

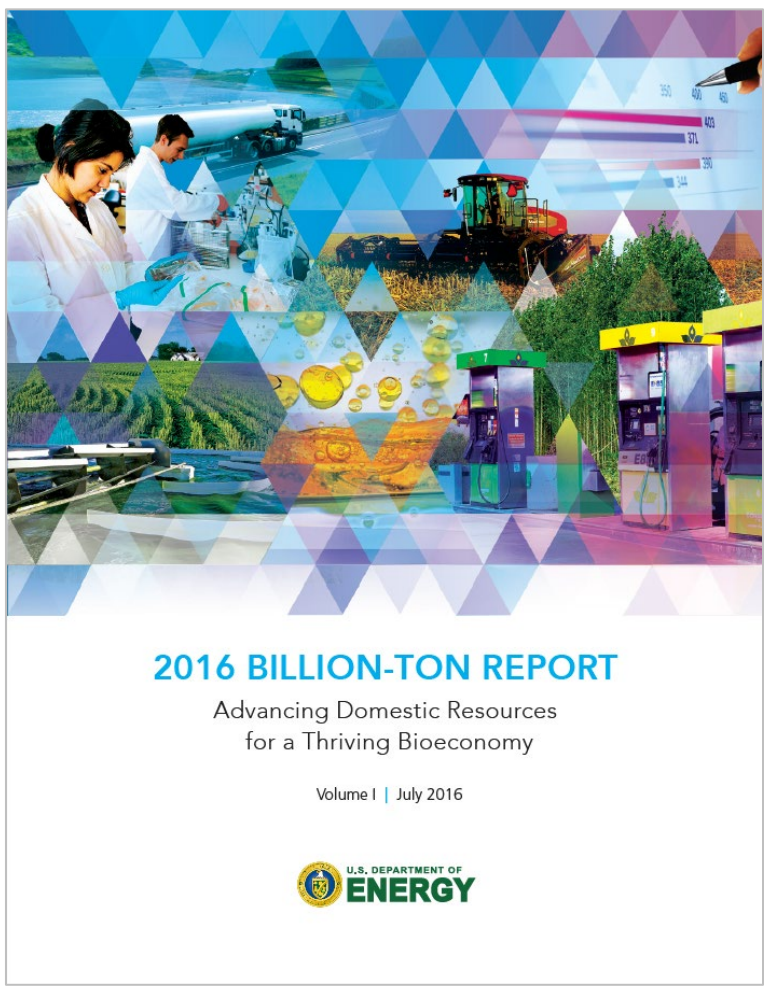
Modeling and Analysis Needs for Biofuels

