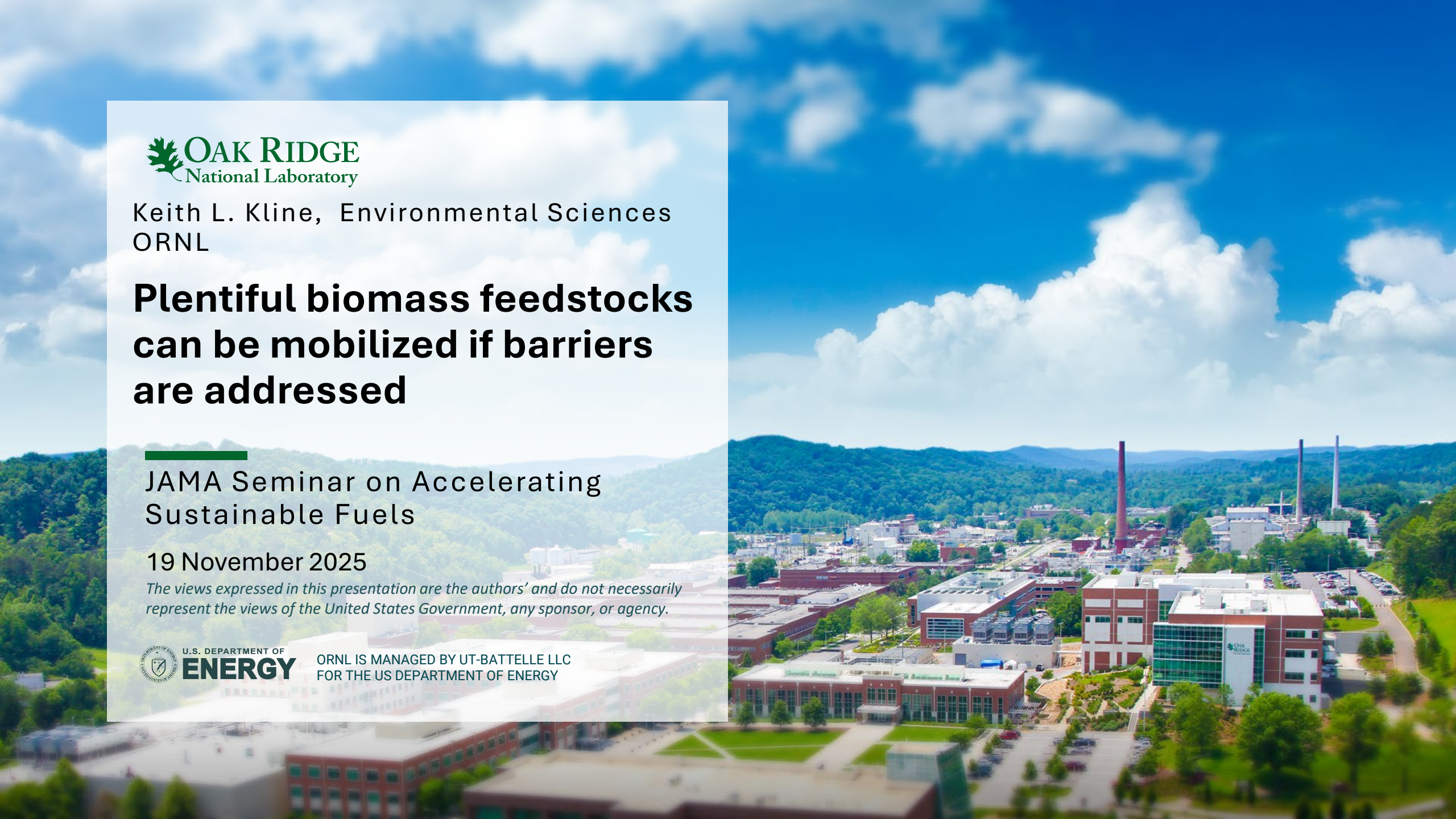

OAK RIDGE National Laboratory

Keith L. Kline, Environmental Sciences
ORNL

Plentiful biomass feedstocks can be mobilized if barriers are addressed

JAMA Seminar on Accelerating Sustainable Fuels

19 November 2025

The views expressed in this presentation are the authors' and do not necessarily represent the views of the United States Government, any sponsor, or agency.

