Biofuels policy as Agriculture policy

Jeremy Martin
Union of Concerned Scientists
August 21, 2025

ILLINOIS

Biofuels policy as agriculture policy

Outline

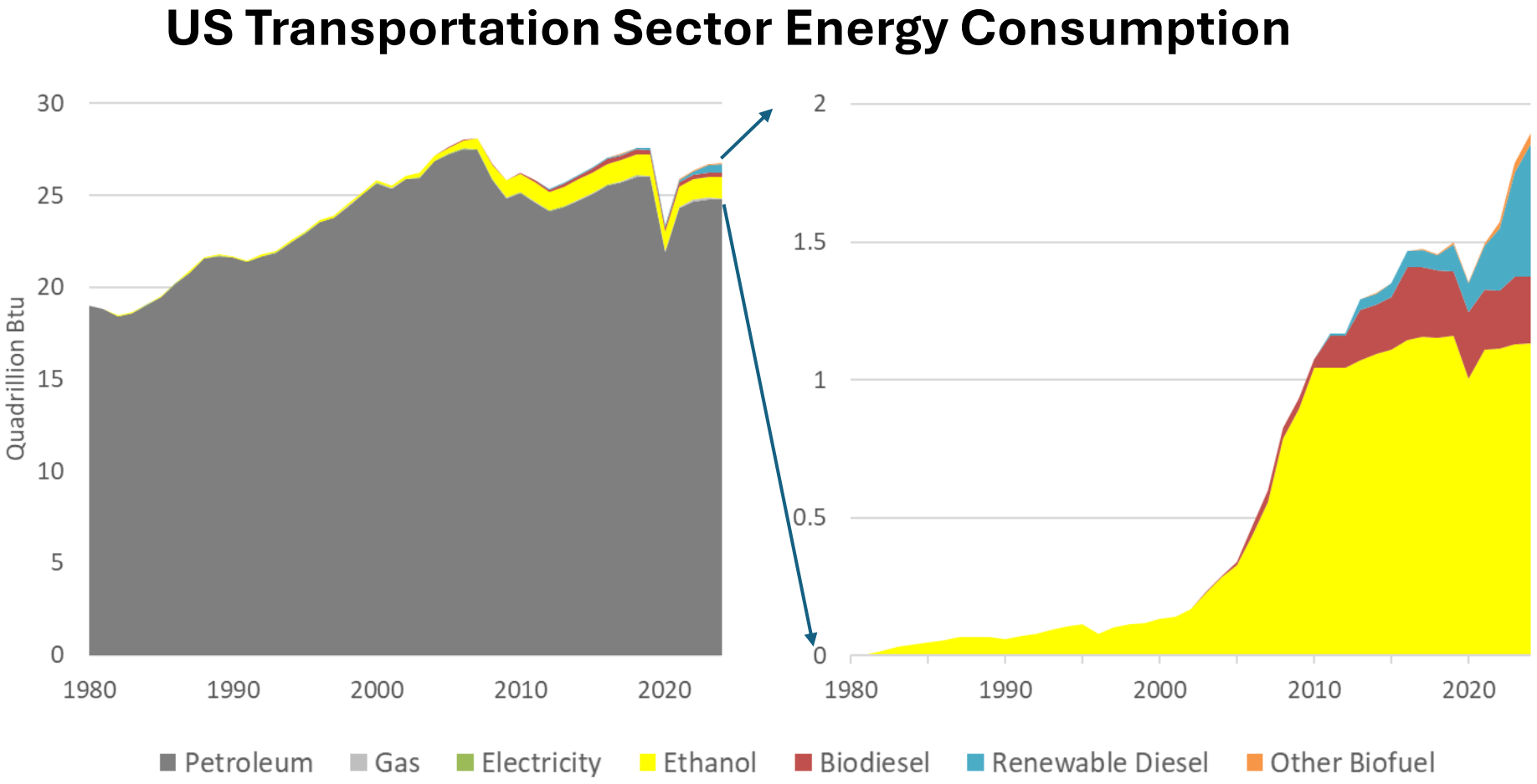
- **Biofuels policy as transportation fuel policy**
- **Corn ethanol's impact on agriculture**
- **Biodiesel and the renewable diesel boom**
- **Can biofuels support sustainable agriculture?**
- **Beyond transportation fuel carbon intensity**
- **What does this mean for biomass?**

Register Here:
https://go.illinois.edu/biomasswebinarseries

Biofuel as transportation energy

Biofuel share of US transportation energy
1980 – 0%
1990 – 0.3%
2000 – 0.5%
2010 – 4.1%
2020 – 5.8%
2024 – 7.1%

2024
- **92.6% Petroleum**
- **0.2% Natural gas**
- **4.2% Ethanol**
- **0.9% Biodiesel**
- **1.8% Renewable diesel**
- **0.2% Other**