DOE Bioenergy Technologies Office
Generation 1 Ethanol Opportunities Workshop

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January 31, 2022

Outline of “Billion-Ton” Report



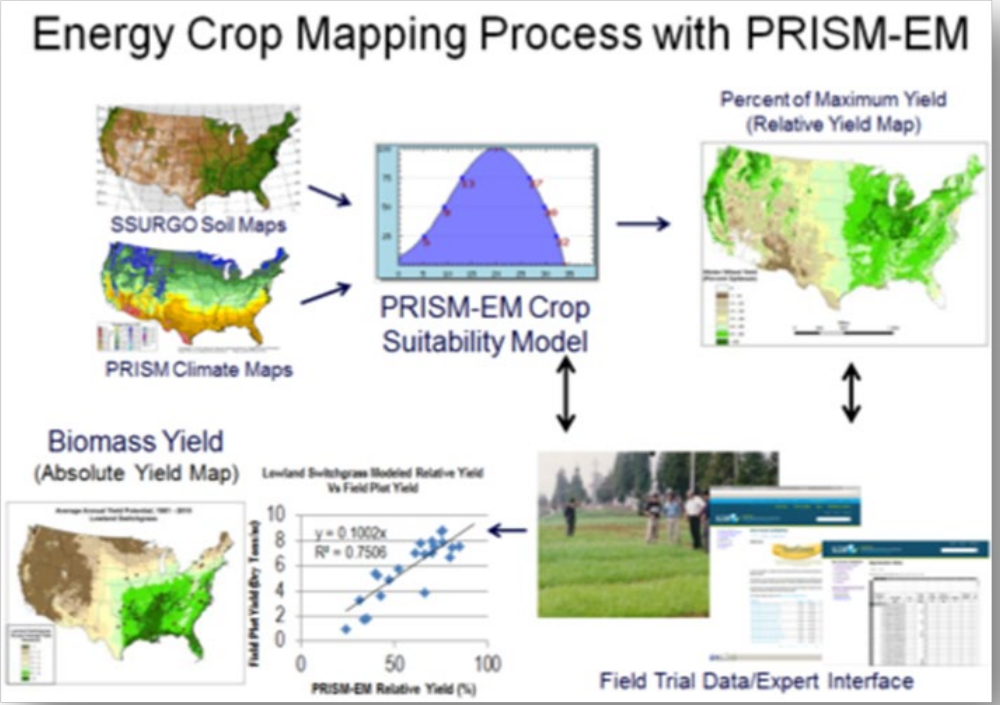
Volume 1

- Currently Used Resources (biomass for biopower, bioproducts, biochemicals, and biofuels)
- Roadside Forest Resources
- Farmgate Agricultural Resources
- Secondary and Waste Resources
- To The Biorefinery: Delivered Resources
- Microalgae

***Released: July 12, 2016**

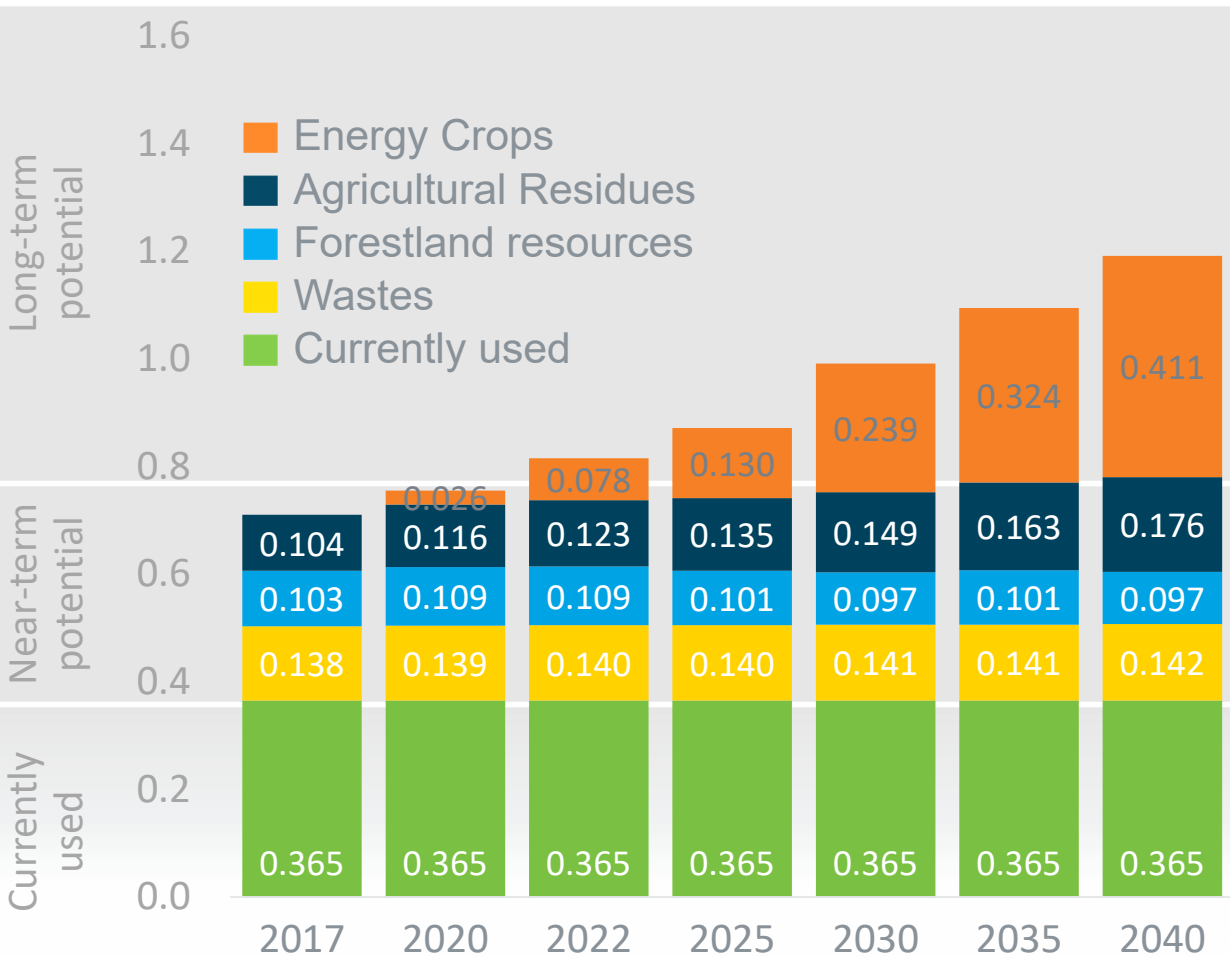
Objectives of Biomass Resource Assessment Study