U.S. DEPARTMENT OF ENERGY

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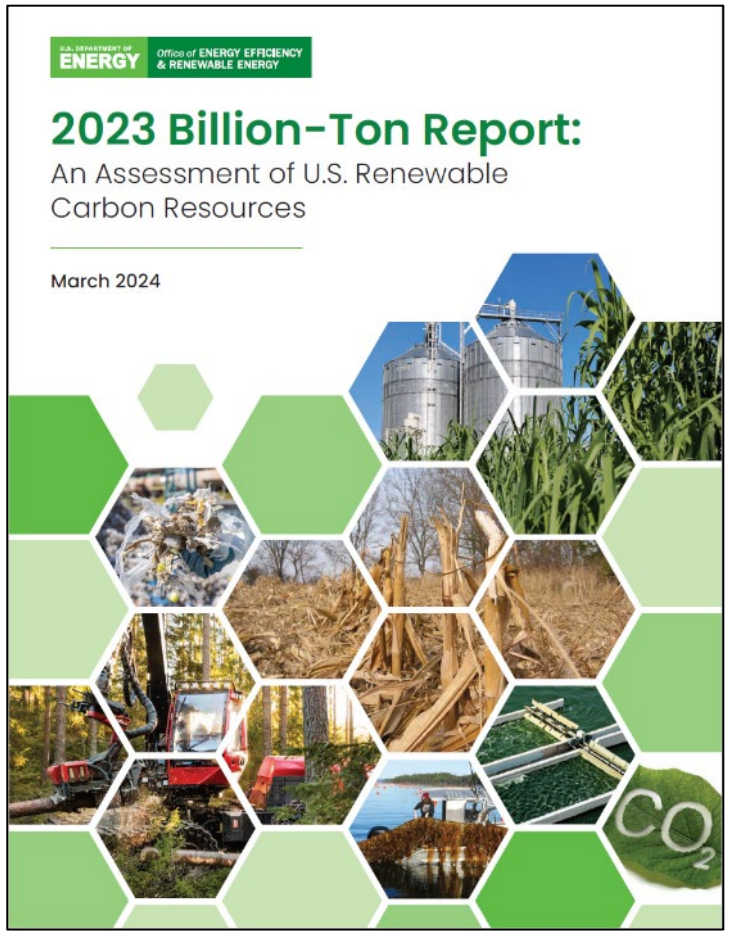
Plentiful biomass feedstocks are well-documented.