EIA Annual Energy Outlook
Transportation energy excluding pipeline fuel

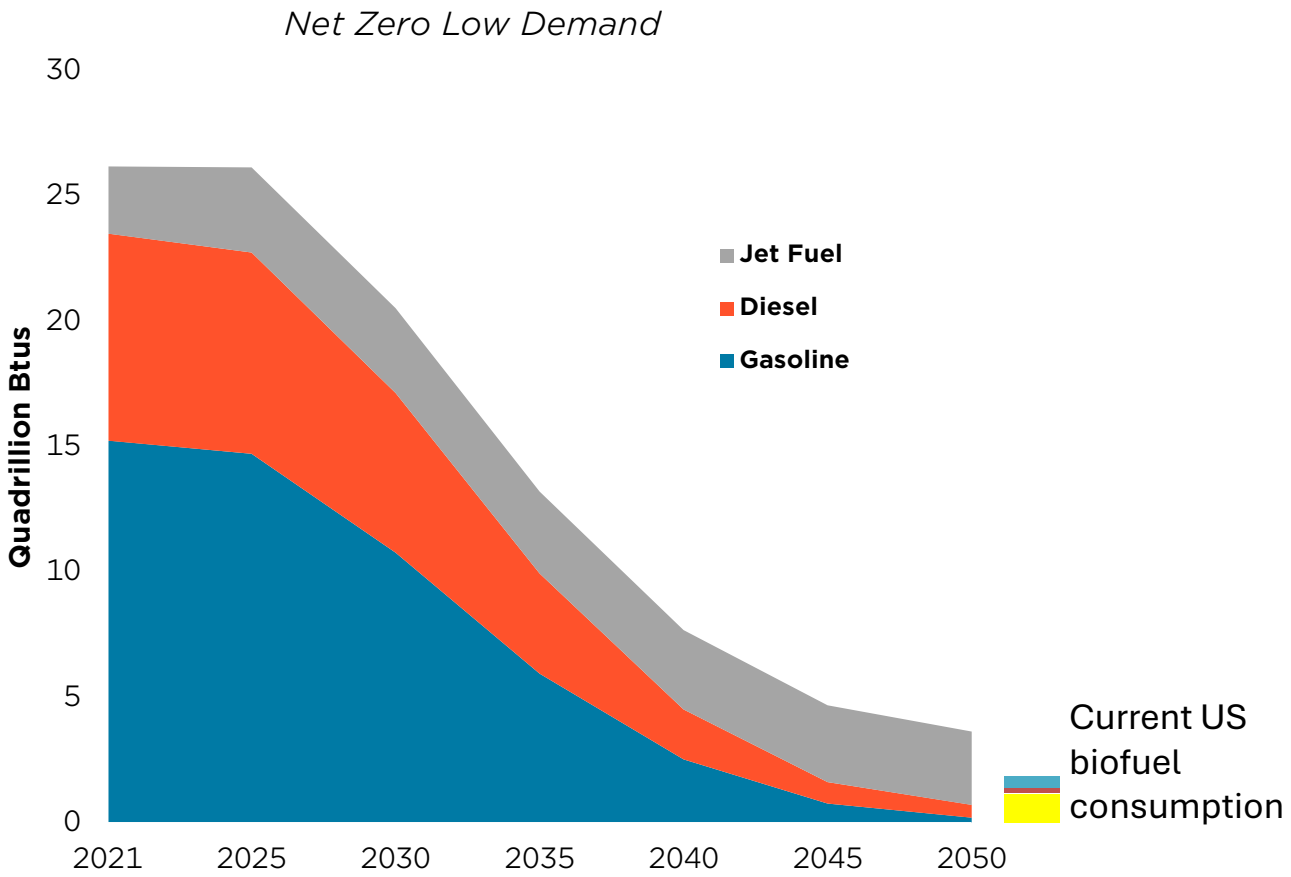
Electrification is central to transportation decarbonization

Electrification of cars and trucks will cut liquid fuel consumption by 70-85 percent

The timeline is uncertain, but the direction of technological change is clear

Post-electrification, remaining liquid fuel demand is primarily for jet fuel

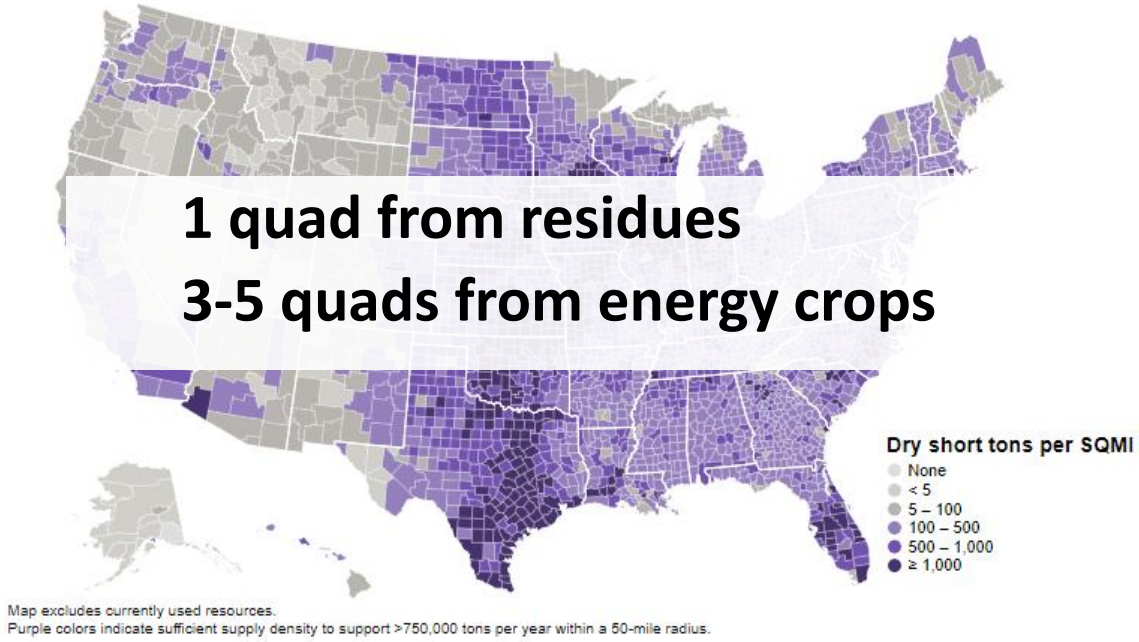
Post-electrification, liquid fuel demand is 2-4 times larger than current biofuel consumption



Union of Concerned Scientists: Accelerating Clean Energy Ambition
ucsusa.org/resources/accelerating-clean-energy-ambition

Existing biofuels provide ~1.5-2 quads of liquid fuels and we need 4-8 quads, what *else* is there?

