RETHINKING INDIRECT LAND USE CHANGE (iLUC)

Indirect land use change (iLUC) captures the market-mediated changes in land use that can occur in response to biofuel production. When biofuel feedstocks displace food and fiber production in the economy, this can drive an expansion of agricultural production into lands with high carbon storage, such as forests or wetlands, that release greenhouse gases. The idea of iLUC has been around for more than a decade, but there are strong disagreements in both the scientific community and between regulators on how to measure and address it.

Estimates of iLUC emissions are aggregated calculations across the entire biofuel sector rather than being tied to a specific agricultural project or fuel production process. For example, an iLUC model may look at the total effects of increasing corn ethanol production by 15 billion gallons, and the resulting land use change that this could cause across the world. It isn't possible to measure these changes precisely in the real world, so modeling is typically used to estimate it instead. These models are attempting a Herculean task—they must simulate all the potential economic responses to biofuels and their co-products that could result in land use change across the globe, without any real-world calibration to check the results.

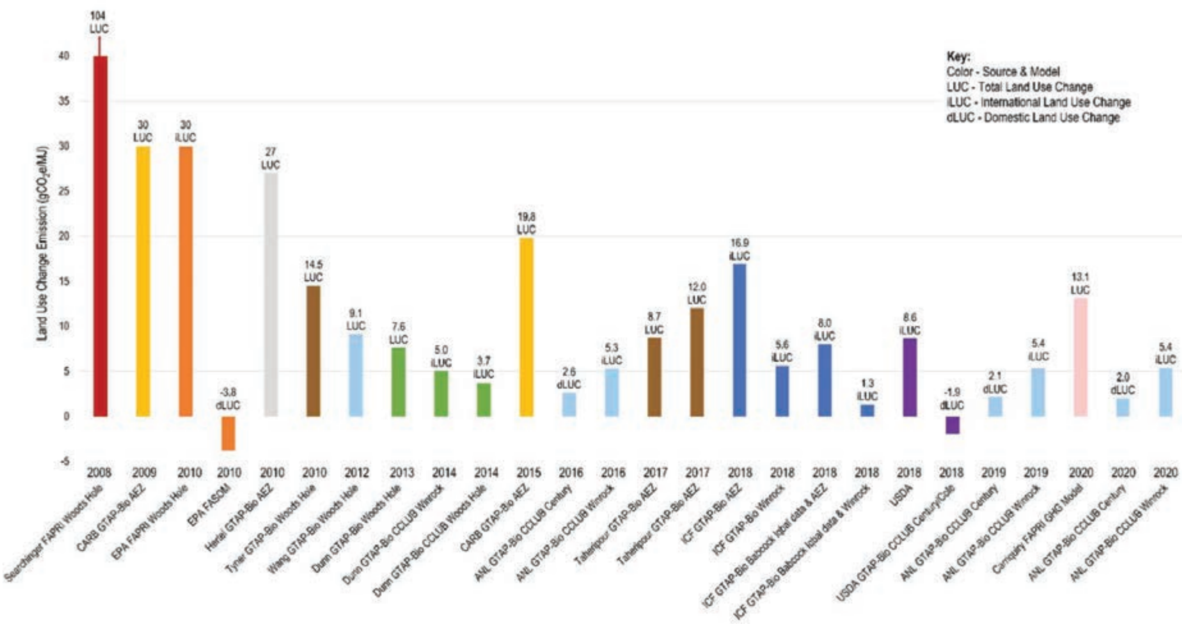
CHANGE ON A GLOBAL SCALE

The idea is to estimate the change and its impact as accurately as possible. Once the land use change has been estimated, we must then estimate the greenhouse gas emissions associated with these changes across all the land and vegetative types that exist around the world. If this sounds complicated, that's because it is—and for a scientific discipline that has been around for less than 15 years, there is still a long way to go before this modeling achieves high levels of certainty.