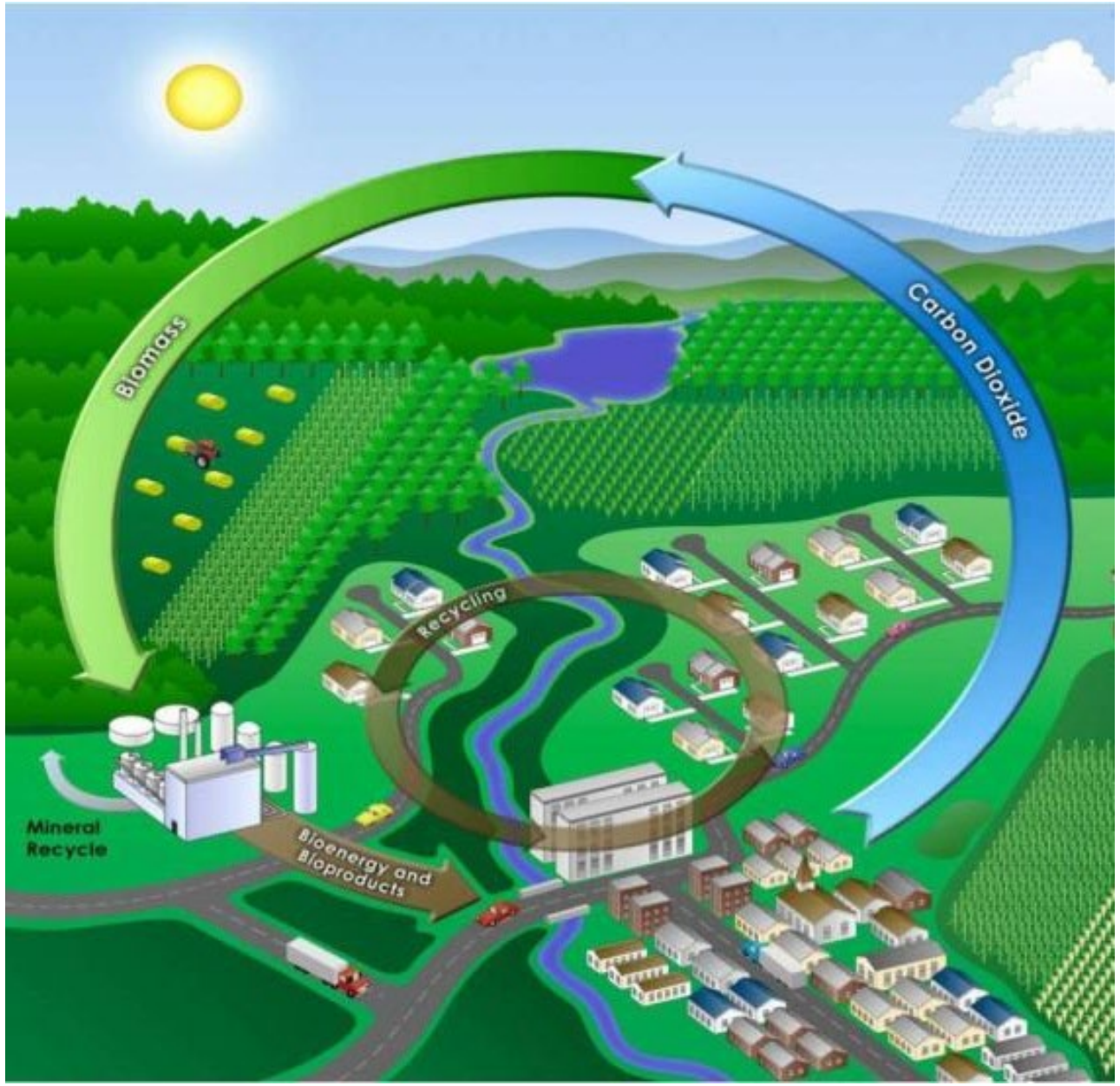
IEA Bioenergy Task 43 and CEM Biofuture *International Biomass Resource Assessment – data portal & reports*

biofuture platform
Kickstarting a global, advanced bioeconomy
AN INITIATIVE OF THE CLEAN ENERGY MINISTERIAL

IEA Bioenergy
Technology Collaboration Programme



QR code or link to data and reports: https://bioenergykdf.ornl.gov/document/international-feedstock-reporting
For EU, see DG RTD Study on biomass for biofuels
Jacobson et al. 2024 Synthesis of International Biomass Supply Assessments. https://doi.org/10.2172/2573572
IEA Renewables 2025 https://www.iea.org/reports/renewables-2025