Biomass

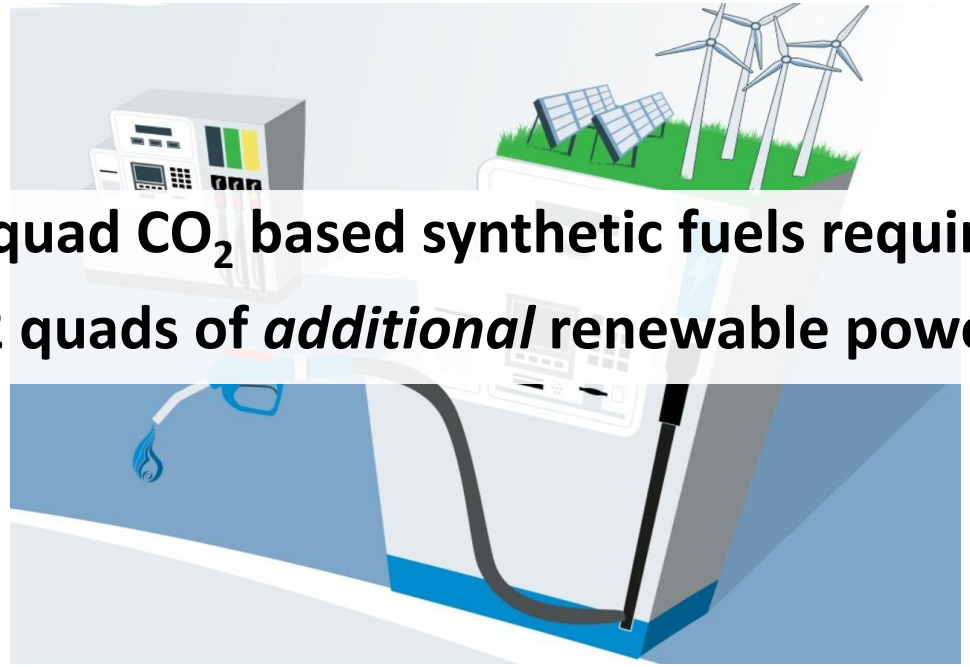


1 quad from residues

3-5 quads from energy crops

bioenergykdf.ornl.gov/bt23-data-portal

E-Fuels



1 quad CO_2 based synthetic fuels requires

~2 quads of *additional* renewable power

Cerulogy, Jane Robertson Design

- Substantial investment required in feedstock production and conversion technology scaleup and cost reduction
- Uncertain economic competitiveness with incumbent feedstocks and technologies, highly dependent on policy

Biofuels as transportation fuel

- Biofuels can compliment or replace petroleum in applications where electrification is expensive or impractical
- The scale of US liquid fuel consumption is currently 14 times US biofuel consumption
- Post electrification, liquid fuel demand would be 2-4 times current biofuel consumption
- Scalable alternatives to existing biofuels include biomass-based fuels and e-fuels

Oregon Department of Transportation

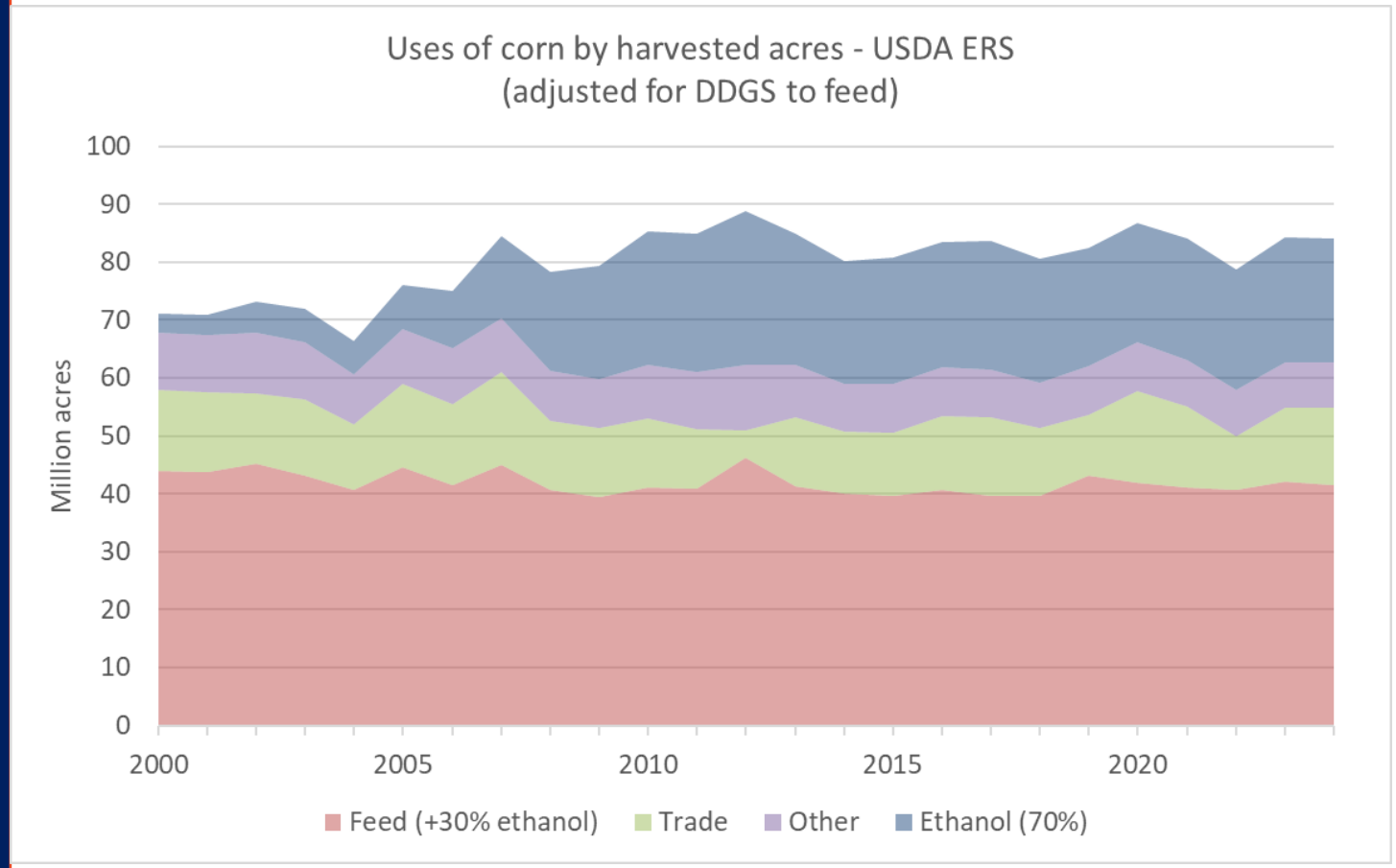
Biofuels from an agriculture persperctive

