Indirect Land-Use Change from Biofuels: Recent Developments in Modeling and Policy Landscapes in the US

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Sustainability Principles/Requirements in Major Biofuel Programs

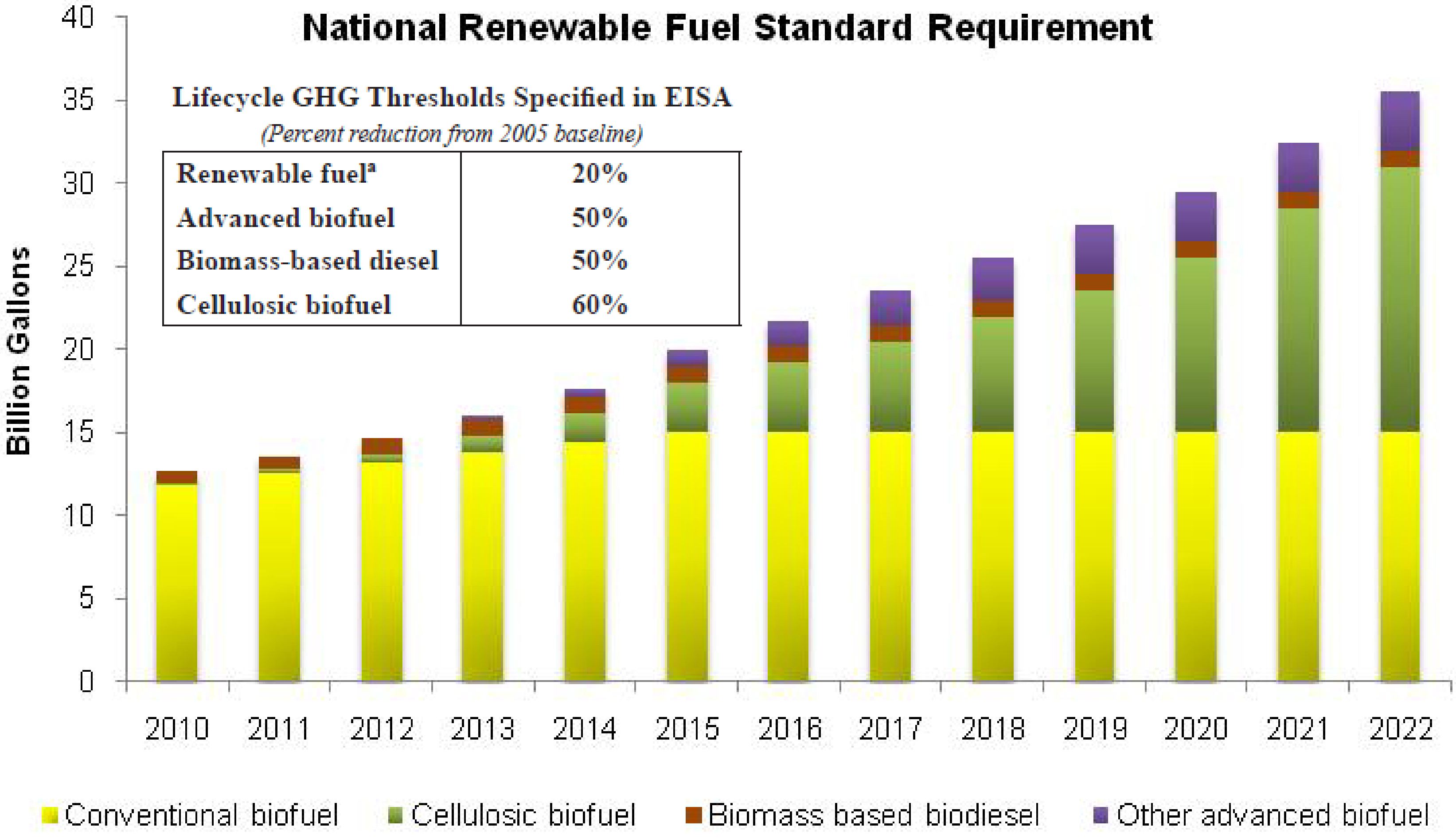
Volumetric or blend-in requirement

- US Renewable Fuel Standard Program (RFS2)
  - **Minimum GHG savings** by biofuel category
  - Excludes feedstock produced from non-agricultural land, federal forest lands, and ecologically sensitive forestland
- UK Renewable Transport Fuel Obligation (RTFO)
  - Environmental: **minimum GHG savings**, biodiversity, soil, water, and air
  - Social: workers' rights and land rights
- EU Renewable Energy Directive (RED)
  - Biodiversity no-go areas; conversion of high carbon stock areas prohibited; **minimum GHG savings**