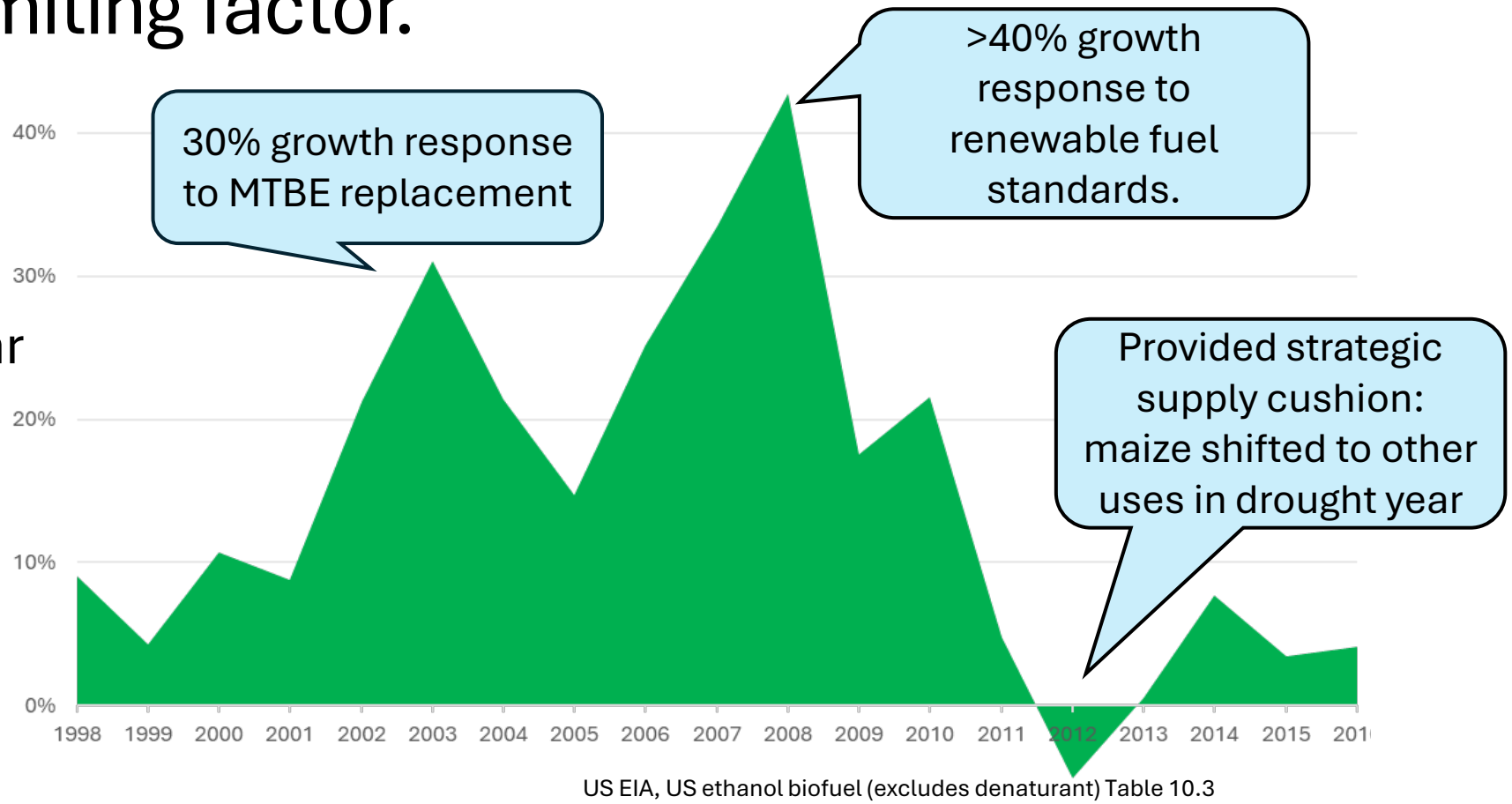


To unlock potentials, we need stable incentives for investments in efficient supply chain mobilization and management.

- *IEA Bioenergy 30.10.2025 webinar: https://www.youtube.com/watch?v=qTa89PGQsMU*
- IEA 2025 *Delivering Sustainable Fuels*
- Jacobson & Kline (2025) Addressing Investment Barriers… https://doi.org/10.2172/2574462
- Kline et al. 2017, Bioenergy & Food Security GCB-Bioenergy 9(3):557-576
- Souza et al. 2023 (T39) Biofuels in Emerging Markets; SCOPE 72 (Souza et al. eds.) Bioenergy & Sustainability http://bioenfapesp.org/scopebioenergy/index.php
- Figure from: Dale et al. (2016) Incorporating bioenergy into sustainable landscape designs. Renew. & Sust. Energy Reviews

Experience shows that when demand signals & rules are clear, investments & production grow to meet targets. Land is not the limiting factor.

