DOE Bioenergy Technologies Office (BETO) 2021 Project Peer Review

1.1.1.3 Supply Scenario Analysis

3/11/2021

Feedstock Technologies Program

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Oak Ridge National Laboratory

This presentation does not contain any proprietary, confidential, or otherwise restricted information

Project Overview

- *Bioeconomy growth depends on biomass quantities, costs, quality, environmental effects, etc.*
- *Goal: Provide BETO and bioeconomy stakeholders with biomass feedstock quantity and cost information.*
  - *Support other BETO projects with biomass feedstock supply data (quantities, type, cost, spatial distribution, current and future potential).*
  - *Important where future supply/price is uncertain (e.g. energy crops, forestland resources)*
  - *Risk: Erroneous feedstock assumptions → Suboptimal R&D $*

1 – Management

Team is aware of tasks, milestones, budget; Team develops approach and executes

- *Work plan is developed and coordinated with DOE and collaborators (INL, Software Engineering Group, University of Tennessee).*
- *Maggie Davis: supply modeling; Nicole Samu: logistics modeling; Steven Hahn, William Godoy, Addi Thakur, Donnie Earnest, Jenna Delozier: Programming*
- *Bi-weekly calls with BETO technology manager and team.*
- *Coordination with 1.1.1.2 Feedstock Supply Chain Analysis, 4.2.1.20 Integrated Landscape Management.*
- *Risks:*
  - *Erroneous resource supply/cost data can misinform other platforms; Mitigate with peer reviews.*
  - *Increased precision or resolution without increased accuracy; Mitigate with uncertainty analyses.*
  - *Over-apply HPC resources; Mitigate with cognizance and course correction*

2 – Approach

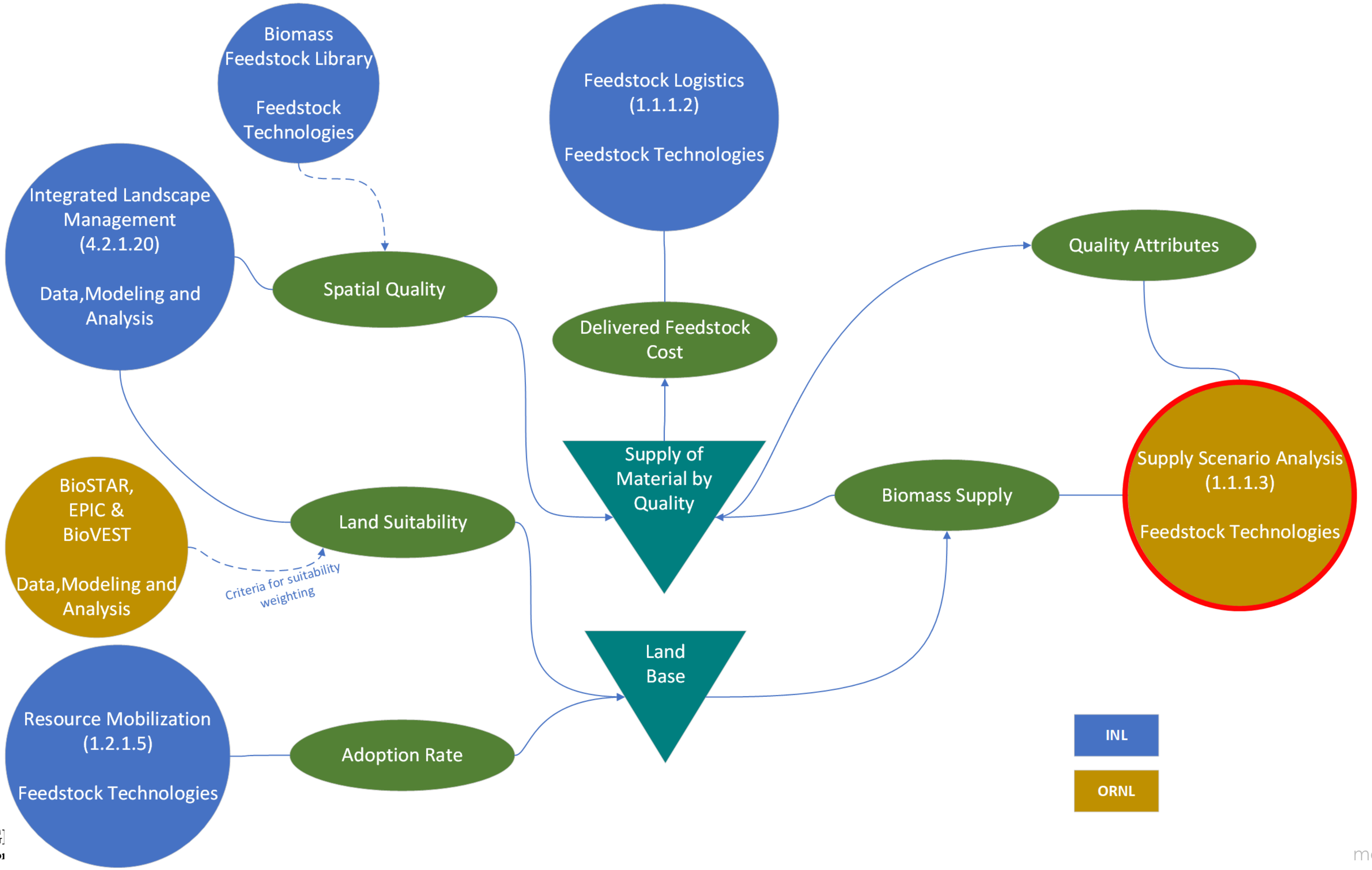
1) Maintain county-level supply modeling (e.g. Billion-ton Report).

- *Ag residues and energy crops: Policy Analysis System, a partial equilibrium economic model.*
- *Forestland resources: Forest Sustainable and Economic Analysis Model.*
- *Wastes: EPA, USDA NASS, USDA ERS, USDA FS*

2) Future work: Build subcounty modeling.

- *Field-level impacts (yield, operational costs, environmental effects) not captured in county-level modeling.*
- *Collaborate with INL to quantify field agronomic, operational, and environmental suitability criteria*
- *Build high-performance computing (HPC) stochastic capabilities to account for subcounty probability distribution of attributes*
- *Explore HPC capability to solve at millions of fields rather than 3,100 counties.*