- Estimate current use of biomass for energy
- Apply state-of-the-art science to estimate resource potential
- Simulate potential supply – not a supply or demand prediction



Current and Potential, Base-case, \$60/dt

Billions of Dry Tons per year



Energy crops	2017	2040
(million dry tons)		
Switchgrass	-	160.5
Miscanthus	-	160.0
Poplar	-	44.9
Willow	-	25.1
Biomass sorghum	-	19.3
Eucalyptus	-	0.9
Energy cane	-	0.3
Pine	-	0.1
Total	-	411

Interactive Resources

<http://bioenergykdf.net/2016-billion-ton-report>



The screenshot shows the Bioenergy KDF website with the following content:

- Header: BIOENERGY KNOWLEDGE DISCOVERY FRAMEWORK, U.S. DEPARTMENT OF ENERGY. Navigation: OVERVIEW | TOOLS & APPS | MAP | BIOENERGY LIBRARY | CONTRIBUTE.
- Main Title: 2016 BILLION-TON REPORT INTERACTIVE VERSION.
- Introductory Text: "The 2016 Billion-Ton Report: Advancing Domestic Resources for a Thriving Bioeconomy is the third in a series of national biomass resource assessments..."
- Buttons: Access Report, Data Explorer, Data Download Tool.
- Section 01: Executive Summary/Overview. "This 2016 Billion-Ton Report, Volume 1, includes an assessment of the potential economic availability of biomass resources delivered to biorefineries..."
- Section 02: Biomass Consumed in the Current Bioeconomy. "View detail for feedstocks that contribute to current biofuel production and energy generation in the industrial sector."
- Section 03: Forest Resources. "View estimates of primary biomass from forest resources, including wood wastes, harvest from forest thinning, and purpose-grown trees, as well as biomass residues."
- Section 04: At the Farmgate. "See an updated assessment of the potential economic availability of biomass, including crop residues and dedicated energy crops, from agricultural lands."
- Section 05: Waste Resources. "Access data on secondary and waste resources that may be mobilized to grow the bioeconomy, including agricultural production waste, municipal solid waste, and industrial waste."
- Section 06: To the Biorefinery. "Leverage data to estimate the costs and quantities of feedstocks that could be available at biorefineries."
- Section 07: Microalgae. "Estimate the site-specific and national economic availability of algae biomass under on-location scenarios."
- Footer: From the Bioenergy KDF, Access the Report, Billion-Ton 2016; Maps and Data, Agricultural Maps, All Billion-Ton 2016, Forestry Maps, Data, Agricultural Resources; Questions, Billion-Ton 2016, Report Information, Contact Us, Feedback.