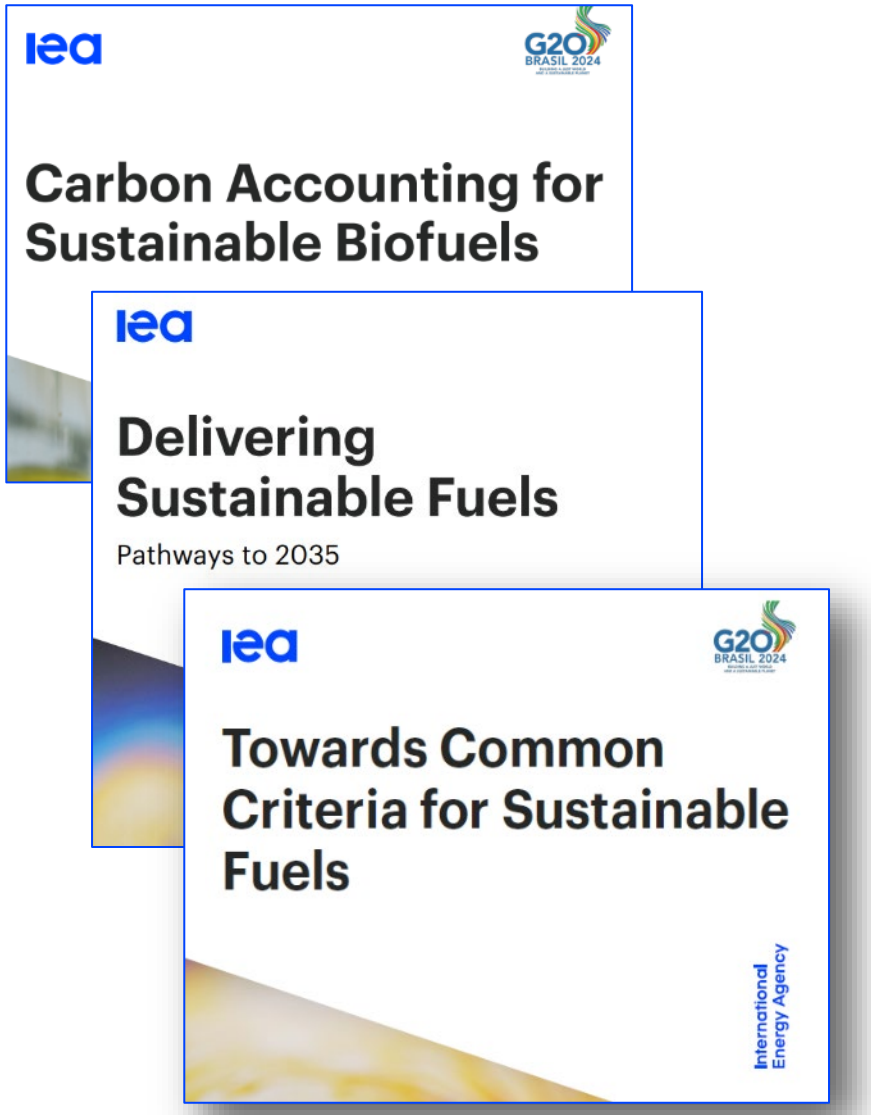
U.S. Fuel Ethanol Production:
% Change over prior Year
1998-2016



US EIA, US ethanol biofuel (excludes denaturant) Table 10.3

For other examples, see IEA reports www.iea.org/reports/ and Biofuture Platform website (resources): https://biofutureplatform.org/ and Biofuture best practices https://biofutureplatform.org/wp-content/uploads/2023/08/CEM14.pdf

Simulated Indirect Land-Use Change (ILUC) increases uncertainty and risk, undermining investment



Consistent and verifiable Life Cycle Assessments (LCA) support fair comparisons but are undermined by unverifiable Indirect Land Use Change (ILUC) values.
Solutions:

- The ILUC quandary is eliminated with accountability for all direct land-use change
- Risk-based approaches using empirical measures can more effectively address concerns
- Causal analysis based on evidence contradicts ILUC model assumptions

References:

- IEA 2024-25: www.iea.org/reports/ and Biofuture Platform website (resources): https://biofutureplatform.org/
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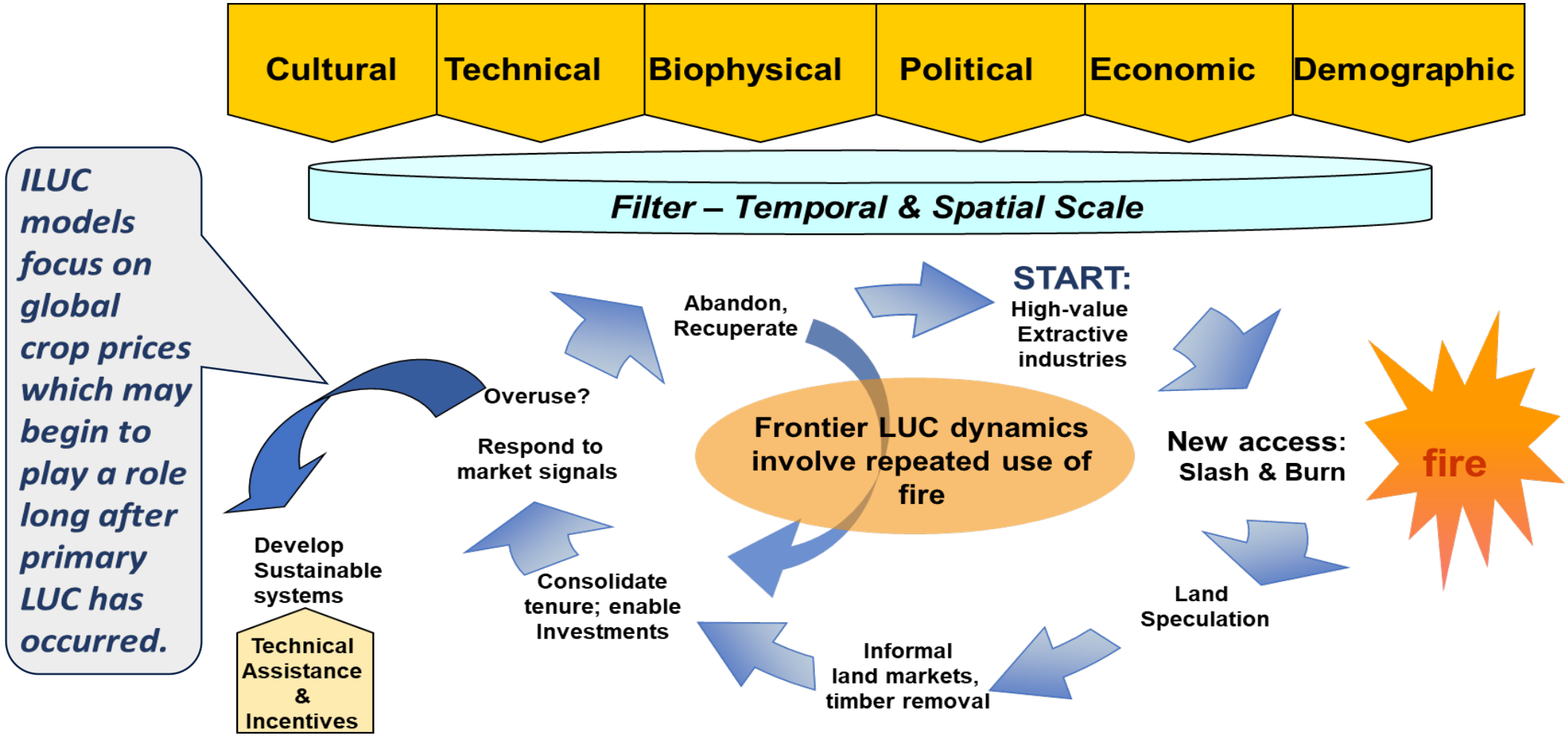
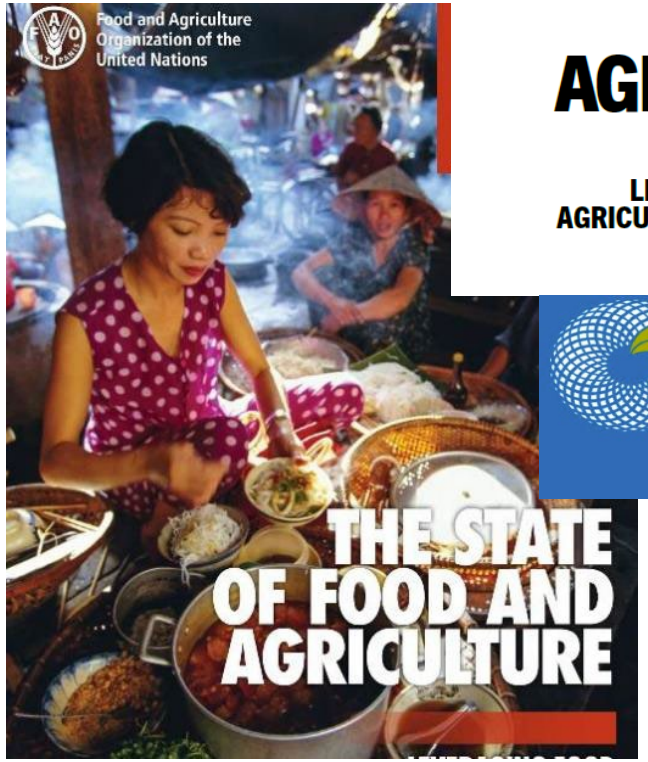
ILUC models omit ***local*** drivers of frontier land-use change