This uncertainty bears out in academic studies. iLUC estimates in the scientific literature for corn ethanol range anywhere from over 100 g GHG/MJ to just 5 g GHG/MJ, with scores consistently falling over time due to improvements in modeling (Figure 1). Researchers don't agree on which model is best, so their calculations incorporate different economic assumptions and different data sources for emissions factors. Despite this uncertainty, biofuels policies in the U.S. account for land use change emissions by adding a pre-calculated iLUC carbon intensity score onto each fuel's process specific life cycle assessment (LCA). These scores cannot be changed regardless of how the feedstock is produced, and, due to differences in model selection, can vary widely from policy to policy. The same ethanol will have an iLUC score of 20 g GHG/MJ in California but 7.6 g GHG/MJ in Oregon. Moreover, most regulatory iLUC values were calculated a decade or more ago and do not reflect the latest science, despite advancements and new understanding in iLUC modeling in recent years.

The U.S. regulations stand in stark contrast to the approach used by European and Canadian regulators, who do not calculate an iLUC score at all. These regulators instead do a general iLUC risk assessment based on observed expansions in cropland and designate each feedstock as either 'high-risk' or 'low-risk'. They currently only consider palm oil to be a high risk. Other countries, such as Japan and Brazil, don't consider iLUC at all in their fuels policies.

Timeline of estimated GHG emissions associated with corn ethanol-related LUC, 2008–2020.



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RETHINKING INDIRECT LAND USE CHANGE (iLUC)

SETTING POLICY TO REFLECT REALITY

Given the rigidity of modeling on a global level and assigning a carbon intensity value to each feedstock used in biofuel production, it is critical that iLUC modeling be based on the most accurate, up-to-date assumptions to set policy that reflects real-world impacts. Outdated modeling can be seen today across multiple regulations and policies:

• California Air Resources Board (CARB) most recently updated their iLUC emission value for CA-LCFS in 2015.
• The U.S. EPA, which oversees the RFS, most recently updated their iLUC emission value in 2010.
• Both CA-LCFS and ICAO's CORSIA iLUC values rely heavily on IPCC emissions factors from 2006.

We believe regulatory iLUC models should strive to incorporate new knowledge on land use change that has been developed in recent years:

• **iLUC scores for corn feedstocks have dropped consistently over the past 15 years.** Searchinger's 2008 study, which was the first-ever attempt at calculating iLUC and reported over 100 g GHG/MJ for corn ethanol, has had an outdated influence on policy. Subsequent studies and observed land use change have not borne out the results of that study.
• **Modeling improvements have added nuance** to how biofuels and their co-products affect other sectors of the economy.
• **Marginal lands**, such as cropland-pasture, have been added to models. Since not all cropland expansion quantified by iLUC models is into rainforest, wetlands, or other high-carbon-storage areas, including marginal lands generates a more accurate representation of reality in the models.
• **Agricultural technology** has improved yield and reduced land use and must be considered for current figures and adapted to future models as improvements continue.
• **Estimates of carbon stock in different land types are becoming better understood. For example, IPCC** revised their soil carbon emission factors in 2019, but most emissions models still use Intergovernmental Panel on Climate Change (IPCC) data from 2006.

GEVO BELIEVES THAT POLICIES AND REGULATIONS SHOULD:

1. Use models that capture the nuances of how land use change occurs in the real world, such as Argonne GREET's CCLUB-CENTURY model. The Argonne GREET model integrates many data points that other models discount, such as soil, climate, and yield data down to the county level.
2. Rely on the most up-to-date science on land carbon stocks and use new emissions factors as they are released.
3. Incorporate the model by reference rather than prescribing outdated values from older models so that values can be continuously updated.

FOOD *AND* FUEL

Gevo also mitigates iLUC emissions by producing both food and fuel from our corn rather than displacing lands used for food production. In fact, according to the European Commission, its "overwhelming majority" of agricultural expansion into high-carbon lands due to biofuels are from increased production of oil crops, rather than by starch crops like corn.

Rather than promote innovation, these antiquated assumptions stifle innovation by lowering—or even removing—the incentive to produce the fuel. Scientific models and policies that have a basis in science have the advantage of repeatability and reliability—and can continue to be modified intelligently as science improves.

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