The corn ethanol boom of 2000-2010 increased corn production by more than 10 million acres

Increased demand for corn had major impacts on crop prices for corn and other commodity crops competing with corn for land.

> *The RFS is arguably the most successful farm policy to date, even though it is technically energy and environmental policy. It has driven crop prices for all commodities to record highs, surpassing historical impacts from exports and war.*
>
> Jonathan Coppess
> The Fault Lines of Farm Policy

Increased corn cultivation set back agricultural conservation outcomes, increasing land conversion and nutrient pollution and decreasing land in conservation programs



Feed Grains Yearbook
USDA ERS

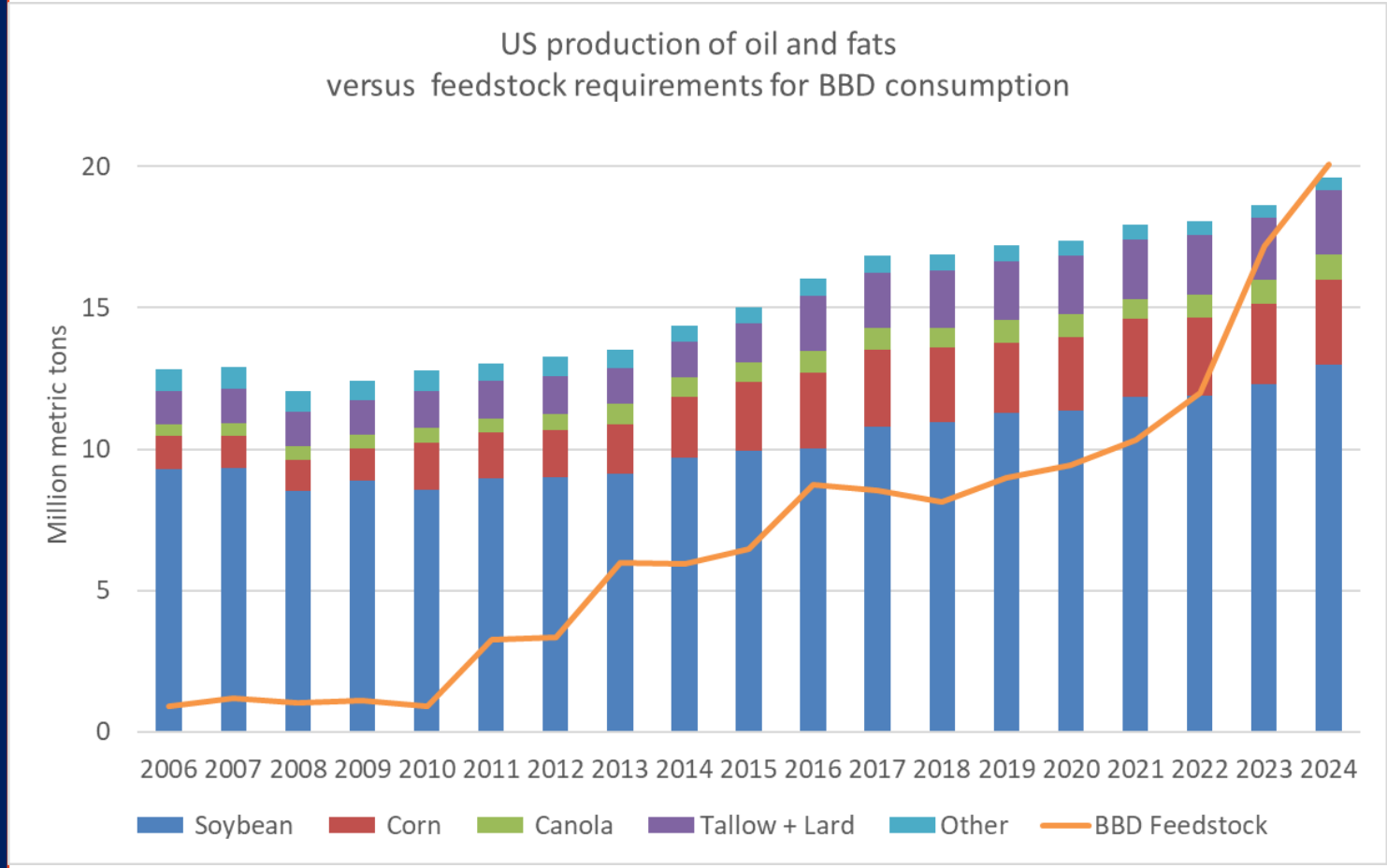
Biofuels impact on vegetable oil markets