Adapted from Dale and Kline Fig 8.2 "**Initial LUC drivers**" *in* ***Land Use and the Carbon Cycle-Advances in Integrated Science****, Management, and Policy*. D. Brown et al. (Eds) Cambridge Univ Press 2013. Add'l references: Engert, J. E. et al. (2024) Nature; Laurence 2024 Roads of destruction; Protecting Biodiversity through Forest Management: Lessons Learned and Strategies for Success. DOI: 10.19080/

Evidence shows how bioenergy supply chains add value to rural production and contribute to enhanced food security and ecosystem services

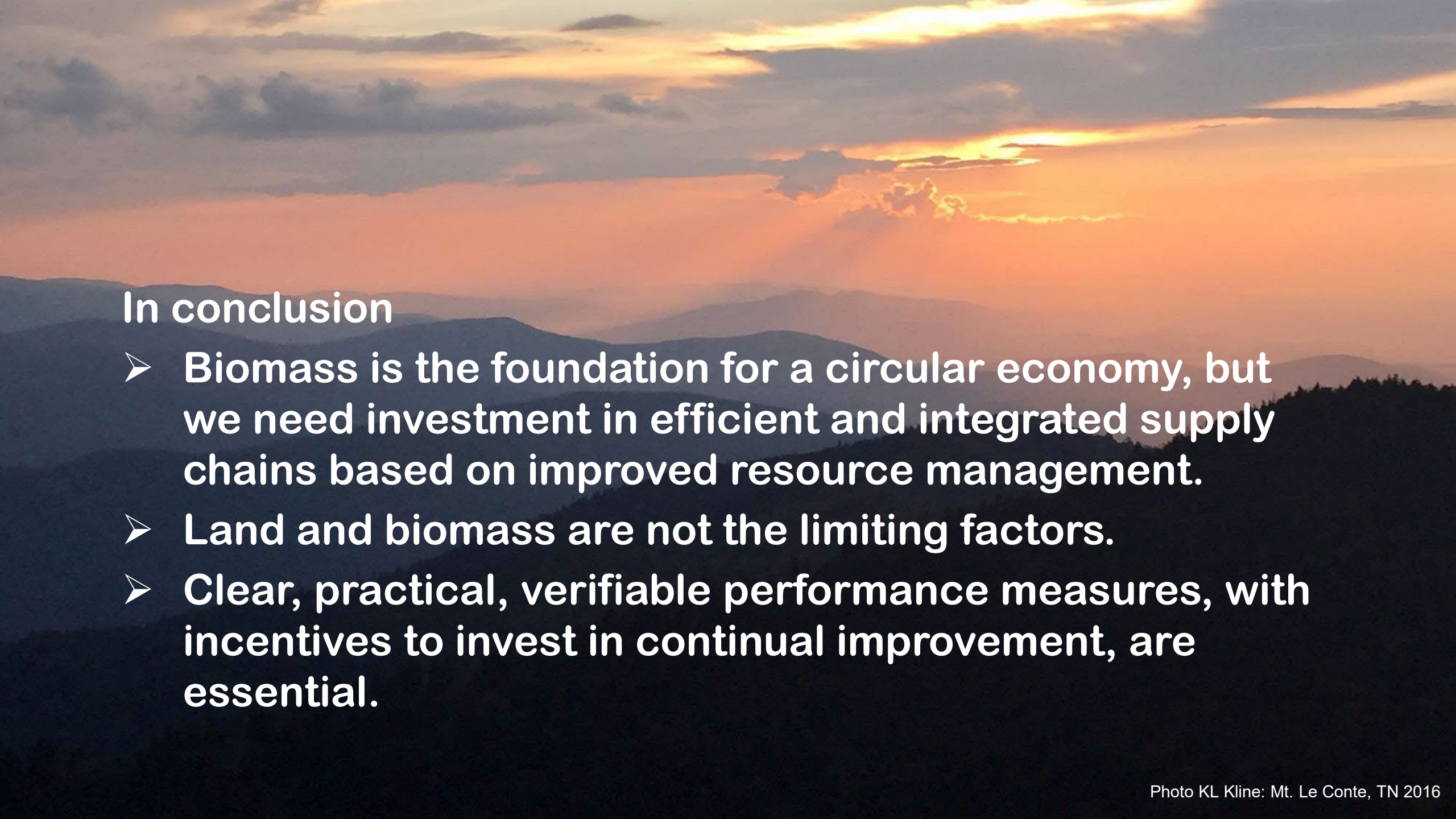


2022
THE STATE OF
FOOD AND AGRICULTURE

LEVERAGING AUTOMATION IN AGRICULTURE FOR TRANSFORMING AGRIFOOD SYSTEMS

BEFS
Bioenergy and Food Security Projects

- Justus et al. 2025. Revisiting Hypothesized Trade-Off Between Food and Fuel: Empirical Evidence from Brazil https://doi.org/10.1111/gcbb.70085
- Gursel et al. 2020. Variable demand as a means to more sustainable biofuels and biobased materials, BioFPR 15(1) https://doi.org/10.1002/bbb.2164
- Kline et al. 2017. Reconciling biofuels & food security: Priorities for action https://doi.org/10.1111/gcbb.12366
- Bioen Factsheet 2025. https://bioenfapesp.org/biofuels-as-an-immediate-and-effective-solution-for-decarbonization-of-transportation-factsheet/
- Biofuel-Food Market Interactions: A Review of Modeling Approaches and Findings. http://www.mdpi.com/2077-0472/3/1/53/htm



In conclusion

- Biomass is the foundation for a circular economy, but we need investment in efficient and integrated supply chains based on improved resource management.
- Land and biomass are not the limiting factors.
- Clear, practical, verifiable performance measures, with incentives to invest in continual improvement, are essential.

Photo KL Kline: Mt. Le Conte, TN 2016

Thank you! Send your comments and questions to KlineKL@ornl.gov

Photo: ORNL

Additional Resources

Websites

- ORNL https://www.ornl.gov/ == CEM Bioenergy Initiative & Sustainability Workstream https://www.cleanenergyministerial.org/initiatives-campaigns/biofuture-platform/ == Data on biomass resource quantification and standards: https://bioenergykdf.net/ == IEA Bioenergy http://www.ieabioenergy.com/ and Common Criteria-Sustainable Fuels https://www.iea.org/reports/towards-common-criteria-for-sustainable-fuels ISO TC323 Circular Economy https://www.iso.org/committee/7203984.html

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Additional reports and references to relevant literature and standards are available. Please contact Keith L. Kline, Oak Ridge National Laboratory klinekl@ornl.gov

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The author's' work is dedicated to grandchildren and future generations.