Performance-based standard

- California Low Carbon Fuel Standard (LCFS)
  - Regulate average **GHG intensity target** of total transportation fuels
  - A framework for including sustainability provisions by December 2011

US Biofuel Requirement – Renewable Fuel Standard (RFS2)



California's Low Carbon Fuel Standard

- **Performance based**: GHG intensity reduction target for transport fuels

$$AFCI(\text{gCO2-eq/MJ}) = \frac{\sum_{i}^{n} E_i \times CI_i}{\sum_{i}^{n} E_i \times EER_i}$$

Numerator ← Total GHG emission

Denominator ← Total transportation fuels produced/displaced

- **Lifecycle measurement** for "carbon intensity" of all fuels on an equal basis

- **Regulated parties are transport energy suppliers** (oil providers, plus others who want to earn credits, such as biofuel, electricity, NG and H_2 providers)

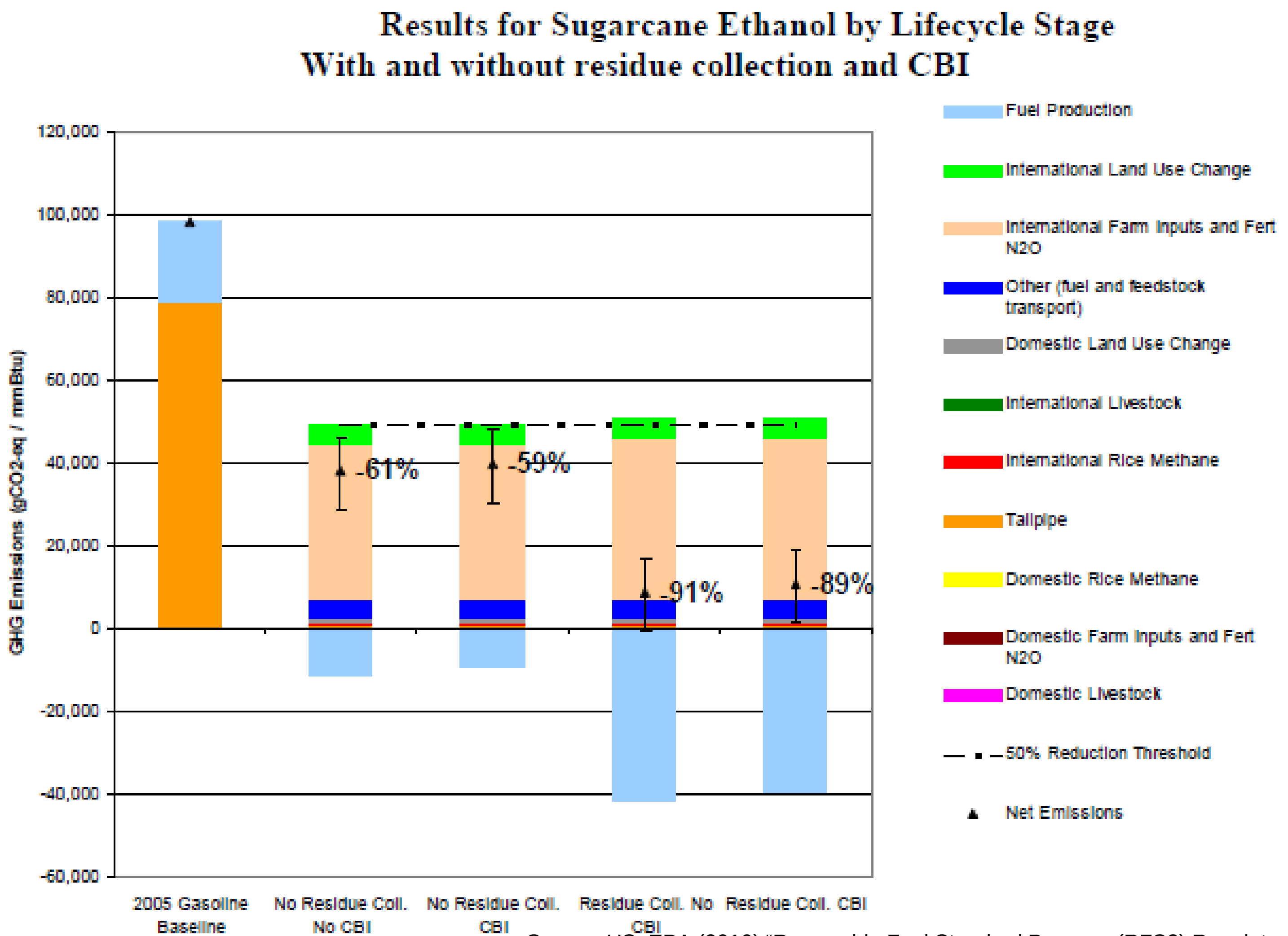
- **Harnesses market forces**: Allows trading of credits among fuel suppliers, which stimulates investment and continuing innovation in low-carbon fuels
  - *The lower GHG-intensity rating, the more carbon credits (and thus economic value) generated*