Since 2011, bio-based diesel consumption has grown much faster than domestic production of vegetable oils and fats

- **Production increasing 0.5 MMT/yr**
- **Consumption increasing 1.5 MMY/yr**

Near term growth in US vegetable oil is expected to come primarily from soybeans

- **Trend yield growth on 87 mil harvest acres adds 0.22 MMT of soybean oil each year, if all additional beans are crushed for oil**



/blog.ucs.org/jeremy-martin/epas-proposal-to-focus-biofuel-policy-on-domestic-fuels-doesnt-add-up/

Biofuels impact on global vegetable oil markets

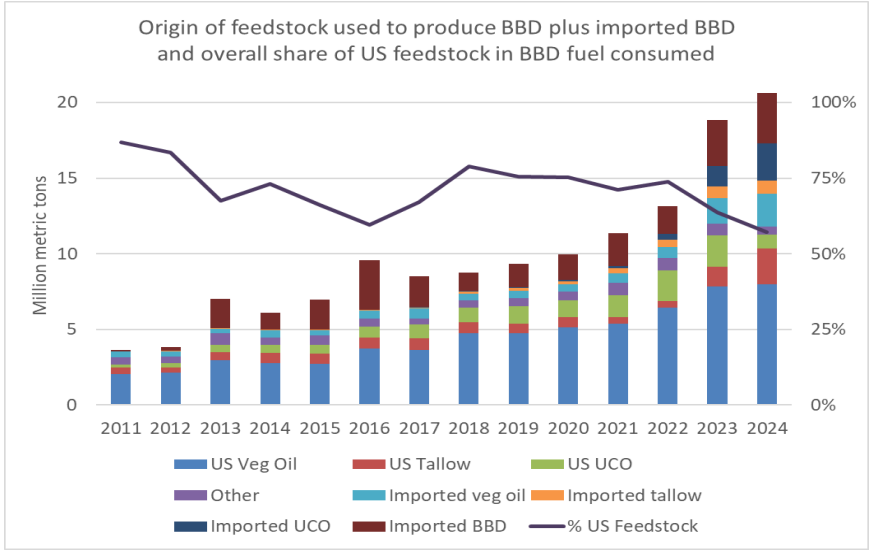
Because consumption is outpacing production imports are mathematically inevitable

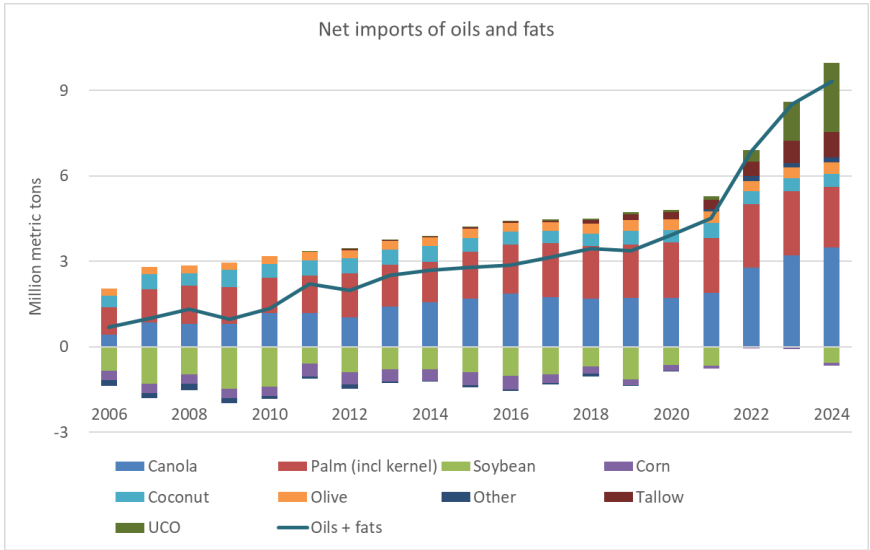
US bio-based diesel consumption is increasingly coming from imported feedstocks or fuels

- **In 2024 43% of US BBD consumption came from imported feedstocks or fuels**
- **72% of growth between 2022 and 2024 from imported feedstocks or fuels**

The US has become a major global importer of oils and fats

- **Net imports (less exports) grew from 0.7 MMT in 2006 to 9.3 MMT in 2024**
- **In 2024 the US was the 4th largest importer of vegetable oil in the world, behind India, China and the EU**





/blog.ucs.org/jeremy-martin/epas-proposal-to-focus-biofuel-policy-on-domestic-fuels-doesnt-add-up/