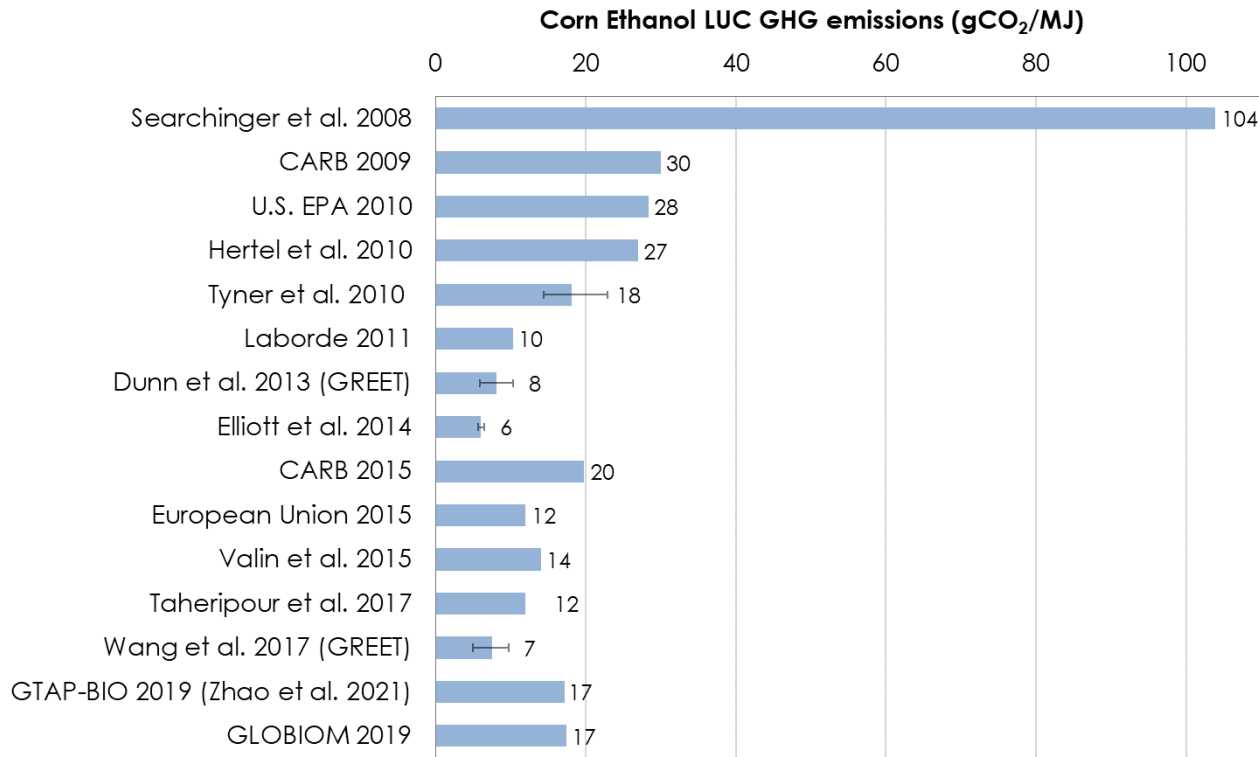
The screenshot shows the Bioenergy KDF website with the Billion-Ton 2016 Data Explorer interface overlaid on a map of the United States. The interface includes the following controls:

- Search bar: Search
- Category Selection: Agriculture, Forest, Wastes
- Select Data Aggregation: County Data, State Data
- Select Result Type: Production, Production Density, Harvested Acres, Yield
- Select Scenario: 3% yield inc.
- Select Feedstock: Miscanthus
- Select Biomass Price (per dry ton): Slider from \$30 to \$100
- Select Year: 2014 to 2040
- Map: Shows a heatmap of biomass availability across the United States.
- Bottom Bar: Data Grid (Click to Expand)