Issues of Indirect Land Use Change (iLUC)

- Massive consumption of biofuels in the U.S. leads to expansion of cultivated land area in and outside of the US (to replace diverted ag production)
  - These iLUC effects cannot be directly observed or easily measured
  - Three principal pathways of market response to higher feedstock demand: reduced consumption, higher production through higher yields, or higher production through increased cultivated area (iLUC)
  - When lands with rich soil and biomass carbon deposits are initially converted to agricultural production, a large amount of carbon is emitted

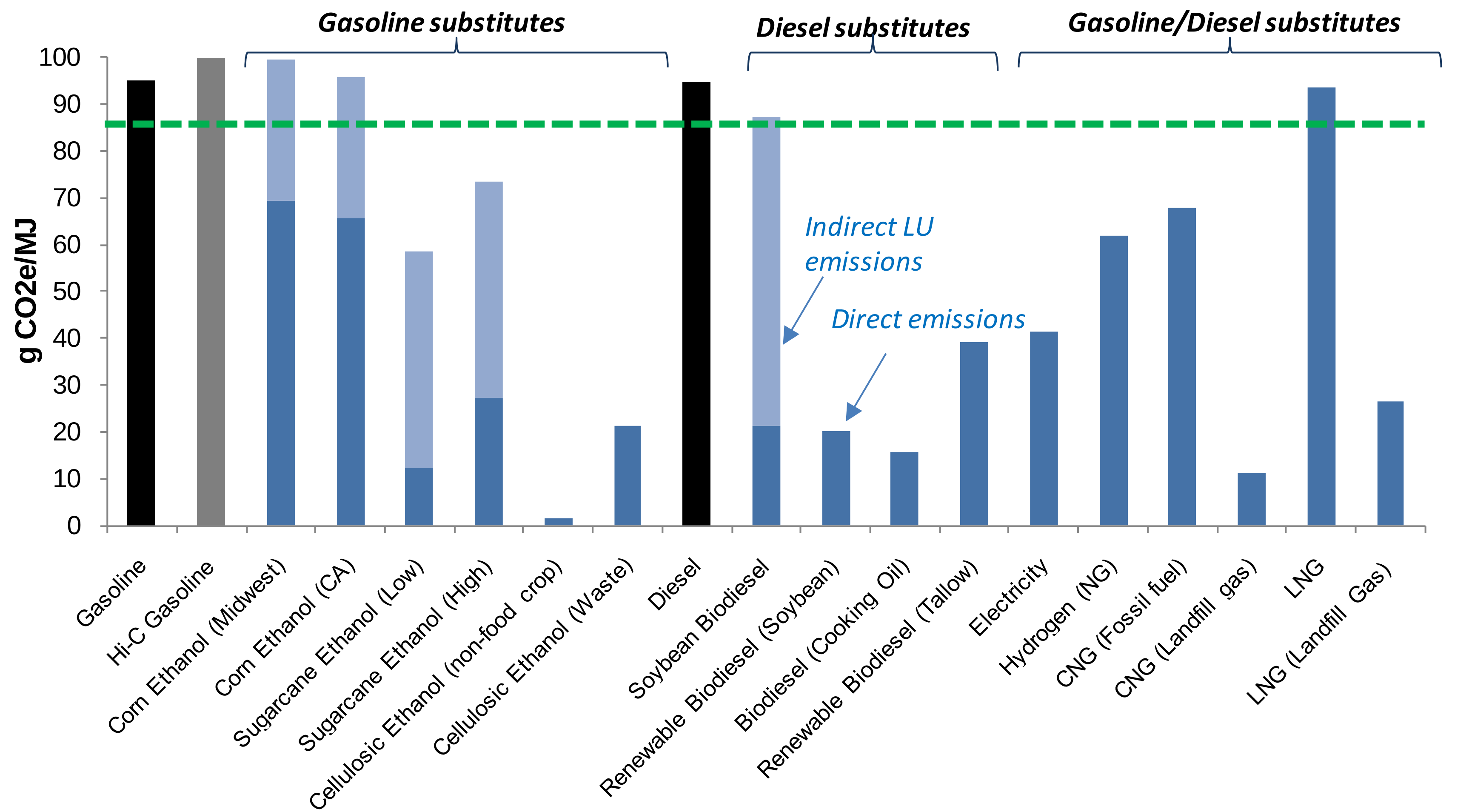
- Policy impact analysis (and LCA used as a policy tool) should include all significant effects, including land use changes

RFS2's Analysis of the Indirect Land Use Change – Sugarcane Ethanol



Source: US. EPA (2010) "Renewable Fuel Standard Program (RFS2) Regulatory Impact Analysis."