2 – Approach

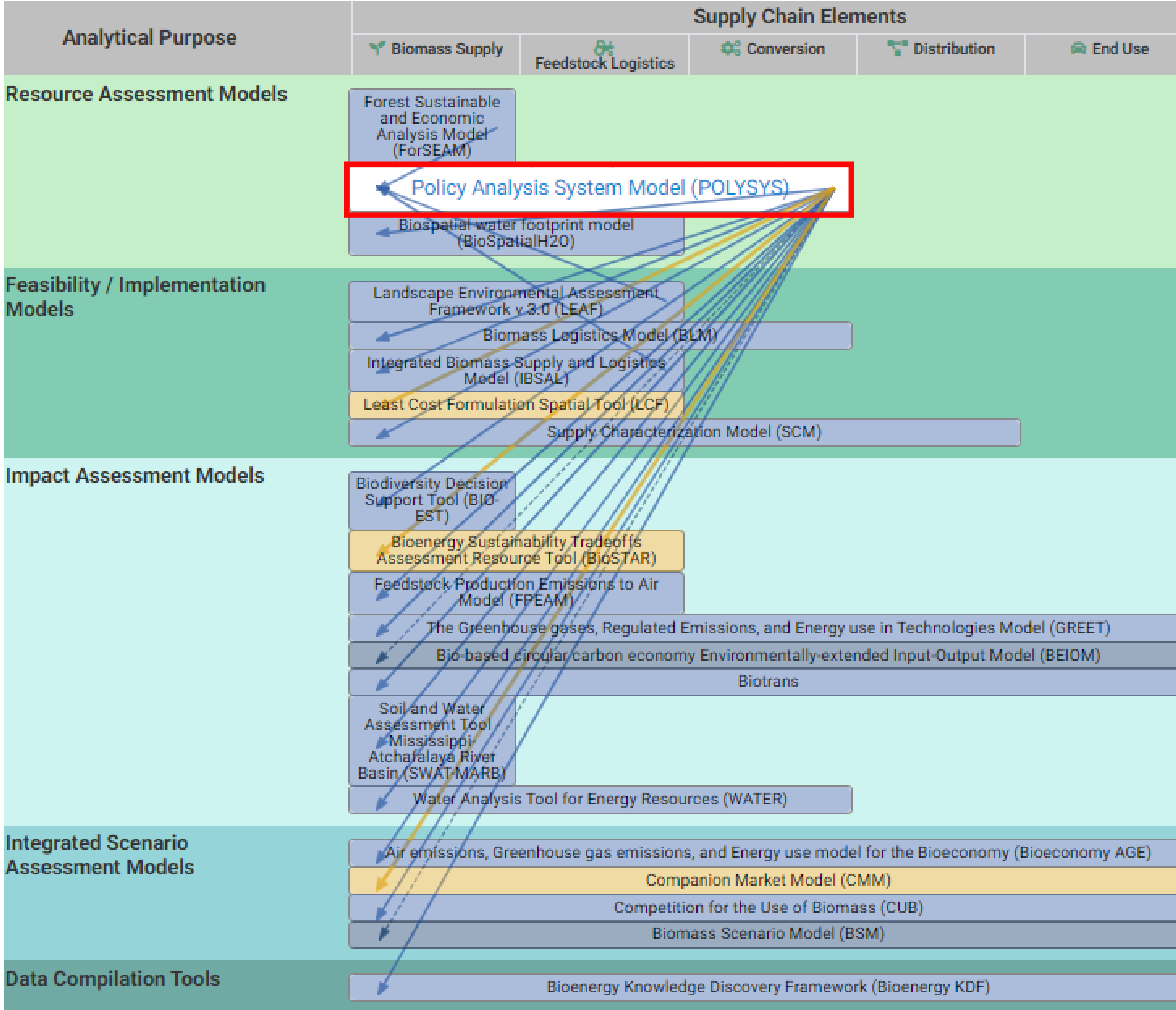


Biomass Feedstock Library
Feedstock Technologies
Feedstock Logistics (1.1.1.2)
Feedstock Technologies
Integrated Landscape Management (4.2.1.20)
Data,Modeling and Analysis
Spatial Quality
Delivered Feedstock Cost
Quality Attributes
Supply of Material by Quality
Biomass Supply
Supply Scenario Analysis (1.1.1.3)
Feedstock Technologies
BioSTAR, EPIC & BioVEST
Data,Modeling and Analysis
Land Suitability
Criteria for suitability weighting
Land Base
Resource Mobilization (1.2.1.5)
Feedstock Technologies
Adoption Rate
INL
ORNL

3 – Impact

Feedstock data used by other projects, platforms, and stakeholders, e.g.:

- *INL woody and herbaceous State of Technology Reports.*
- *Biomass Scenario Model and others.*
- *Data available at bioenergykdf.net since last peer review:*
  - *+12k views*
  - *+9k data downloads*
  - *5 of top 10 pages on KDF*



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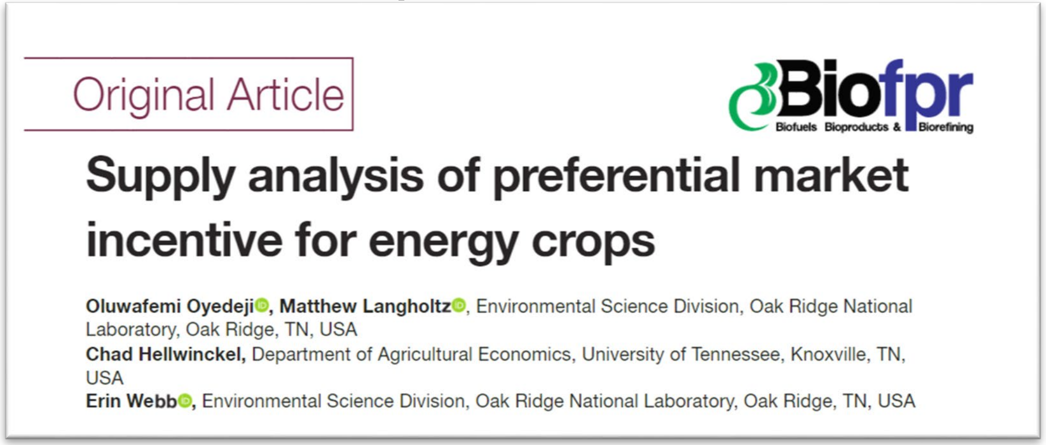
4 – Progress and Outcomes

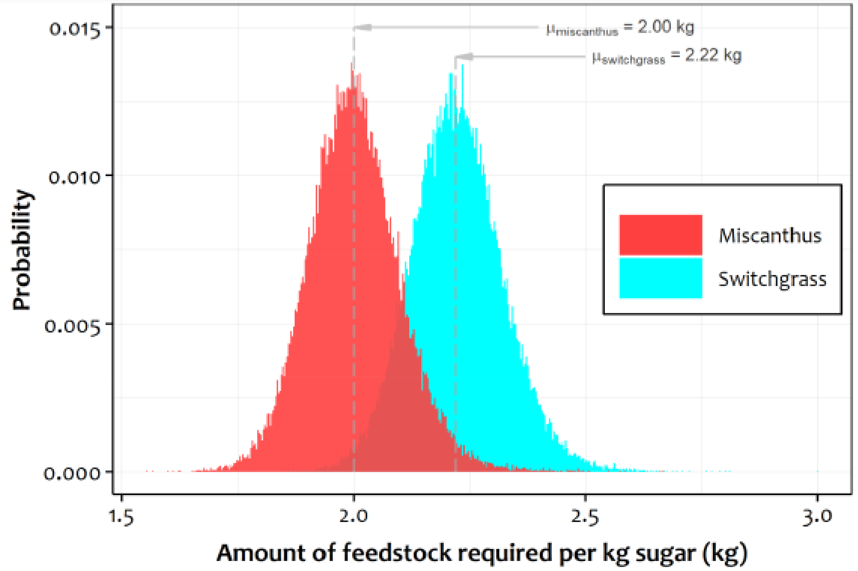
Price premiums for feedstock quality can increase supply of desirable feedstocks by ~10%.