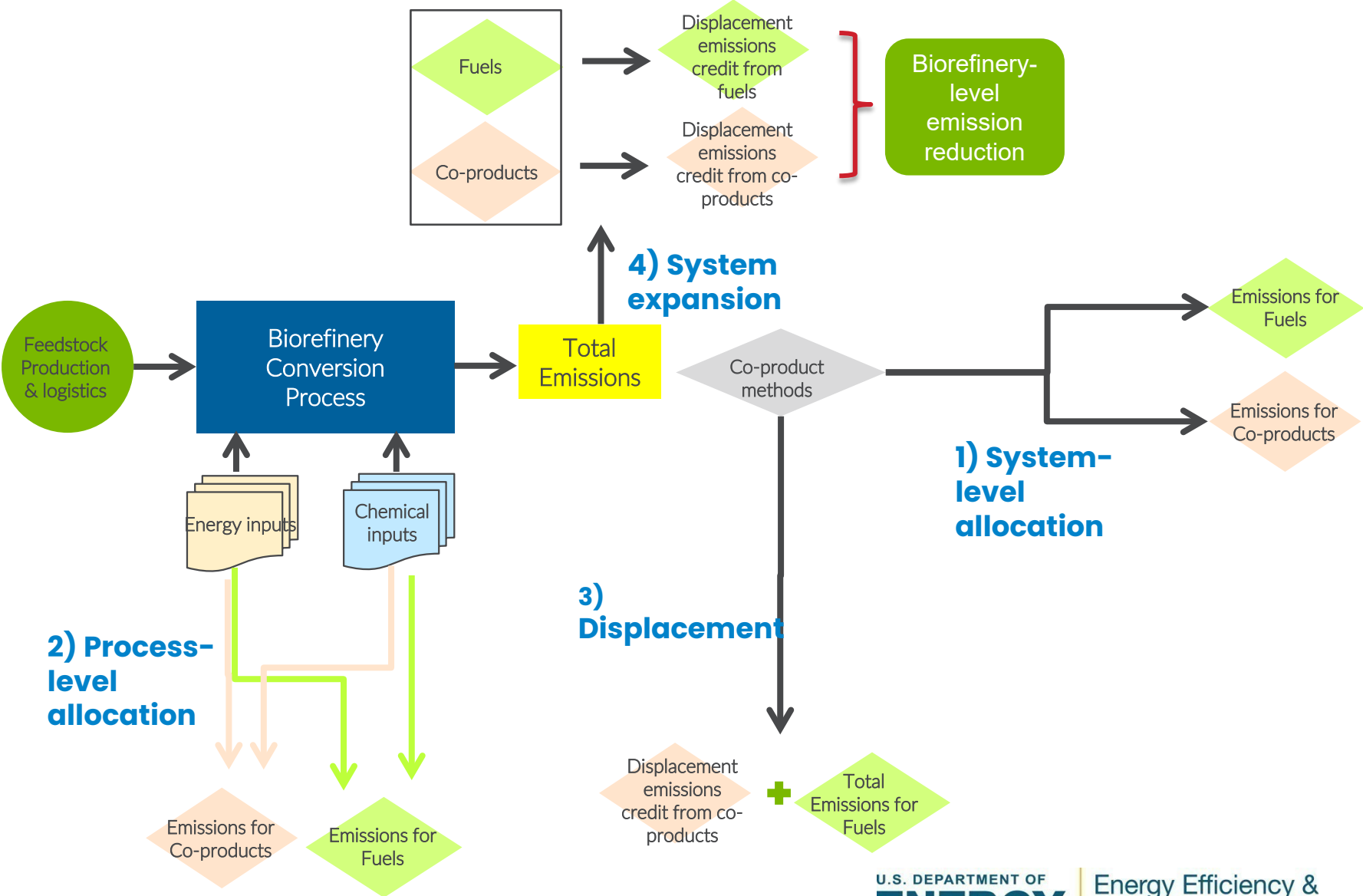
Corn ethanol land use change

The GHG emissions from LUC that could be induced from large-scale feedstock production for biofuels have been simulated for corn ethanol