Corn versus soybean biofuels

Corn ethanol is largely a domestic story

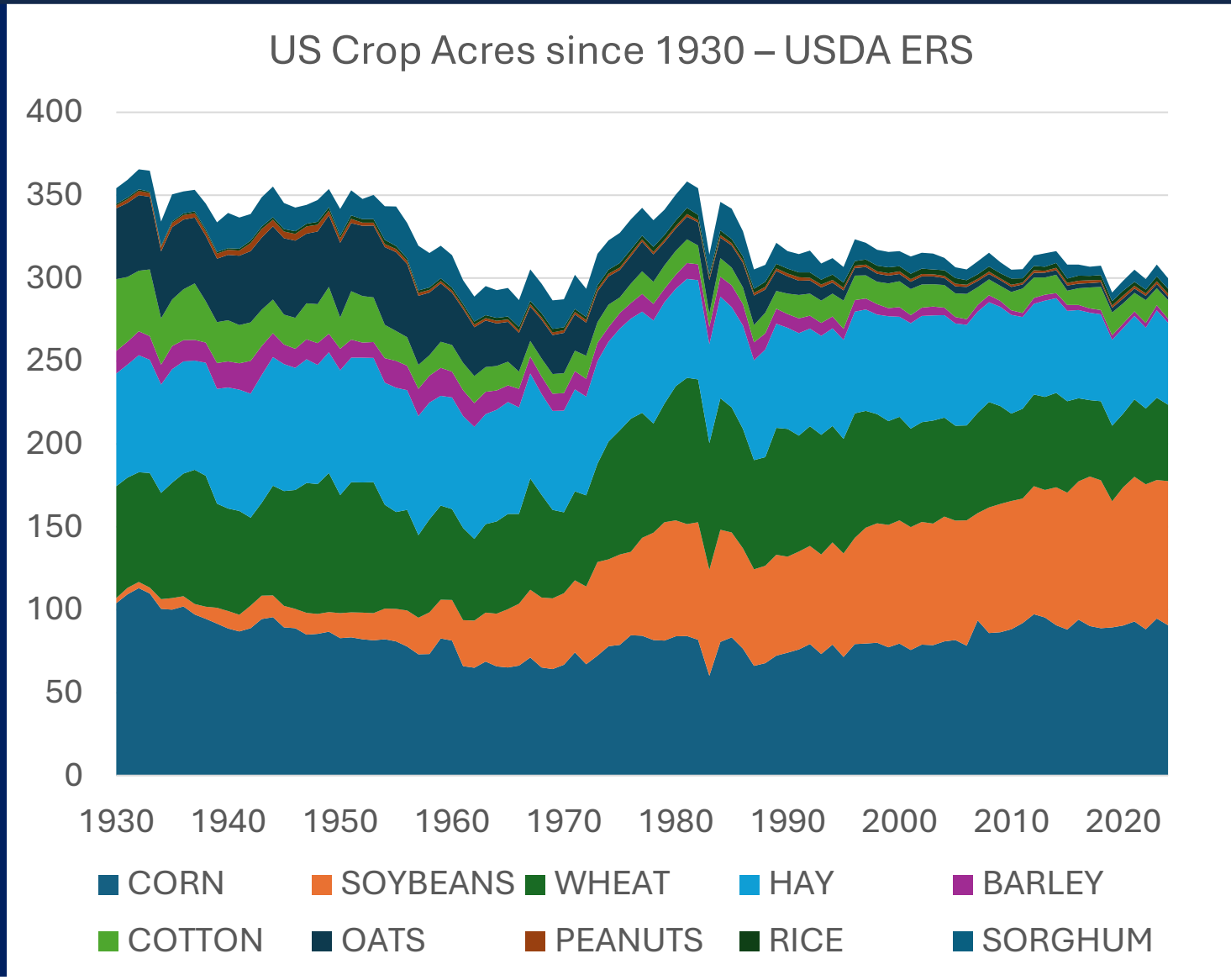
- Ethanol established a cost-effective role as high octane blending component in gasoline
- Demand for ethanol increased US corn production
- Ethanol consumption increased prices and acres of corn and competition for acres raised prices of other commodities.
- Increased corn cultivation had environmental costs, especially in the US Midwest, increasing nutrient pollution, land conversion and reducing land in conservation programs.

Bio-based diesel is a global story

- Vegetable oil-based fuels are expensive, entirely uneconomic without continued subsidies of $2/gallon or more
- Feedstock consumption outpaced domestic supply, growth has come largely from imports and diversion from other markets
- Increased prices for soybean oil are offset by falling prices for soybean meal, leading to smaller increases in soybean prices
- Soybean expansion is limited by demand for meal, so the primary beneficiaries are palm oil producers, who don’t produce meal
- Palm oil expansion creates major climate and biodiversity problems, mostly in the tropics

Biofuels role in US agriculture

- Biofuels have contributed to the increased share of US acres in corn and soybeans
- US agricultural output is shifting from global food and feed markets to US fuel consumption
- Biofuels have made the US a major global importer of vegetable oil



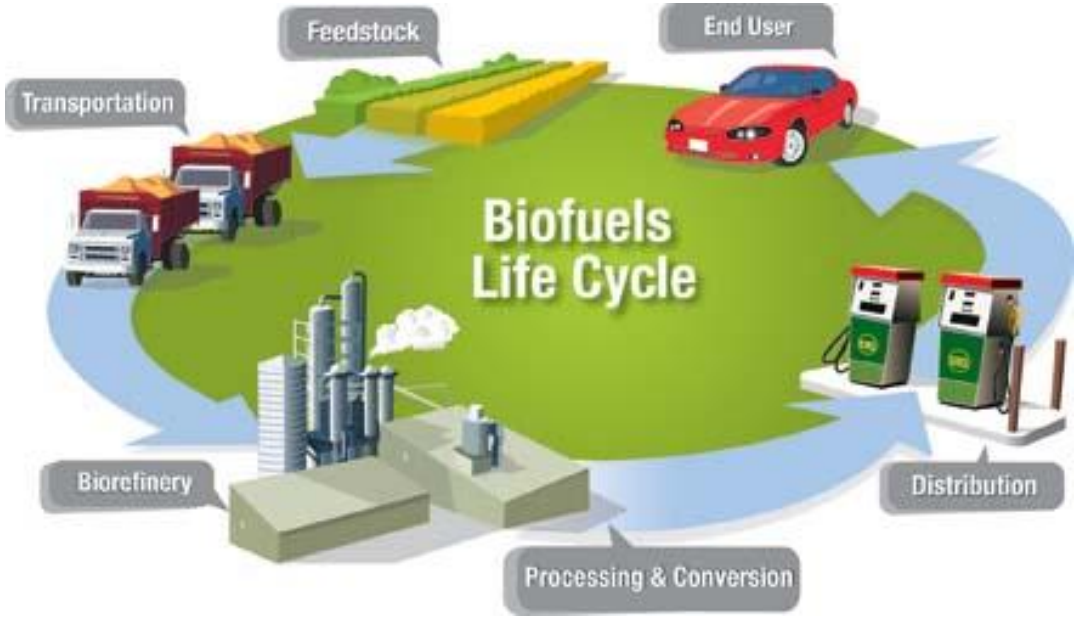
Can biofuels support sustainable agriculture?