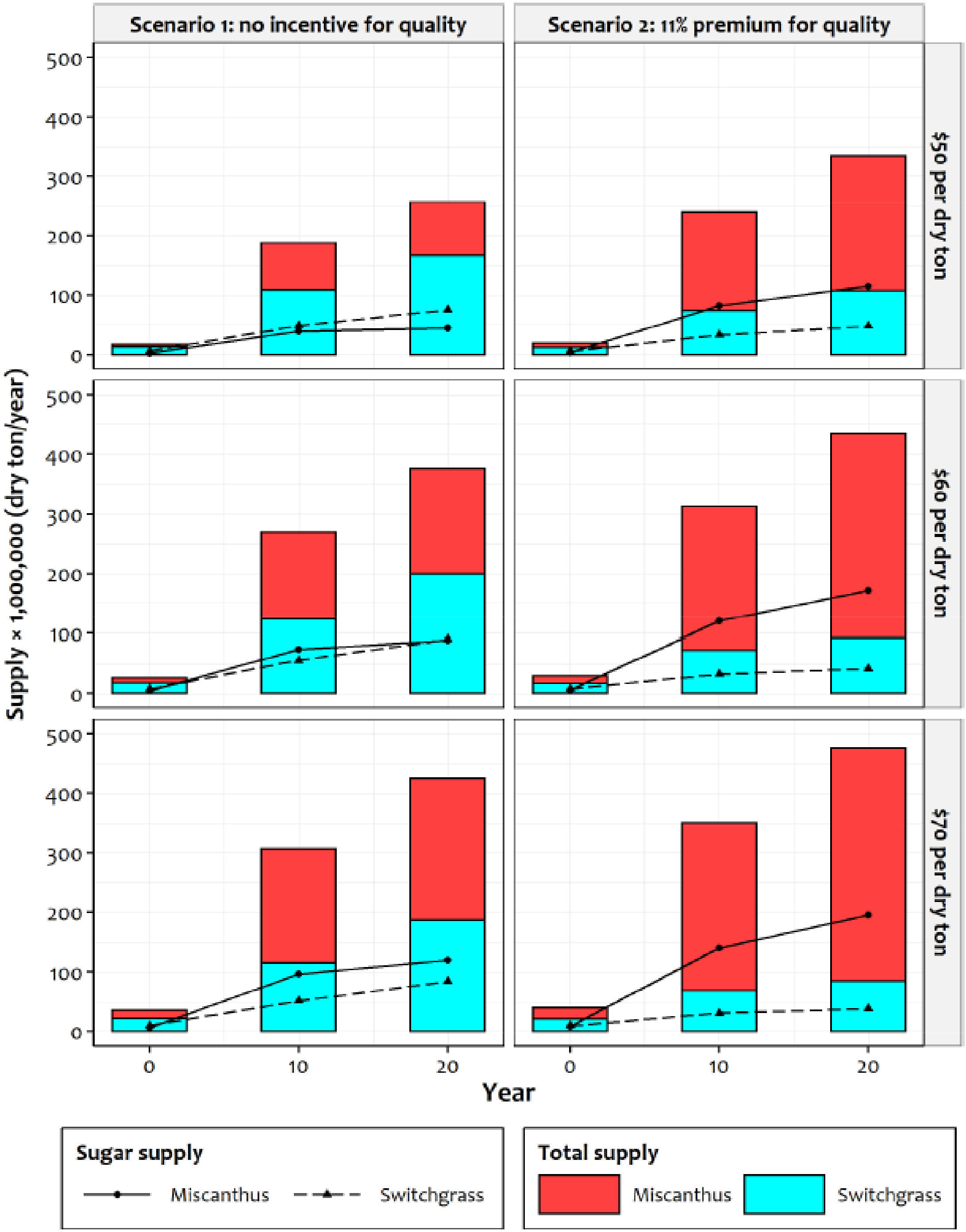

Original Article

Biofpr Biofuels Bioproducts & Biorefining

Supply analysis of preferential market incentive for energy crops

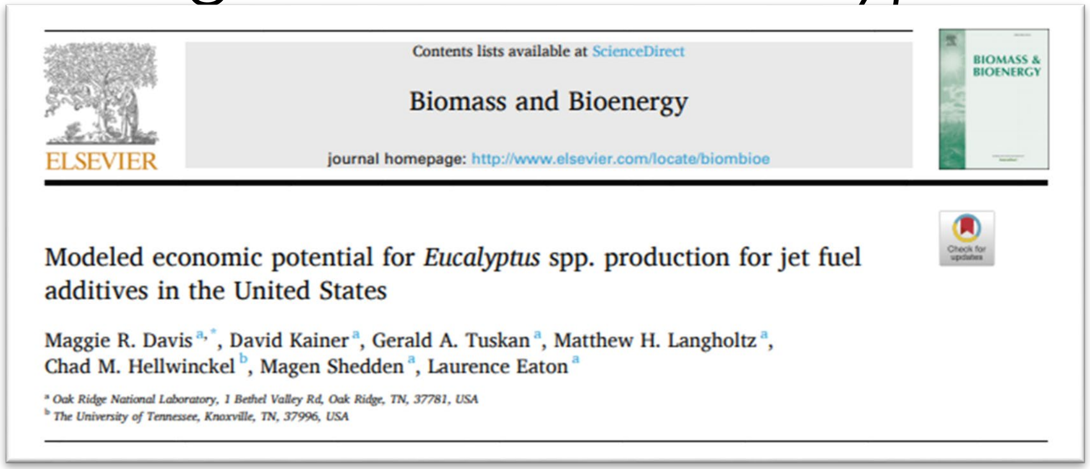
Oluwafemi Oyedeji, Matthew Langholtz, Environmental Science Division, Oak Ridge National Laboratory, Oak Ridge, TN, USA
Chad Hellwinckel, Department of Agricultural Economics, University of Tennessee, Knoxville, TN, USA
Erin Webb, Environmental Science Division, Oak Ridge National Laboratory, Oak Ridge, TN, USA





4 – Progress and Outcomes

Demand for aviation fuels could generate over 51 million L yr^{-1} of JP-10, 75 million L yr^{-1} of Jet A, and 77 million L yr^{-1} of gasoline from eucalypts.



