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Exploring Bioeconomy Growth through the Public Release of the Biomass Scenario Model

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

The Biomass Scenario Model (BSM) is a carefully validated, state-of-the-art dynamic model of the U.S. bioenergy supply chain. It focuses on policy alternatives and potential effects, integrating resource availability, constraints (physical, technological, and economic), and behavior to explore bioenergy deployment scenarios. The model simulates the system dynamics of interactions across the supply chain (Figure 1). The BSM tracks biofuels production given technology improvement and the response of investors (Figure 2), as a function 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. The model resolves ten U.S. geographic regions; cellulosic, oil, algae, and starch resources; and conversion processes that produce hydrocarbons, ethanol, and butanol. The BSM is used to develop insights into the bioenergy industry growth and market penetration. It is suitable for coupling to vehicle-choice, agriculture, oil-industry, and general economic models. The system attributes—initial conditions, connections, and rates of change—are built on peer-reviewed data and rigorous calibration and validation of the input data and simulation results. An example of a validation is the strong agreement between the historic and the simulated development of the starch ethanol industry.

Selected Policy Inputs

- Capital cost incentives
- Carbon taxes
- Low Carbon Fuel Standard
- 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
[2] BETO, Multi-Year Program Plan, DOE/EE-1385, U.S. Department of Energy, Energy Efficiency and Renewable Energy, Washington, DC, March 2016.
[2] U.S. Energy Information Administration, 2015. Annual Energy Outlook.
[3] Newes, E., J. Han., and S. Peterson. "Potential Avenues for Significant Biofuels Penetration in the U.S. Aviation Market." NREL, 2017.

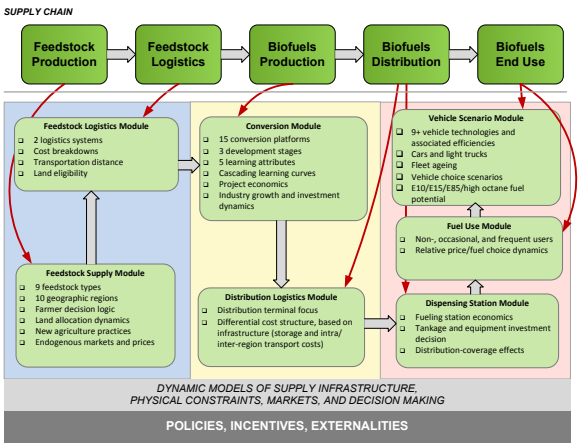

Figure 1. Overview of the biomass to bioenergy supply chain and the BSM structure. Source: [1]

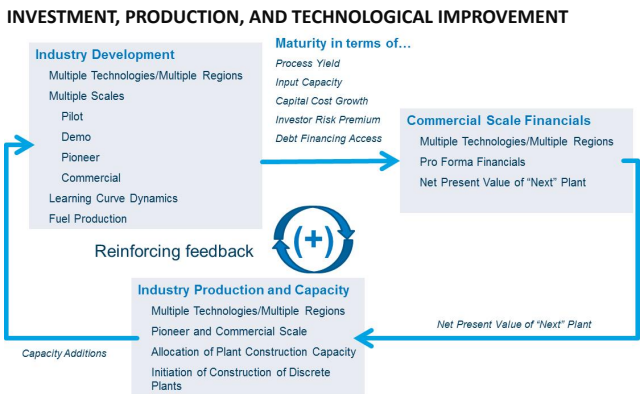

Figure 2. Dynamic feedback among investment, production, and technological improvement.

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

Public Release of the Biomass Scenario Model

Pending Release: NREL and the U.S. Department of Energy (DOE) Bioenergy Technologies Office (BETO) have developed the Biomass Scenario Model and are now preparing to make it publicly available under an open source license.

User Support: User guidance, frequently asked questions, model tutorials, fact sheets, data definitions, default inputs, test scenario inputs, and analytic questions with a key to relevant inputs will accompany the release. In parallel, the BSM viewer (https://bsm-viewer.nrel.gov/) will allow users to browse publicly-available analytic results.

Benefits: The release of the BSM will provide direct public access to a public asset that has been developed for more than a decade (Figure 3).

- It supports decision-making through dynamic exploration of interactions across bioenergy systems, accounting for nonlinearity, constant change, historical dependence, and evolving markets.
- It allows the user to run case studies to better understand market responses to parameters or nonlinear disproportionate results, potentially clarifying non-intuitive system behaviors.
- It enables stakeholders to consider impacts in other parts of the supply chain and over extended periods of time of decisions or actions being made locally.
- It allows the exploration of a multitude of different potential outcomes, given assumptions, caveats, and scenario inputs (Figure 4, for example).