- Create value from underutilized land and resources
- Build healthy soils, improve water quality, habitat, biodiversity, etc.
- Diversify agriculture
- Protect sensitive ecosystems
- Protect food security

Iowa State University STRIPS Program

Biofuel policies focus on carbon intensity

- How do biofuels compare to petroleum fuels?
- Carbon Intensity (CI) based on lifecycle analysis has been core to biofuel policies since 2007
  - Renewable Fuel Standard eligibility is based partly on CI
  - State Low Carbon Fuel Standards are administered almost entirely based on CI
  - Federal 45Z Clean Fuel Production Tax Credits are based on CI
- A pure CI framework translates policy preferences into the CI score, leaving outcomes to the market
- This works out better in theory than in practice



US Dept. of Energy

The Theory of a CI based biofuel policy

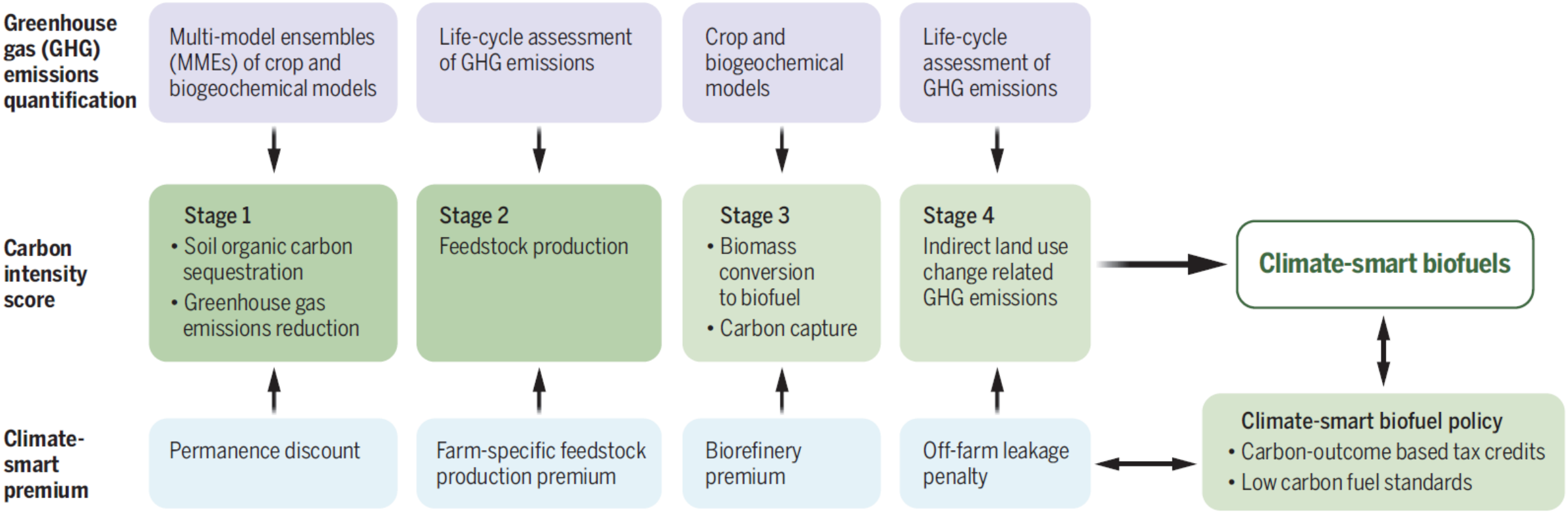
Climate-smart biofuel policy as a pathway to decarbonize agriculture

A policy that relies on farm-specific carbon-intensity scores can promote climate-smart agricultural practices.

Science
AAAS

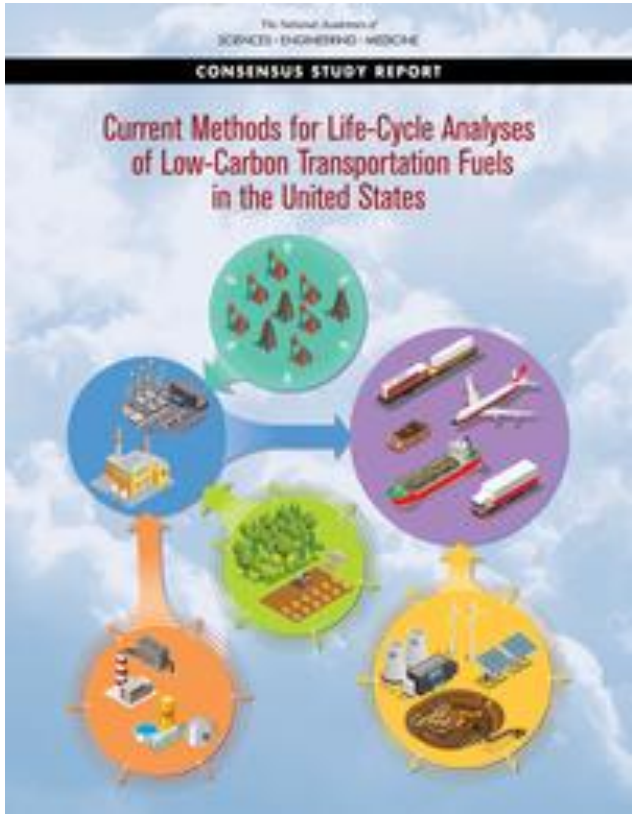
Madhu Khanna[1,2], Bruno Basso[3], Jeff O'Hara[4], David Zilberman[5], Gal Hochman[1]