Contents lists available at ScienceDirect

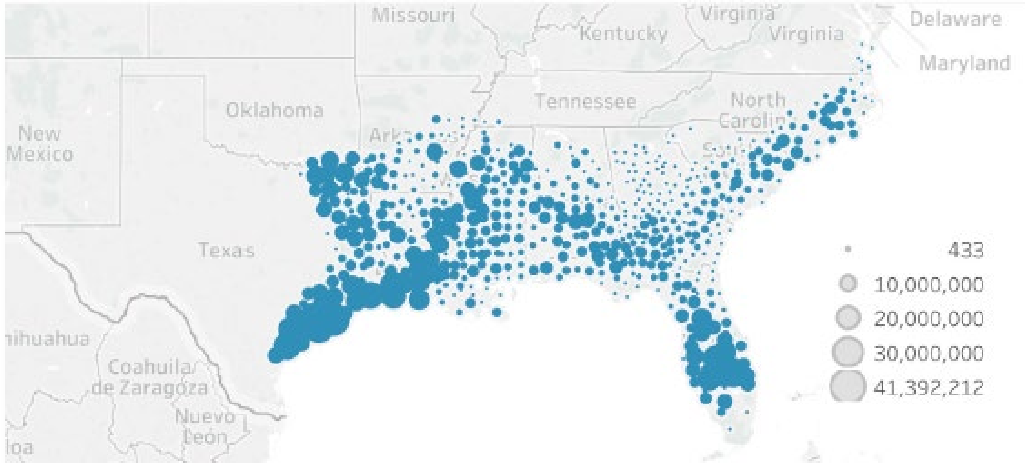
Biomass and Bioenergy

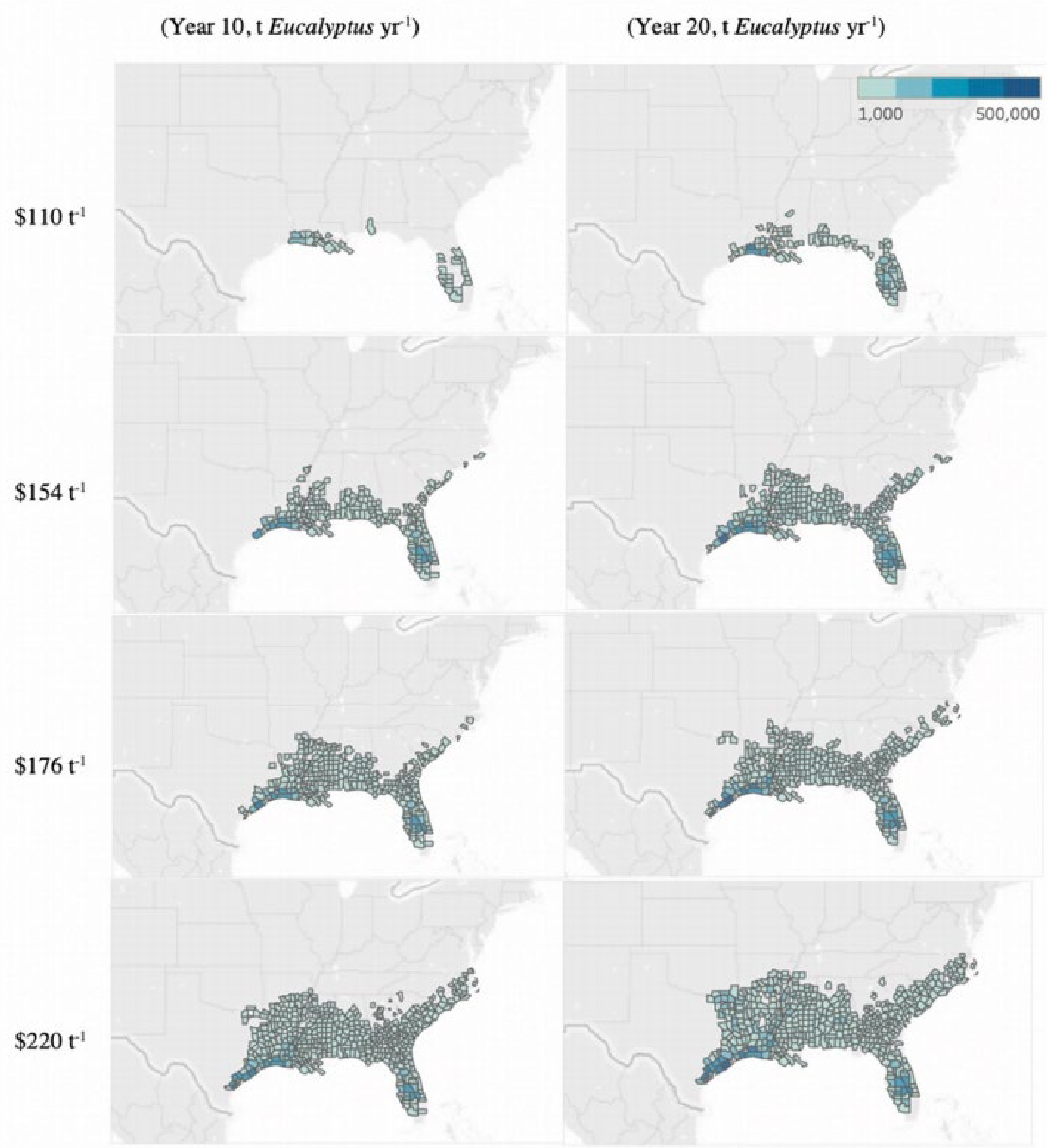
journal homepage: http://www.elsevier.com/locate/biombioe

Modeled economic potential for *Eucalyptus* spp. production for jet fuel additives in the United States

Maggie R. Davis[a,*], David Kainer[a], Gerald A. Tuskan[a], Matthew H. Langholtz[a], Chad M. Hellwinckel[b], Magen Shedden[a], Laurence Eaton[a]

[a] Oak Ridge National Laboratory, 1 Bethel Valley Rd, Oak Ridge, TN, 37781, USA
[b] The University of Tennessee, Knoxville, TN, 37996, USA





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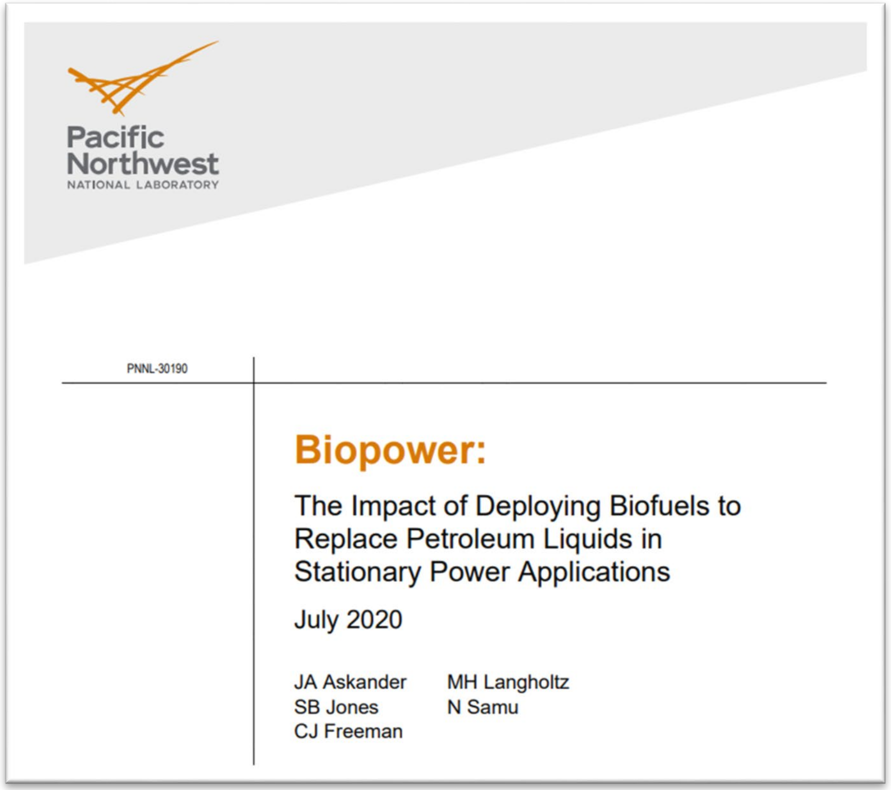
4 – Progress and Outcomes

A 90% reduction in facility capacity needed to reduce feedstock costs by ~$10-$20/tonne for biopower.