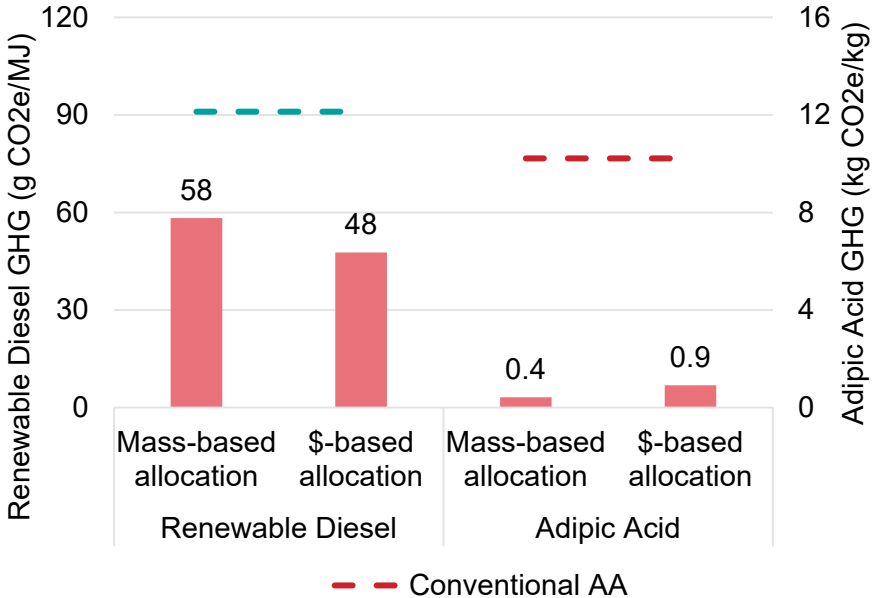
- Reduction in estimated LUC emissions are a result of better developed and calibrated economic models to incorporate most recent data
- CCLUB has developed GHG emission results from GTAP by adopting detailed output with a process-based model of soil carbon changes implemented in GREET



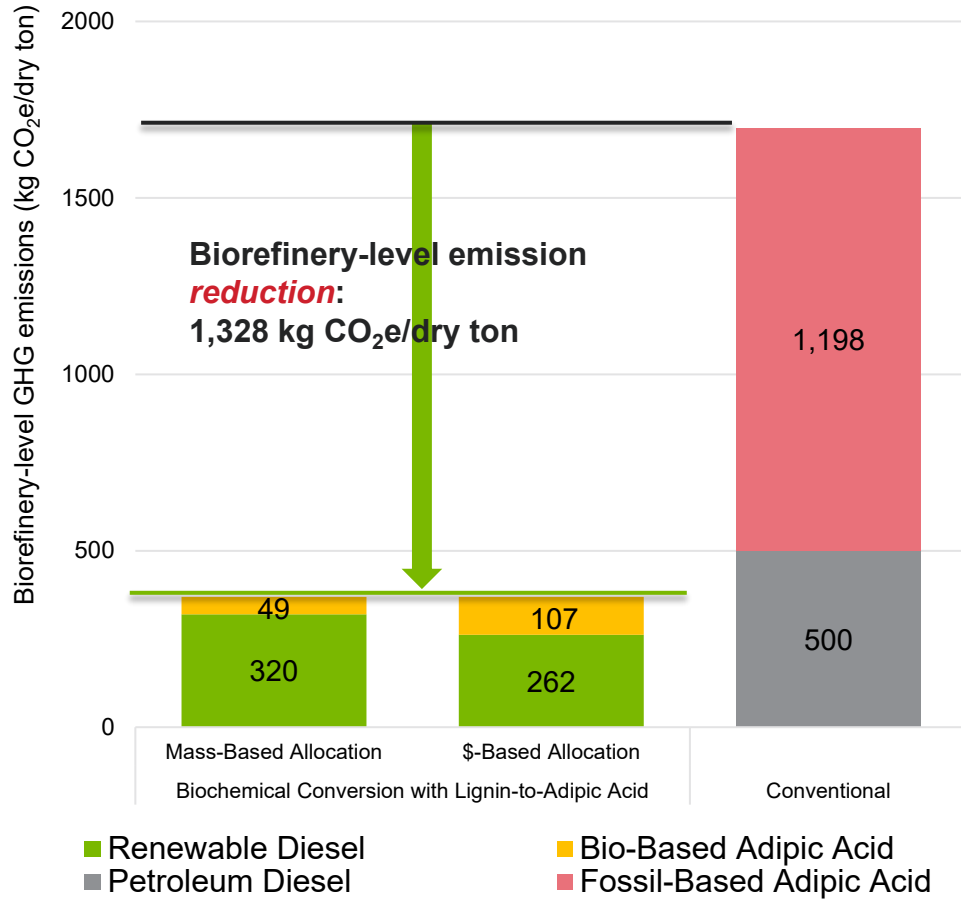
Several methods exist to account for co-products