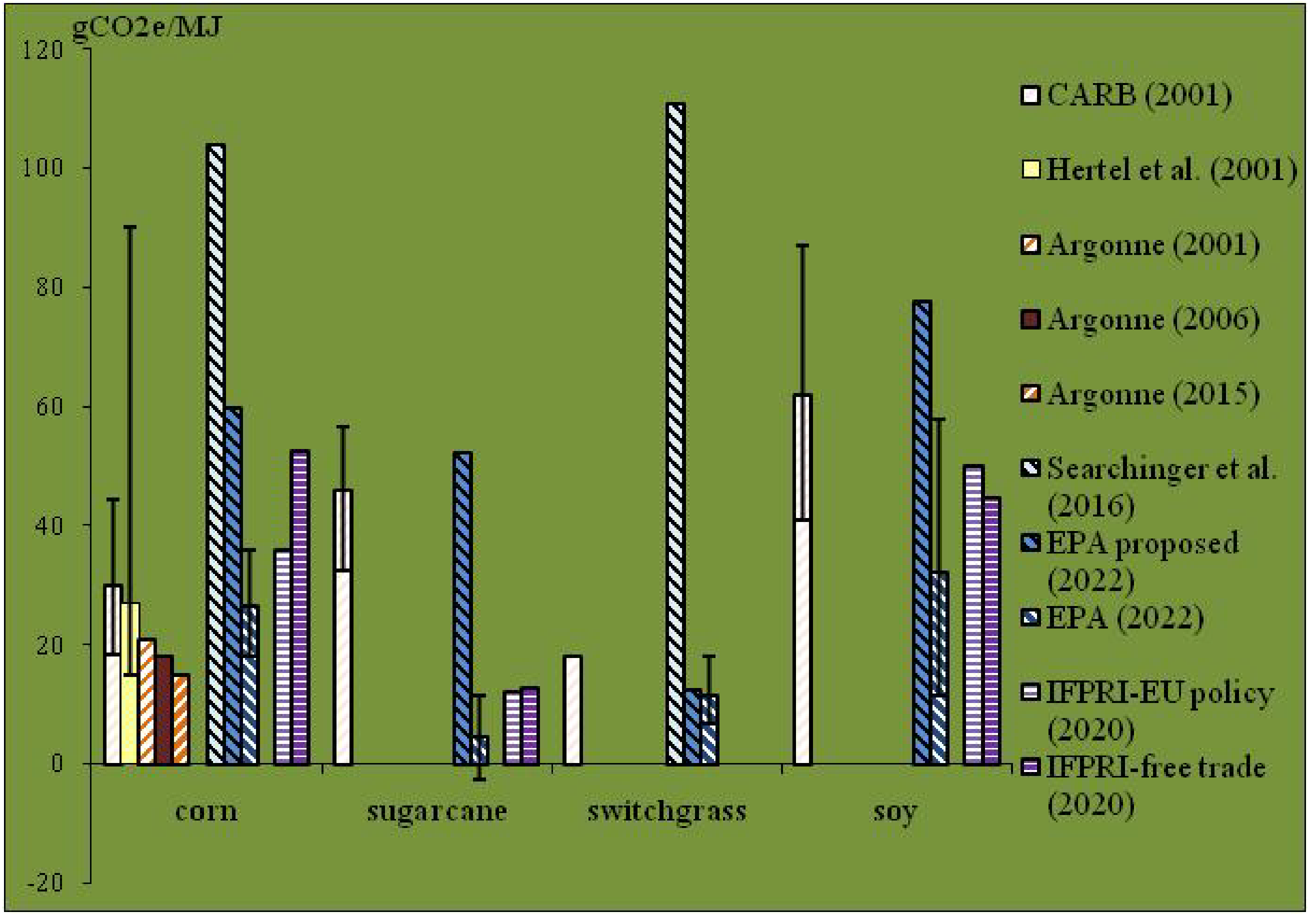
California's Lifecycle GHG Emissions of Fuels



California LCFS greenhouse gas (GHG)-intensity ratings (gCO2e/MJ) for transportation fuels, adjusted for vehicle efficiency. Although uncertainties are not indicated in this graph, the uncertainties of indirect emissions are much larger than the uncertainties of direct emissions. Source: CARB (2009, 2010). The cellulosic ethanol pathways do not yet have an iLUC value.