Pacific Northwest NATIONAL LABORATORY

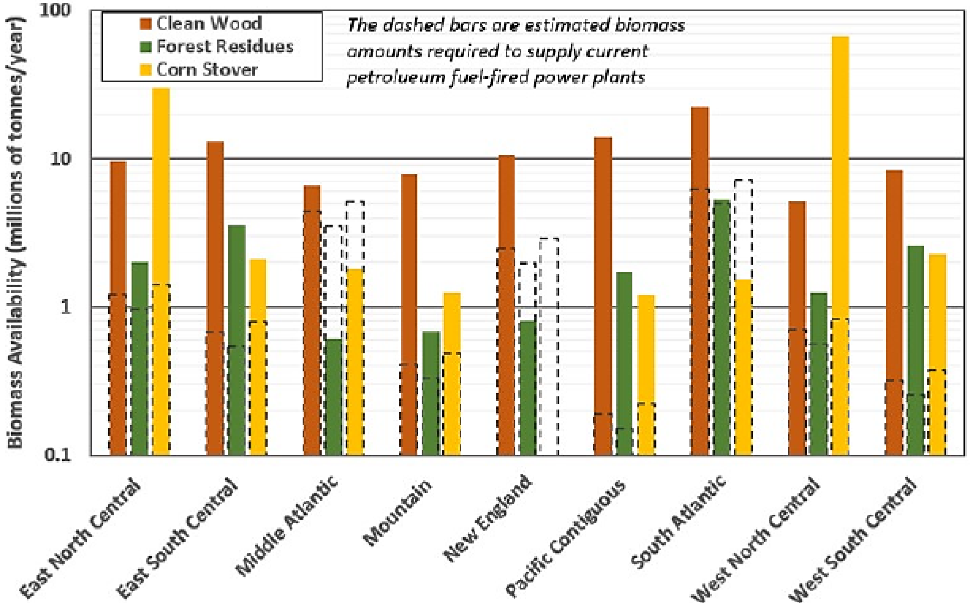
PNNL-30190

Biopower:

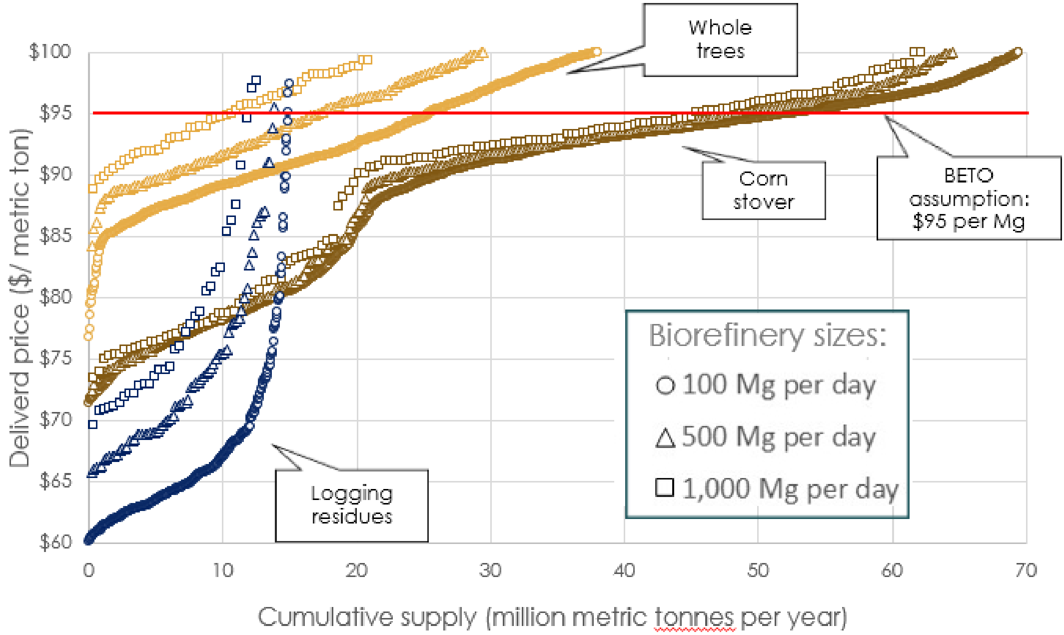
The Impact of Deploying Biofuels to Replace Petroleum Liquids in Stationary Power Applications

July 2020

JA Askander
SB Jones
CJ Freeman
MH Langholtz
N Samu

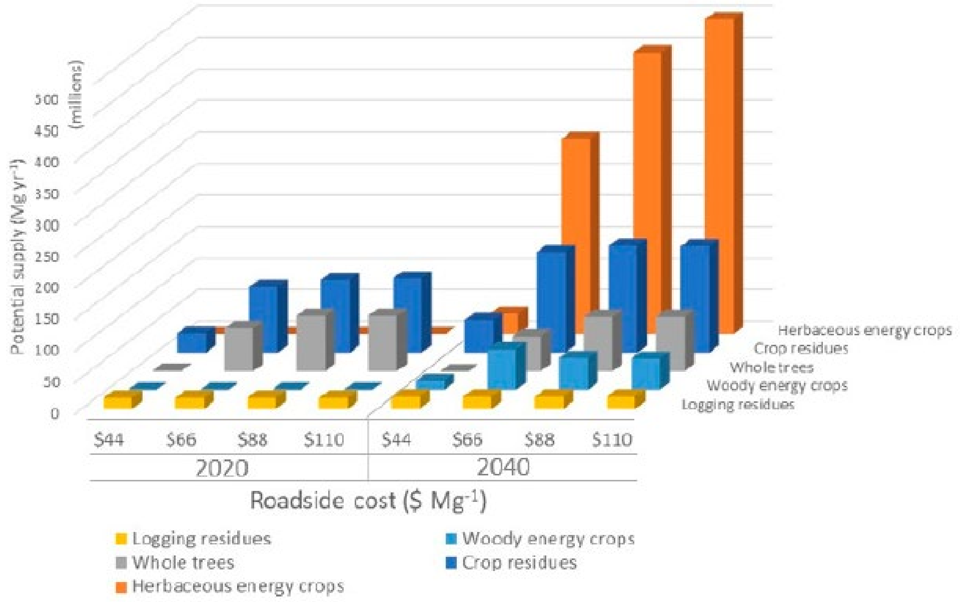


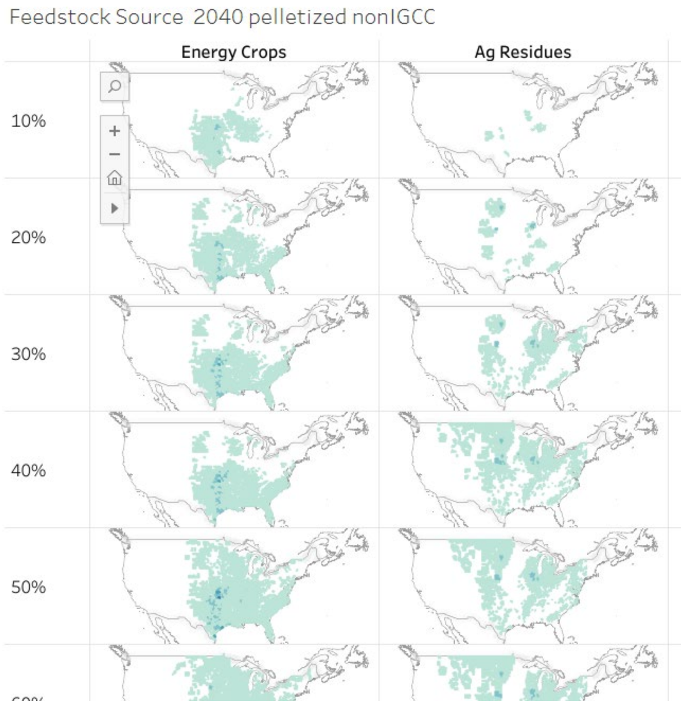
Biomass Availability for U.S. Census Divisions, along with Required Amounts for Each Respective Region's Petroleum Fuel-Fired Power Plants (dashed bars).