Co-product methodology can have a large effect on CI

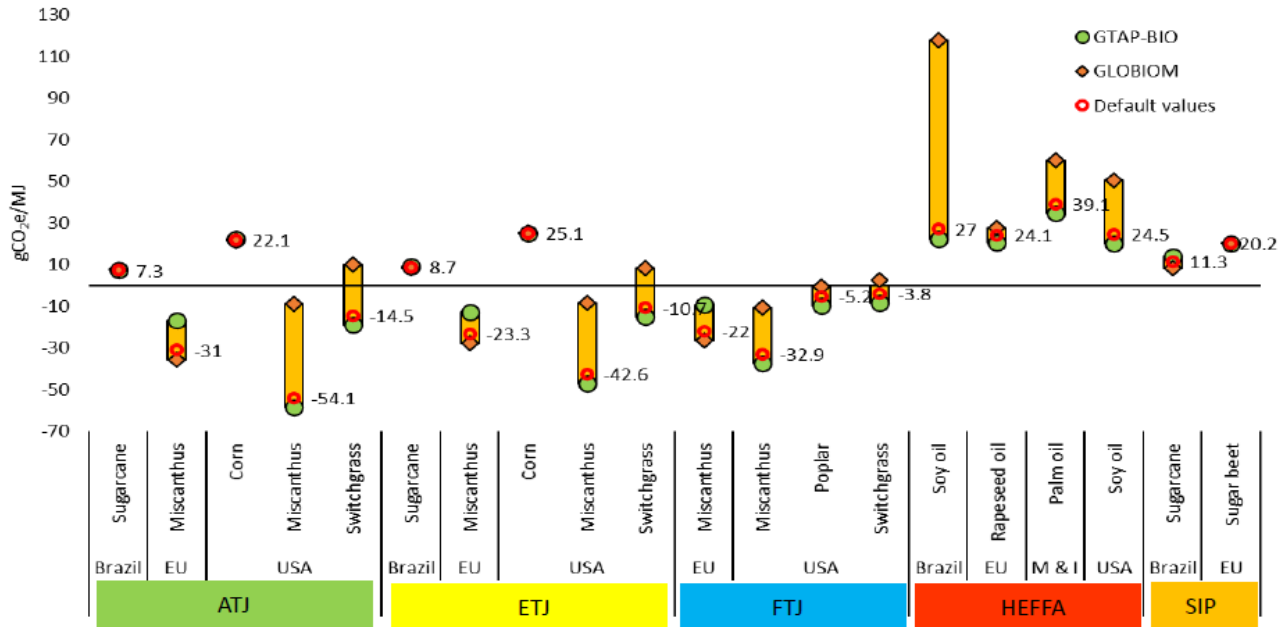


Biorefinery-Level GHG Emissions



Differences Between Models

Estimated ILUC values for SAF pathways in CAPE11



Work in progress on ILUC

- Pathways using dedicated energy crops based on ETJ technologies,
- Pathways using second oil crops: carinata, camelina, pennycress, jatropha,
- Estimating global ILUC values for unexamined regions,
- A major model improvement is in progress to update the GTAP-BIO data base and assess ILUC values for more disaggregated geographical regions.

Source: Farzad Taheripour, Purdue University, presentation at ASCENT Conference, April 27, 2021

Life-Cycle Analysis Key Issues for DOE/BETO

Land use and harmonization:

- Should the differences between models due to induced land use change and allocation methodology remain or be reconciled?
- Should an attempt be made to harmonize results (EPA, CARB, CORSIA)?
- How should countries be encouraged to adopt best land management practices?

