development roadmap accelerating the pace of aviation biofuel development, with many of the engineering milestones completed. The upstream portion of the roadmap, from biofeedstock production through delivery to the biorefinery, will require technology, skills, policy, and know-how from the agricultural community. Creating a sustainable supply chain originating from the most suitable local feedstock will require a regional focus with national coordination - all in conjunction with the simultaneous production of food, feed, and fiber. The land grant universities are the nation's primary source of agricultural and plant science expertise, and are the logical choice for delivering this component of the roadmap.

Aviation Biofuel Supply Chain and Funding Sources



The agriculture sector's ability to resolve these dynamic factors, critical to the establishment of any new crop or agricultural production system, is well known. For nearly three decades, methods such as the Production-Marketing-Consumption (PMC) decision matrix have been successfully used and modified to introduce new crops. Such planning tools are needed to enhance the CAAFI roadmap, and if used in conjunction with stakeholder input, such as the Future Fuels Forum being used in Australia and the Roundtable on Sustainable Biofuels, could improve the competitiveness and sustainability of biofuels. Aviation biofuels offer the US biofuels industry a fresh approach and target, as the market has been defined and organized first, and CAAFI's roadmap has proven successful in accomplishing the proof of concept. Now the entire supply chain needs to be coupled together for commercial fuel production at scale.

CAAFI's milestones for 2010 include ASTM certification for the bio-derived aviation fuel, further flight tests with Navy and Air Force aircraft, obtaining permits and construction of bio-refineries capable of producing certified fuel, and expanded commercial production of camelina as the biofeedstock. In addition, basic research will continue on biomass-to-distillates and algae-based biofeedstock production. In 2011, the first bio-refineries are scheduled to be completed, with commercial oilseed production further expanding, and biomass and algae systems further refined. In 2012, the first commercial use of aviation biofuels should be accomplished, expanding to ~1% of the US market by 2016. Biofuels derived from biomass and algal sources will be introduced and added to the feedstock portfolio as best determined regionally.

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Meeting these milestones for commercial availability of an aviation biofuel over the next five years will be challenging for US agriculture. *Farm to Fly* is proposed as a nation-wide project to bridge the gap between agriculture and aviation through the following functions:

- enhancing the CAAFI roadmap through importing proven decision aids (such as PMC customized for sustainable aviation biofuel markets) to guide development of a multiple feedstock portfolio consisting of oilseed, biomass, and eventually algal sources
- creating a regionally focused, but nationally coordinated research effort on the most promising regionally available feedstock(s) through the Sun Grant Association
- developing agriculture, conservation, and environmental policy that supports the successful evolution and sustainability of the US aviation biofuels industry
- leveraging the Sun Grant Initiative's nationwide research and educational network for exchanging knowledge and information across the supply chain with private sector firms providing inputs, genetics, processing, and logistics

Proposed Participants

- Washington State University as lead institution, in partnership with Oregon State University (lead institution in the Western Sun Grant Center)
- CAAFI and the commercial airlines industry
- Boeing as a key integrator of the aircraft manufacturing industry
- The Sun Grant Initiative national network of Land Grant Universities, national laboratories, and the USDA Agricultural Research Service
- Emerging and existing firms associated with the biofuel supply chain