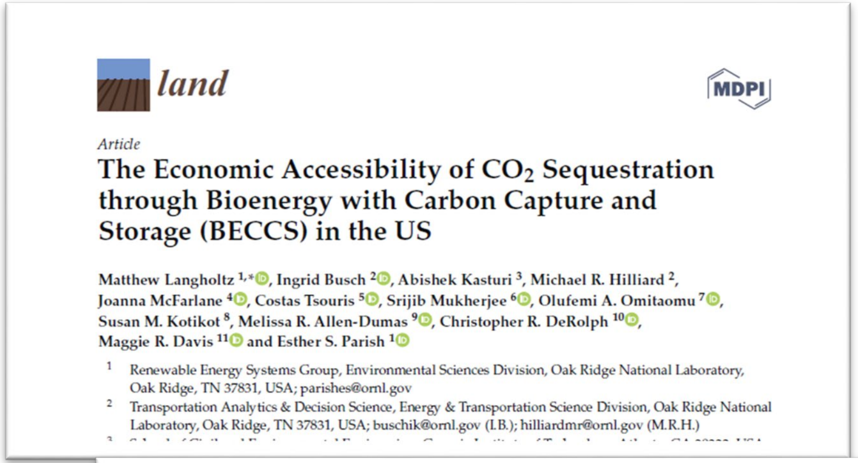


4 – Progress and Outcomes

~700 million tonnes CO_2 can be sequestered annually at scenario-average costs ranging from \$42 to \$92 per tonne CO_2 based on energy crops and agricultural residues.






land
MDPI

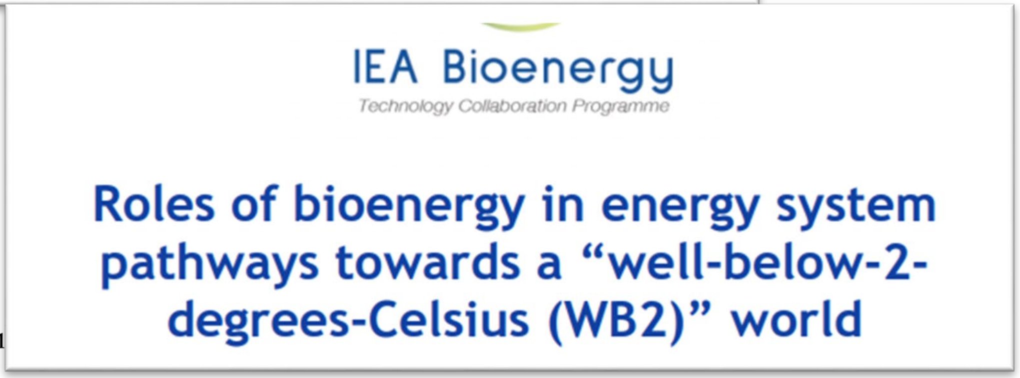
Article

The Economic Accessibility of CO_2 Sequestration through Bioenergy with Carbon Capture and Storage (BECCS) in the US

Matthew Langholtz [1,*], Ingrid Busch [2], Abishek Kasturi [3], Michael R. Hilliard [2], Joanna McFarlane [4], Costas Tsouris [5], Srijib Mukherjee [6], Olufemi A. Omitaomu [7], Susan M. Kotikot [8], Melissa R. Allen-Dumas [9], Christopher R. DeRolph [10], Maggie R. Davis [11] and Esther S. Parish [1]

1 Renewable Energy Systems Group, Environmental Sciences Division, Oak Ridge National Laboratory, Oak Ridge, TN 37831, USA; parishes@ornl.gov

2 Transportation Analytics & Decision Science, Energy & Transportation Science Division, Oak Ridge National Laboratory, Oak Ridge, TN 37831, USA; buschik@ornl.gov (I.B.); hilliardmr@ornl.gov (M.R.H.)

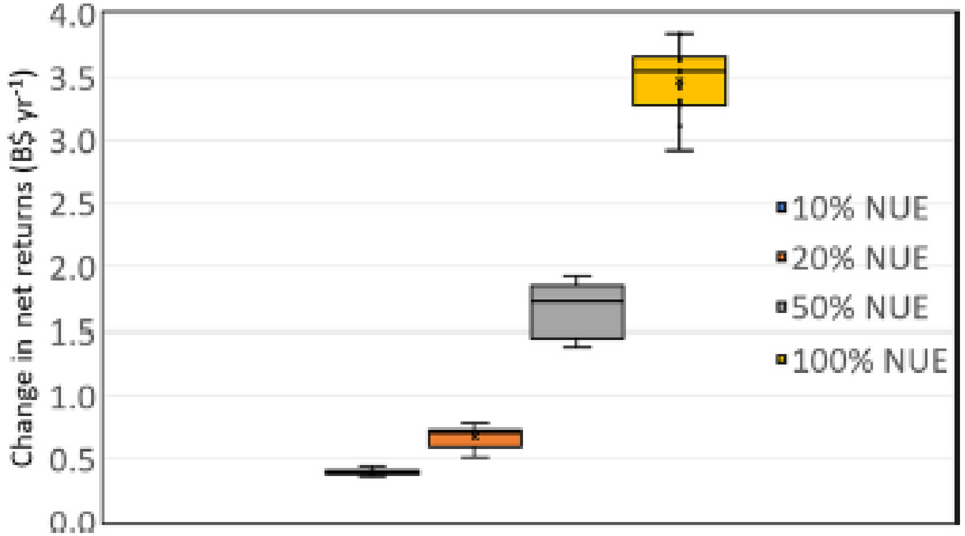

IEA Bioenergy

Technology Collaboration Programme

Roles of bioenergy in energy system pathways towards a "well-below-2-degrees-Celsius (WB2)" world

4 – Progress and Outcomes

Increasing nitrogen use efficiency (NUE) in the U.S. by 20% can save $743 M yr^{-1} and reduce N loadings in freshwaters by 5.7% in a case study.



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Science of the Total Environment xxx (xxxx) xxx

Contents lists available at ScienceDirect

Science of the Total Environment

journal homepage: www.elsevier.com/locate/scitotenv

ELSEVIER

Increased nitrogen use efficiency in crop production can provide economic and environmental benefits

Matthew Langholtz*, Brian H. Davison, Henriette I. Jager, Laurence Eaton, Latha M. Baskaran[1], Maggie Davis, Craig C. Brandt

Environmental Sciences Division, Oak Ridge National Laboratory, Oak Ridge, TN, USA