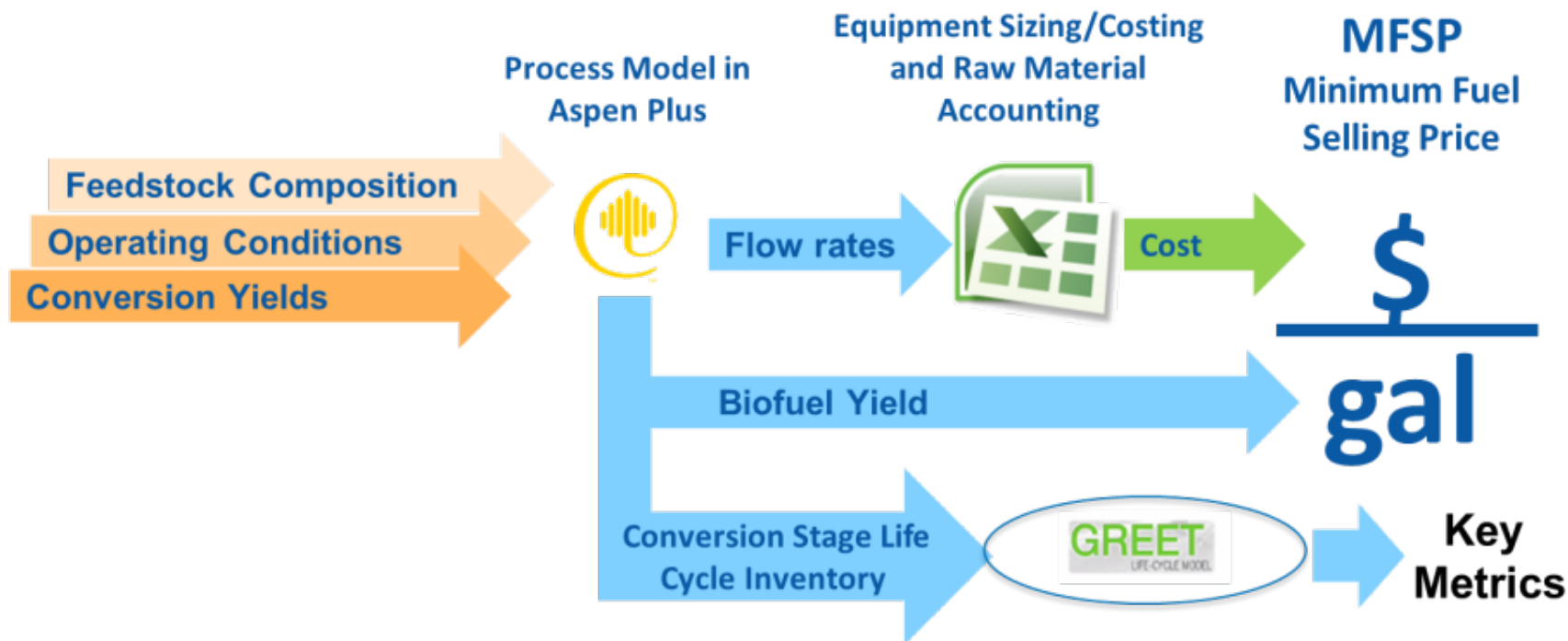
Data issues:

- Should data for LCA be updated periodically to reflect temporal improvements? Should data have enough regional fidelity to reflect regional variations?
- How can more data be provided? Satellite imagery analysis, LIDAR, other tools to globally map real-time land management practices.
- How can the quantification of cause-and-effect relationships be improved?

Co-product methodologies:

- How should co-products be treated in biorefineries?

Techno-Economic Analysis



- Modeling is rigorous and detailed with **transparent assumptions**.
- Baseline assumes n^{th} -plant equipment costs.
- Perform **pioneer plant** evaluations to understand the near-term cost of jet fuel production pathways.
- Quantify the underlying uncertainties through **sensitivity analysis**.
- Prioritize TEAs based on programmatic requests and data availability.

DOE BETO Biofuels TEA Database

MOTIVATION: Support transparency of and ease of access to DOE BETO supported public techno-economic analysis data.

GOAL: Develop and publicly release a biofuels cost data base that summarizes key inputs utilized in conversion TEAs.

APPROACH:

- Currently contains over 40 DOE BETO funded conversion TEA studies, including design reports and publications.
- Reviewed by lead analysts to ensure consistency as well as modify format per suggestions (NREL/PNNL).
- Available for download on the Biomass KDF:
<https://bioenergykdf.net/content/beto-biofuels-tea-database>
- Will be updated yearly with new BETO funded TEAs.