Components of the carbon intensity and premium for climate-smart biofuels



Technical challenges with CI based policies

- CI scores are not well-defined physically measurable values
  - Model structure, boundary conditions, inputs and assumptions lead to very different results
- Different types of lifecycle analysis have different purposes
  - Attributional analysis (e.g. GREET) can provide clear, actionable incentives to shape the behavior of fuel market participants
  - Consequential analysis is required to understand the impact of the policy, for example the market mediated impact on food markets, land use change
  - Combining attributional analysis with consequential analysis does answer a well-defined question



National Academies study: Current Methods for Life-Cycle Analyses of Low-Carbon Transportation Fuels in the United States

Political challenges with CI based policies

- When CI scores do not support preferred outcomes, methodologies are subject to manipulation
- Complex multi-model lifecycle assessments are opaque, constraining meaningful public input
- Policy makers are often trying achieve goals based on feedstock quantity using policies based on transportation fuel carbon intensity
    - Ensure a robust market for US soybean oil in the face of competition from imported used cooking oil
    - Ensure corn has a role in jet fuel markets to compensate for falling demand for ethanol in gasoline blending
    - Limit the expansion of vegetable oil-based fuels within the California Low Carbon Fuel Standard

Architect of the Capitol

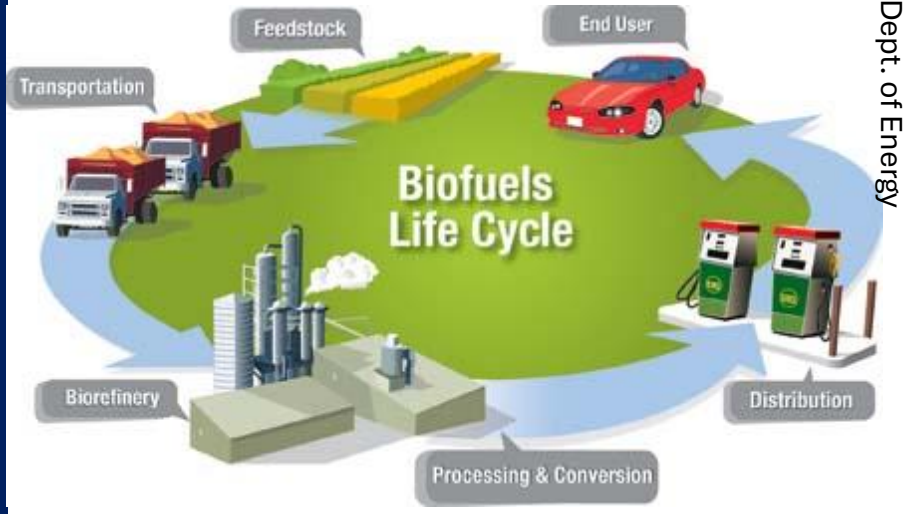
Why not give the policy makers what they want?

- Instead of manipulating the carbon intensity calculations to achieve multiple policy objectives through a single lever, use multiple mechanisms to support policy goals
- Separate incentives and safeguards corresponding to primary policy goals are more transparent and support efficient implementation
  - Attributional LCA (GREET) to reduce pollution from fuel production
  - Feedstock quantity safeguards to align consumption to availability
  - Farm based incentives for preferred crops and practices

Attributional CI scores to govern fuel production

Attributional CI scores using tools like GREET provide flexible and transparent incentives to fuel producers to reduce pollution

- CI scores are a useful way to compare dissimilar fuels like gasoline, ethanol and electricity and create flexibility to adapt to emerging technologies
- CI scores are an indirect means of influencing market-wide phenomena outside the control of individual fuel producers
- CI scores for transportation fuel are a few steps removed from farmers growing feedstocks



US Dept. of Energy

Feedstock safeguards based on sustainable availability

- Analysis of market mediated impacts on food prices and land use change can inform a determination of feedstock availability
- How much corn, vegetable oil, used cooking oil, corn stover, perennial grass is available for biofuels, considering competing uses and the pros and cons of producing more or less?
    - The result could be a simple formula, for example, automatically adjusting availability based on yield increases, or a more complex determination based on multiple factors
- Implement a market wide constraint limiting feedstock utilization at sustainable availability across all biofuel uses (gasoline, diesel, jet, shipping, etc.).


Andrew Butko


John Caveny


Wikideas1

Farm based incentives for preferred crops and practices

Farmers play a key role in the sustainability of biofuels, but their involvement in biofuel policies has been limited to date

- Initial efforts to quantify the CI benefits of Climate Smart practices are being included in federal tax policy implementation.
- Many vital ecosystem services and water quality benefits may not be well represented in the CI of a biofuel
- Alternative policy mechanisms could shift control towards farmers versus biofuel producers and support environmental outcomes beyond CI

USDA NRCS

NRCS/SWCS photo by Lynn Betts

What does this mean for biomass crops

- Biofuel policies have a more profound impact on agriculture than on transportation, they should be designed with agriculture in mind
- Sustainable biomass feedstocks can build soil health, improve water quality, diversify agriculture and create additional value from underutilized land
- Safeguards based on sustainable availability will create opportunities for biomass crops
- Incentives based on agricultural conservation outcomes will support biomass crops that advance these outcomes
- Biofuel policies should not be so technology neutral that they ignore opportunities to improve the agricultural system

University of Minnesota, Forever Green Initiative

University of Illinois, L. Brain Stauffer

Discussion

Jeremy Martin
Union of Concerned Scientists
August 21, 2025

ILLINOIS