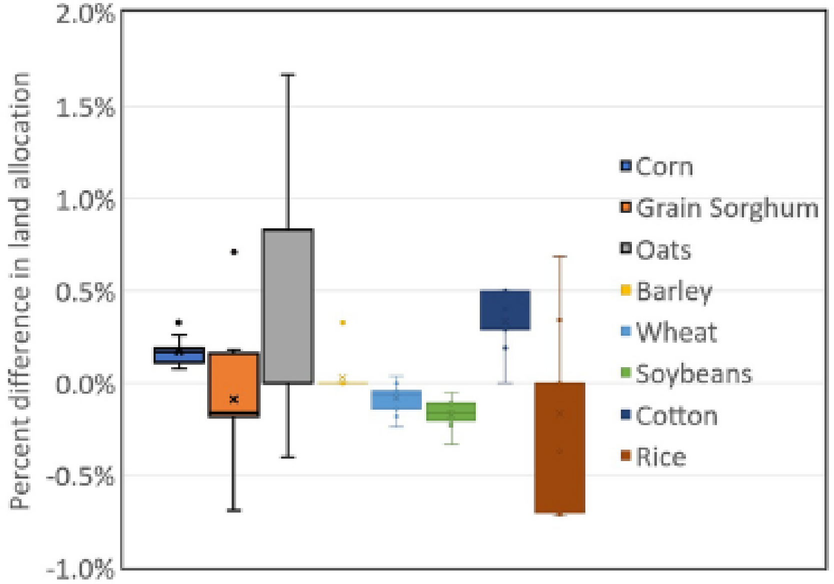
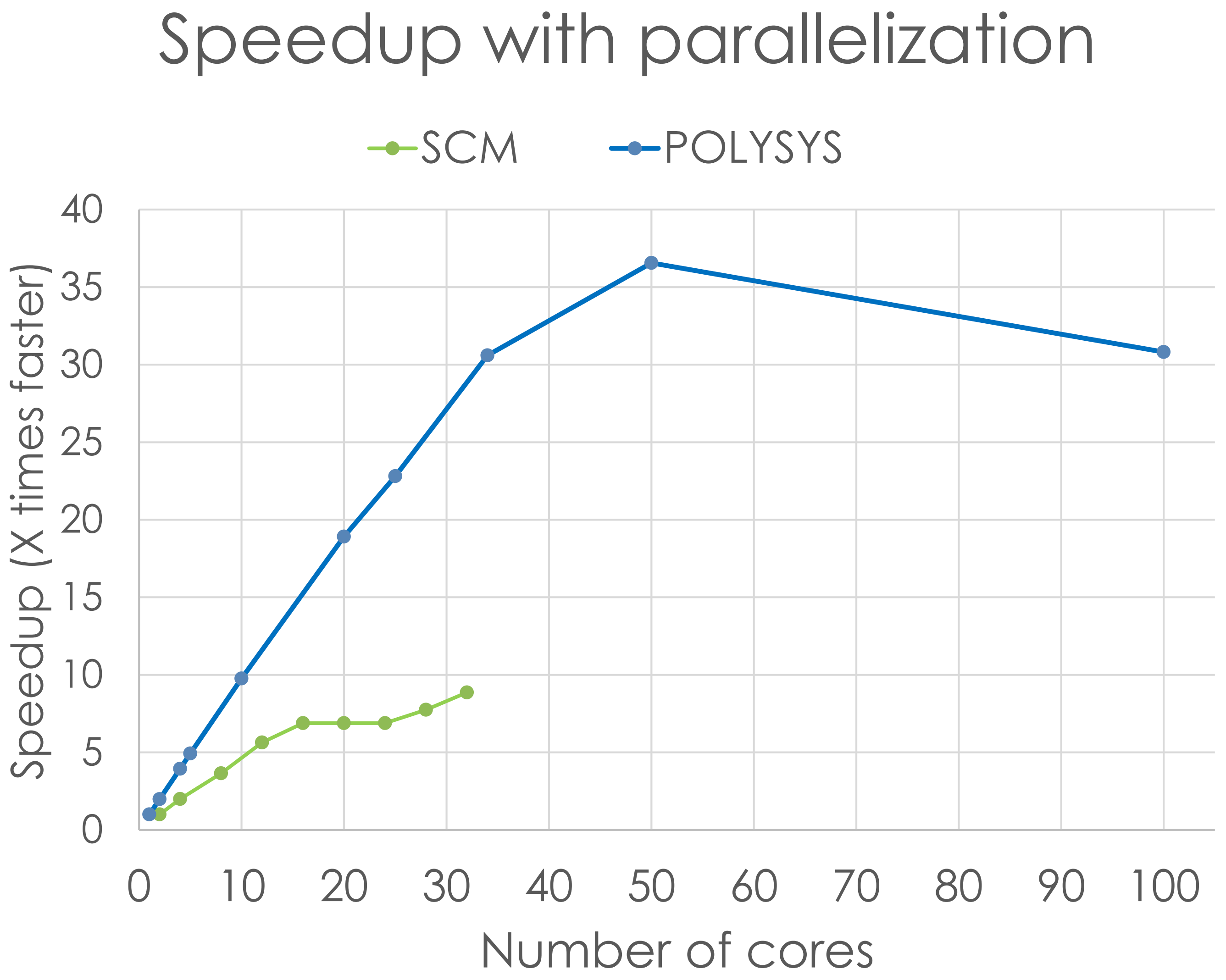


Fig. 5. Percent difference in land allocation of commodity crop in 20% NUE scenario relative to baseline for simulation years 2016–2026.

4 – Progress and Outcomes

Parallelization benefits:

- Supply Characterization Model speedup 9x, reduced runtime from ~100 days to ~10 hrs.
- Policy Analysis System runtime reduced from ~10 hours to ~15 minutes (20-year stochastic simulation).
- Next: Ridge EERE computational resources, graphical processing units.



Summary

- Overview: Supply Analysis to provide robust feedstock supply information.
- Approach: Using economic and logistics simulation models and data visualization.
- Technical accomplishments: Provided data for SOTs, MYP targets, data requests for other FT and A&S projects.
- Relevance: Bioeconomy dependent upon biomass supply.
- Future work:
  - Supply analytics.
  - Coordinate with INL on Integrated Landscape Management, “nth” plan) modeling assumptions.

Quad Chart Overview

Timeline
- Project start date: 10/1/2020
- Project end date: 9/30/2023

	FY20	Active Project
DOE Funding	$625k	$1,125K

Project Partners*
- INL
- Agricultural Policy Analysis Center, U of Tennessee

Barriers addressed
Ft-A. Feedstock Availability and Cost

At-C. Data Availability across the Supply Chain

Project Goal
Provide objective feedstock supply & cost data to other projects and platforms.

End of Project Milestone
Provide BETO and bioeconomy stakeholders with scenario-specific biomass feedstock quantity and cost information.

Funding Mechanism
Annual Operating Plan.

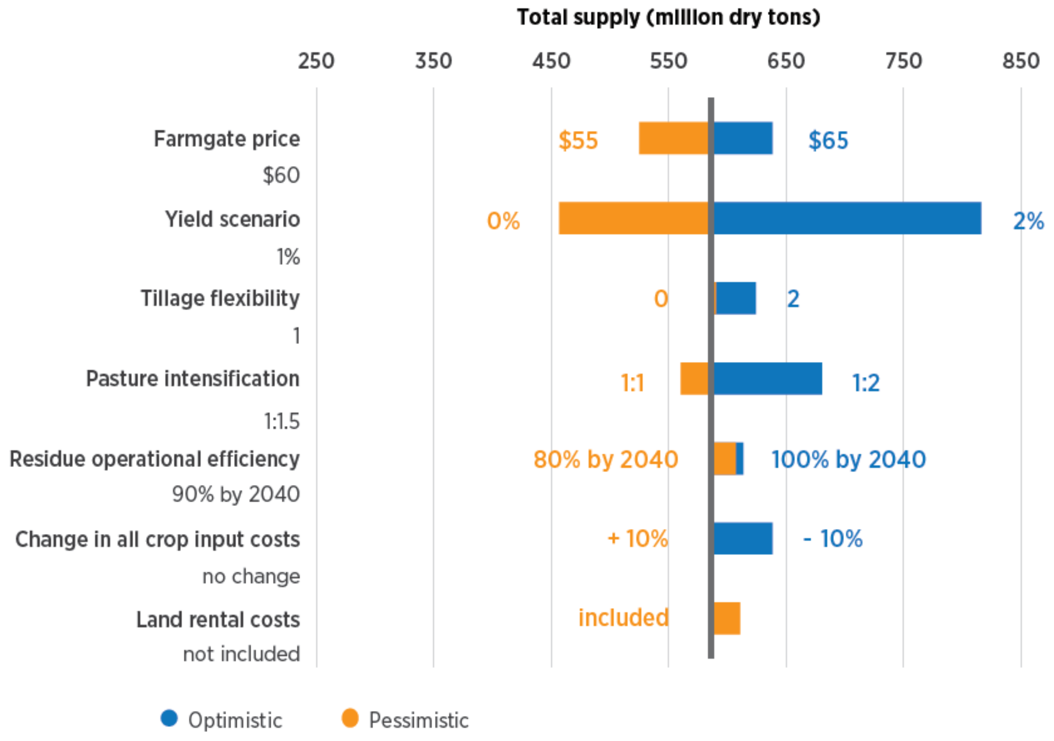
*Only fill out if applicable.