Range of iLUC values in Recent Modeling Studies

- Feedstock-specific iLUC factors across models and over time within a given model framework exhibit considerable variation.



Model Types for iLUC Emission Evaluation

	Economic equilibrium models (general or partial equilibrium models)	'Causal-descriptive' modeling	'Deterministic' modeling (iLUC 'risk adder')
Description	Regional supply and demand for biofuel feedstocks and related agricultural commodities; trade; link to energy market	Traces specific market pathways to iLUC change	Uses externally specified average land-use, trade patterns, land cover
Who uses?	California LCFS (GTAP model); U.S. RFS2 (FASOM and FAPRI models); EC (MIRAGE model)	Developed for UK RTFO	Research institute (Öko-Institut)
Pros and cons	History in policy analysis, captures actual economic behavior and linkages. Many data gaps and uncertainties, false sense of precision, lack of transparency	Transparency, exploration of very new scenarios. Can miss complex market feedbacks; relies on historical trends and expert and stakeholder opinion to identify pathways	Transparency, ease of implementation. Can miss complex market linkages and feedbacks; use of averages may not reflect most likely effects; some seemingly ad hoc assumptions regarding actual v. potential iLUC

Key Elements and Uncertainties in Estimating iLUC-related GHG Emissions

Elements	Key uncertainties
Feedstock demand	Fuel yield; co-product markets; price elasticity of demand
Trade balance	Tariffs and other trade barriers (e.g., subsidies); trade impacts of increased biofuel demand (altered trading patterns)
Area and location of lands converted	Increases in crop yields; productivity of new land; bioenergy-induced additional productivity increase; land-use elasticities; supply of land across different uses; availability of idle, marginal, degraded, abandoned, and underutilised land and unmanaged forest; methodology of allocating converted land
LU & LUC emission factors	Biofuel cultivation period; soil and biomass carbon stock data (especially peatlands); soil nitrogen emissions; time accounting of carbon emissions
Other non-iLUC emissions and climate effects	GHG emissions from agriculture production changes such as cattle, methane emissions from rice cultivation and fertilizer inputs; albedo changes (e.g., snow on former boreal or temperate forest land)

Mitigation Strategies being Proposed

Strategy	Level(s) and actor(s)	Issues
Control direct emissions, work toward int'l policies covering all land activities **(e.g. REDD)**	National and international level; governments, industry, NGOs	Allows iLUC emissions until protections in place; more upward pressure on food price when all land-use conversions are covered
Encourage non-land-using feedstocks (such as imposing an iLUC factor to a particular feedstock pathway) **(e.g. iLUC factors/bonus in CA/EU)**	National level; governments	Concerns about regulating on the basis of actions by others outside the jurisdiction, choosing a single number given uncertainties; no incentive for improvement given feedstock choice
Macro measures targeting efficiency of agricultural supply **(e.g., producer setaside funds)**	Firms and industry level; governments, NGOs, and international bodies	Do not address iLUC effect directly, hard to measure additionality, thin on details of how a credit system would work
Avoid displacement (UK Ecofys and Winrock case study work) [avoids price response] **(e.g. low iLUC pathways in UK)**	Project level; supply-chain actors, certification industry	Prescriptive standard, shares issues with other certification schemes (including the Clean Development Mechanism, or CDM), difficult to scale up, hard to measure additionality, thin on details of how a credit system would work
"Contain" iLUC via direct LUC areas [doesn't avoid price response]	Regional level; supply-chain actors	Designing, assessing containment (requires theory of incomplete price transmission), thin on details of how a credit system would work
"Contain" iLUC via avoiding iLUC prone areas	Regional level; supply-chain actors, targeting production systems	Assessing successful containment (given uncertainty regarding location of iLUC response), hard to measure additionality, thin on details of how a credit system would work

Short-term Regulatory Options for Dealing with iLUC

- **Research**: work with academic communities and stakeholders to improve models uncovering the drivers (if not always the magnitude) of iLUC to gain a better handle on the challenging task of improving the scientific understanding of iLUC.
- **Incentives**: directly incentivize the development and use of low-GHG biofuels from less land-using sources, including organic waste, crop residues, and forest waste.
- **Sustainability**: adopt enforceable, effective sustainability policies to prevent
  - conversion of ecologically sensitive and high-carbon areas for biofuels and any other purpose;
  - encourage appropriate use of fertilizers and other inputs to reduce harmful environmental impacts from excess runoff; and
  - work to improve access for the poor to food, especially if prices rise.