Dynamics of Aviation Biofuel Investment, Incentives, and Market Growth: An Exploration Using the Biomass Scenario Model

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Aviation Biofuels Analysis

We simulated aviation biofuel production with different combinations of incentives and public/private investment. Some of our results reach high penetration (six billion gallons) of aviation biofuel by 2030. We found that policy design makes a difference in the timing and magnitude of aviation biofuels production:

- ➢ Incentives targeted toward aviation biofuel production, such as financial incentives (e.g., producer tax credit, carbon tax) can spur growth without other incentive types, as in panel [d].
- ➢ The combination of production incentives with different types of investment in pre-commercial technologies can accelerate industrial growth relative to production incentives alone. See:
  - Pre-commercial investments plus loan: Row [2] vs. Row [1]
  - Pre-commercial investments plus offtake agreements: Row [3] vs. Row [1]

These results occur because pre-commercial investment is assumed to reduce the cost of production through learning-by-doing. High oil prices can also spur production, and they reduce these effects.

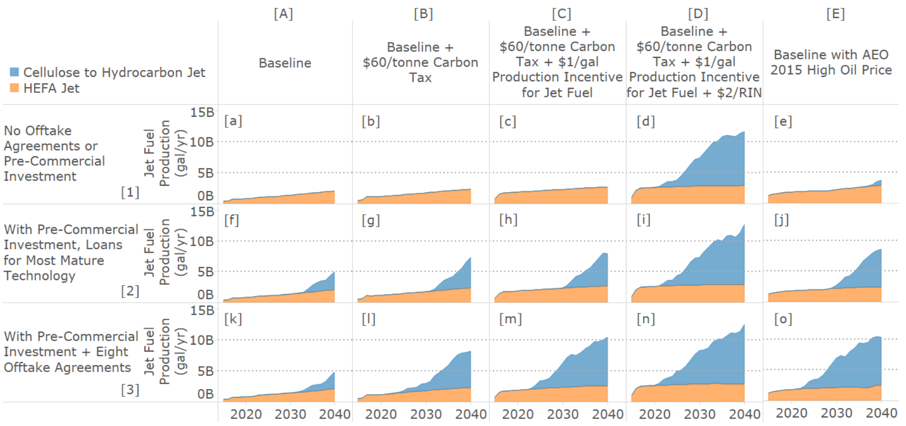

Figure 1. Aviation biofuel production under different public/private investment scenarios (rows) and incentives/oil price scenarios (columns)
Source: [1]

Table 1. Aviation biofuel conversion pathways used in this analysis

Conversion Process	Feedstock	ASTM Certification Status
HEFA – Hydro-processed esters and fatty acids	Waste fats, oils, and greases and oil-seed crops	Approved
Fischer-Tropsch – Gasification followed by Fischer-Tropsch conversion	Coal or biomass, primarily woody feedstocks	Approved
Direct sugars to hydrocarbons – biochemical conversion of sugars to farnasane as a blending component of jet fuel	Herbaceous feedstocks	Approved
Alcohol to Jet – feedstocks to ethanol or butanol and catalytic oligomerization of alcohols to jet	Herbaceous and starch feedstocks	Near-term
Catalytic and fermentative upgrading of sugars	Herbaceous feedstocks	Long-term

Note: Not all pathways had appreciable production levels.
Source: [1]

Baseline Conditions

For the baseline incentive case, the following conditions are applied:

- An incentive of $0.70/renewable identification number (RIN) is held constant for the entire simulation.
- Annual Energy Outlook (AEO) 2015 Reference Oil Prices [2] are used.
- Tax credits are extended for the first one billion gallons of production.
- Loan guarantees of 80% are available for the first one billion gallons of production.
- For each of the aviation biofuel pathways, fuel mix is treated as an input so jet fuel production is maximized and not dynamically determined based on relative prices and other factors.
- Biorefinery construction is limited to 25 plants per year, due to labor and materials constraints.