Additional Slides

Responses to Previous Reviewers' Comments

- "…I am always suspect of the assumptions behind the conclusions reached in the study about the price of the commodities in question…"
  - We acknowledge that prices are impossible to predict because they will vary with future macroeconomic conditions and technical innovations.
  - Our methods and results are peer reviewed but we recognize variability with our sensitivity analyses and hope our ongoing work in stochastic simulations will elucidate impacts of uncertainties.

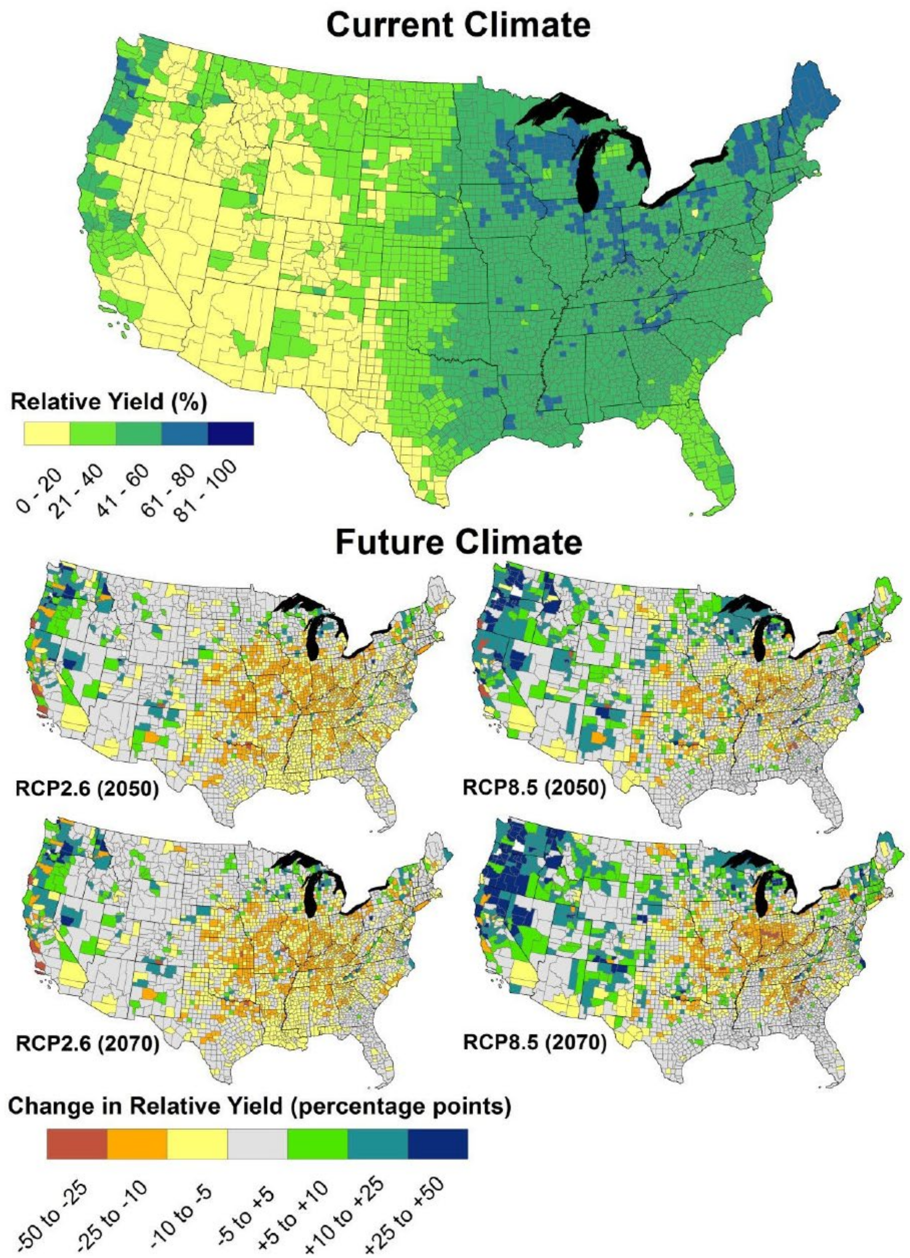
Sensitivity to key variables, base-case (1%), 2040



Responses to Previous Reviewers' Comments

- "…Some factors to consider including in future work might be municipal readiness (i.e., road access)… as well as gradual impact of climate change…"
  - We have included road infrastructure in our delivered feedstock analysis and agree that local attributes should be considered where site-specific simulations are needed.
  - We agree that climate change will affect future yields. The climate change analysis in the Billion-ton Report suggests that geographic distributions of energy crops are likely to migrate north and west.

Relative yields of Miscanthus



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Responses to Previous Reviewers' Comments

Go/No-Go Reviews:

- FY19: Proof of principle of quantification of switchgrass from agricultural lands in the continental U.S. based on 50-m raster analysis.
  - Downscaling corroborates national potential of integrated landscape management: Of 30 million acres allocated within 602 million acres of agricultural land for switchgrass production, 23%, 65%, and 92%, of the switchgrass-producing acres are allocated to lands with NCCPI values less than 0.2, 0.4, and 0.6, respectively.
- FY20: Ensure that feedstock supply assumptions in 1.1.1.3 are harmonized with other FSL projects.
  - Operational assumptions were harmonized with INL project 1.1.1.2 and have been submitted for publication.

Publications, Patents, Presentations, Awards, and Commercialization

- Oyedeji O, Langholtz M, Hellwinckel C, Webb E. 2021. "Supply analysis of preferential market incentive for energy crops." Biofuels, Bioproducts and Biorefining. doi: 10.1002/bbb.2184.
- Langholtz M, Davison BH, Jager HI, Eaton L, Baskaran LM, Davis M, et al. 2021. "Increased nitrogen use efficiency in crop production can provide economic and environmental benefits." Sci Total Environ 758:143602. doi: 10.1016/j.scitotenv.2020.143602.
- Davis MR, Kainer D, Tuskan GA, Langholtz MH, Hellwinckel CM, Shedden M, et al. 2020. "Modeled economic potential for Eucalyptus spp. production for jet fuel additives in the United States." Biomass and Bioenergy 143. doi: 10.1016/j.biombioe.2020.105807.
- Langholtz M, Hartley D, Samu N, Jones D, Brandt C, Davis M, Hilliard M, Hellwinckel C, Webb E, Daly C, Halbleib M, 2020. Nth plant vs. Nth supply: Feedstock costs and supply uncertainty as function of number of biorefineries, 2020 AIChE Annual Meeting, November 19th 2020.
- Askander J, Susanne J, Freeman C, Langholtz M, Samu N, 2020. Biopower: The Impact of Deploying Biofuels to Replace Petroleum Liquids in Stationary Power Applications. PNNL-30190.
- Efroymson R, Langholtz M, Jager Y, Hilliard M. 2019. Environmental supply curves highlight relationship between environmental indicators, cost, and biomass for energy in national-scale assessment. AIChE Bioenergy Sustainability Conference, Nashville, TN, October 21-22, 2019.