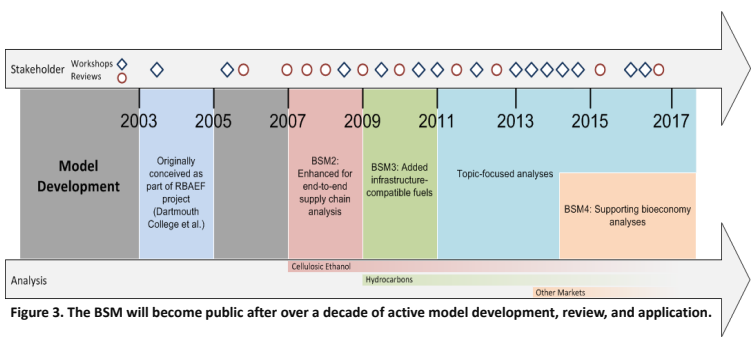

Figure 3. The BSM will become public after over a decade of active model development, review, and application.

Synopsis of Analyses Completed

Individual Policies
- Effect of Biomass Crop Assistance Program
- Influence of ethanol tariffs
- Tradeoffs between grants and loan guarantees
- Conditions for achieving RFS or other targets
- RIN market variability
- CRP and land policy issues

Coordinating Policies
- Effects of phasing out supportive policies
- Synergies between volumetric and capital-oriented policies
- Policy mixes with high benefits for low cost
- Increasing biorefinery pathway diversity
- Keeping total subsidy costs under limits

Pricing and Economics
- Effects of E85 pricing strategies at fueling stations
- Impacts of petroleum price scenarios and price shocks
- Sensitivity of feedstock and ethanol production to plant-gate feedstock prices
- Price-stabilizing influence of forest residues
- Nature of price fluctuations in various elements of the supply chain
- Energy return-on-investment
- End use markets: marine, jet, and high octane fuels
- Offtake agreements

System Characteristics
- Climate change and drought
- Likelihood of boom/bust cycles
- Extent to which policy exacerbates instabilities
- Methods for reducing bottlenecks from lack of distribution or dispensing infrastructure
- Most effective points for volumetric subsidies

Model Assumptions
- Competition for biomass resources
- Detailed sensitivity study of the BSM

Sample Potential Bioeconomy Questions

- What are potential leverage points for incentives to accelerate development of the bioeconomy? This could include exploring how markets such as alternative jet fuels or high-value products could catalyze growth in other bioeconomy markets.
- How might the dynamics of industrial learning-by-doing shape the uses of biomass, the timing and magnitude and types of growth, and the economic and environmental effects associated with the bioeconomy?
- Which pieces of the bioeconomy system might become bottlenecks to growth, and what might be the effects of potential actions to overcome these constraints?

Analysis has informed DOE goals for aviation biofuels.

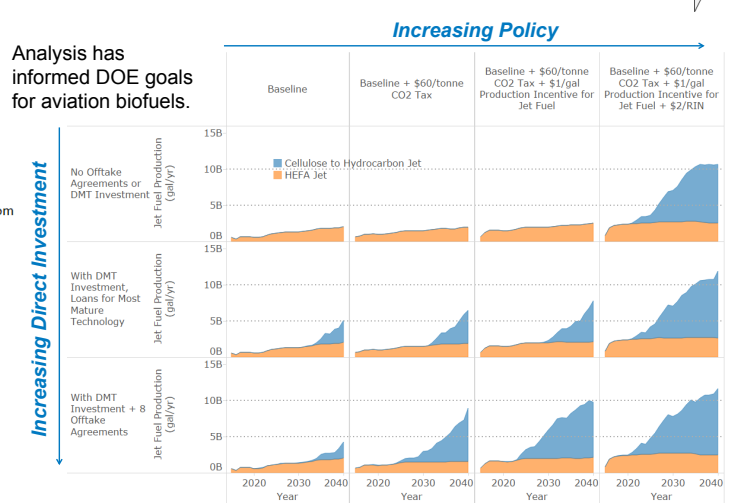

Figure 4. Analysis suggests six billion gallons of aviation biofuel in 2030 is possible. The BSM has been used to explore aviation biofuels scenarios by DOE, the U.S. Federal Aviation Administration, and Airlines for America. Source: [3]

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