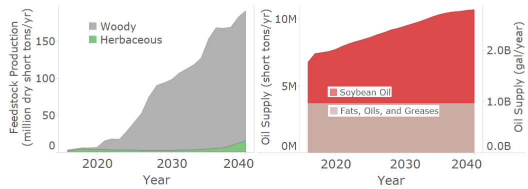

Figure 2. Cellulosic feedstock production (left) and oil supply (right) for all biofuels in the case with $60/tonne carbon tax and $1/gal production incentive for jet fuel in addition to pre-commercial investment and eight offtake agreements (see Panel [m])
Source: [1]

The Biomass Scenario Model: A Biomass-to-Biofuels System Dynamics Model

The Biomass Scenario Model (BSM) is a carefully validated, state-of-the-art dynamic model of the U.S. biofuels supply chain. It focuses on policy alternatives and potential effects, integrating resource availability, constraints (physical, technological, and economic), and behavior. The model simulates the system dynamics of interactions across the supply chain (see figure below). The BSM tracks biofuels production given technology improvement and the response of investors (see figure below at right), in the context of land availability, the competing oil market, consumer demand for biofuels, and government policies over time. It emphasizes the behavior and decision making of various agents across the supply chain, from feedstock producers to fuel users. The model resolves ten U.S. geographic regions; cellulosic, oil crop, algae, and starch resources; and conversion processes that produce hydrocarbons, ethanol, and butanol. The BSM is used to develop insights into the biofuels industry growth and market penetration, particularly with respect to effects of policies and incentives for each supply-chain element (volumetric, capital, operating subsidies; carbon caps/taxes; R&D investment; loan guarantees; tax credits). It is suitable for coupling to vehicle-choice, agriculture, oil-industry, and general economic models.

Selected Policy Inputs

- Capital cost incentives
- Carbon cap or taxes
- Dispensing station infrastructure incentives
- Distribution infrastructure incentives
- Fuel taxes and/or incentives
- Loan guarantees
- Production credits
- R&D investments
- Renewable fuels incentives
- Tariffs
- Tax reductions
- Vehicle purchase incentives

Sources

[1] NREL, April 2016. "Potential Avenues for High Biofuels Penetration in the Aviation Market," Unpublished BSM Analysis Report.
[2] U.S. Energy Information Administration, 2015. Annual Energy Outlook.
[3] L. Vimmerstedt, B. Bush, 2013. "Effects of Deployment Investment on the Growth of the Biofuels Industry. NREL/TP-6A20-60802. http://www.osti.gov/scitech/biblio/1118095

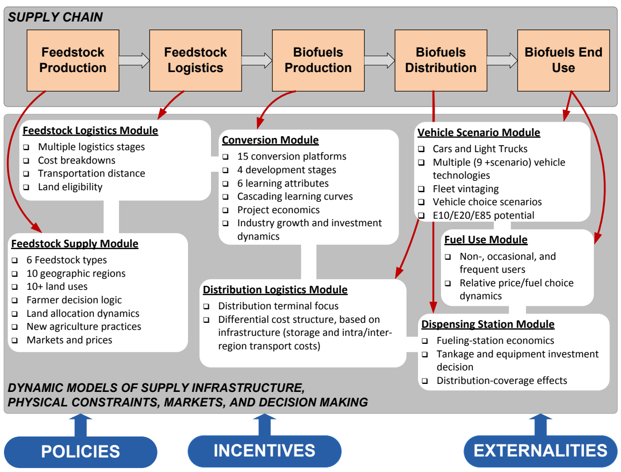

Figure 3. Overview of the biomass to biofuels supply chain and the BSM structure.
Source: [3]

INVESTMENT, PRODUCTION, AND TECHNOLOGICAL IMPROVEMENT

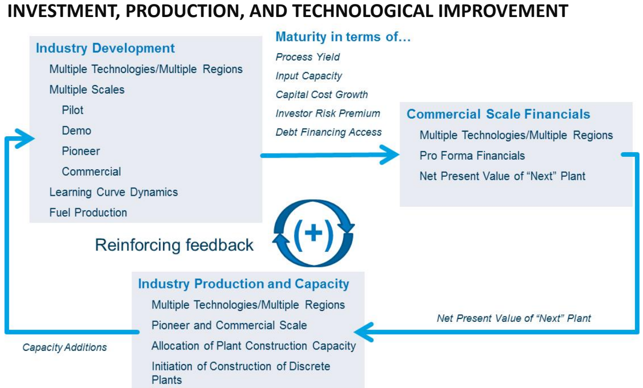

Figure 4. Dynamic feedback among investment, production, and technological improvement.

BSM Publications List: https://www.zotero.org/groups/bsm_publications

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