Uncertainty in Indirect Land Use Change Emissions in the Life Cycle of Biofuels:

Implications for Legislation

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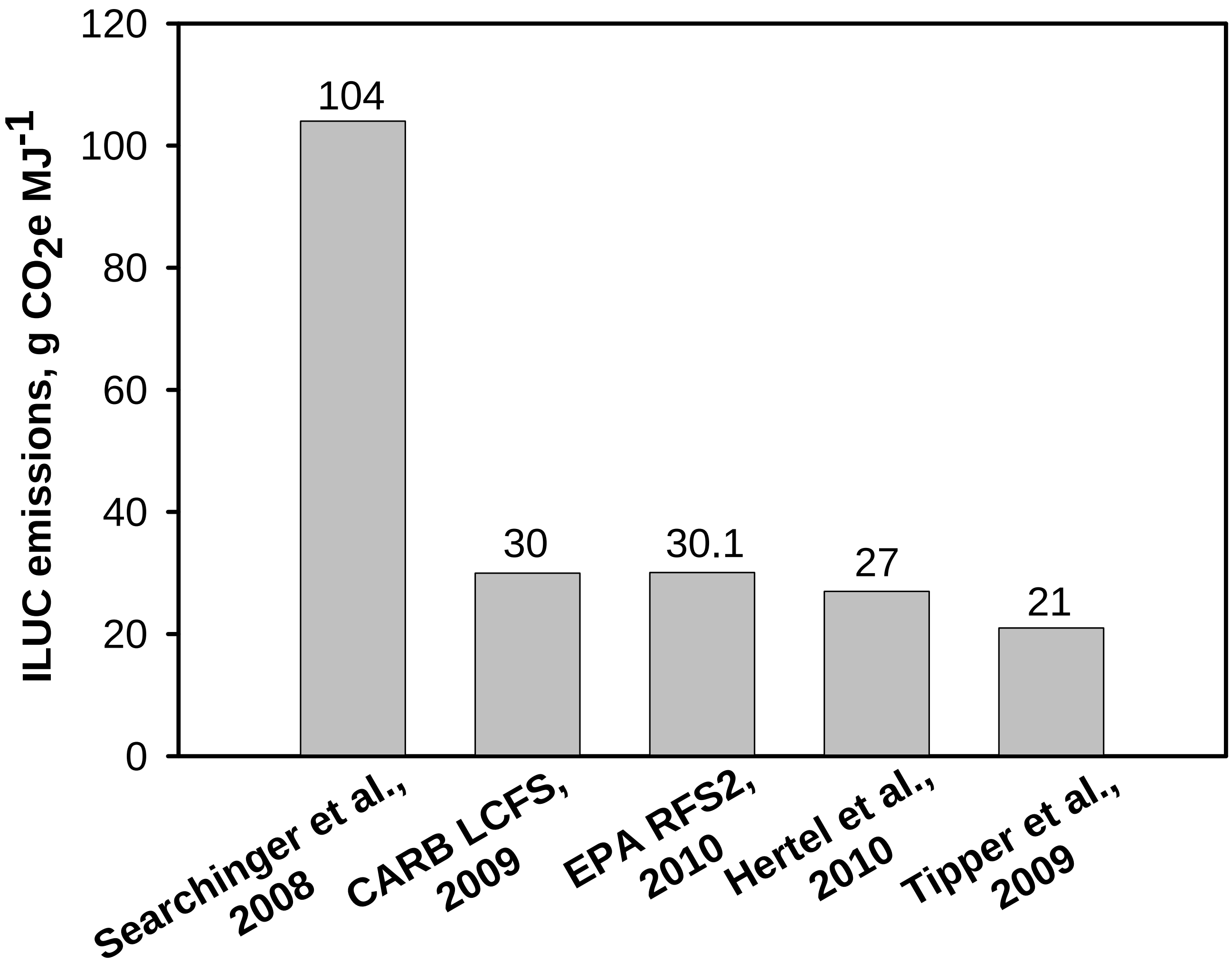
Impending climate change legislation

- H.R. 2454, the *American Clean Energy and Security Act of 2009* was passed in the House on June 26, 2009
- H.R. 2454 contains provisions that would amend the Clean Air Act to establish a cap-and-trade system designed to reduce greenhouse gas emissions from covered sources 17% below 2005 levels by 2020 and 83% below 2005 levels by 2050
- **Sec. 551** of the bill would eliminate a requirement that LCA include GHG emissions from international indirect land use changes (ILUC) from biofuel production in the U.S.
- *Is it accurate to not include ILUC in the life cycle?*
- *Will this provision do away with ILUC?* No.

Source: *Greenhouse Gas Legislation: Summary and Analysis of H.R. 2454 as Passed by the House of Representatives*. M. Holt and G. Whitney. Congressional Research Service

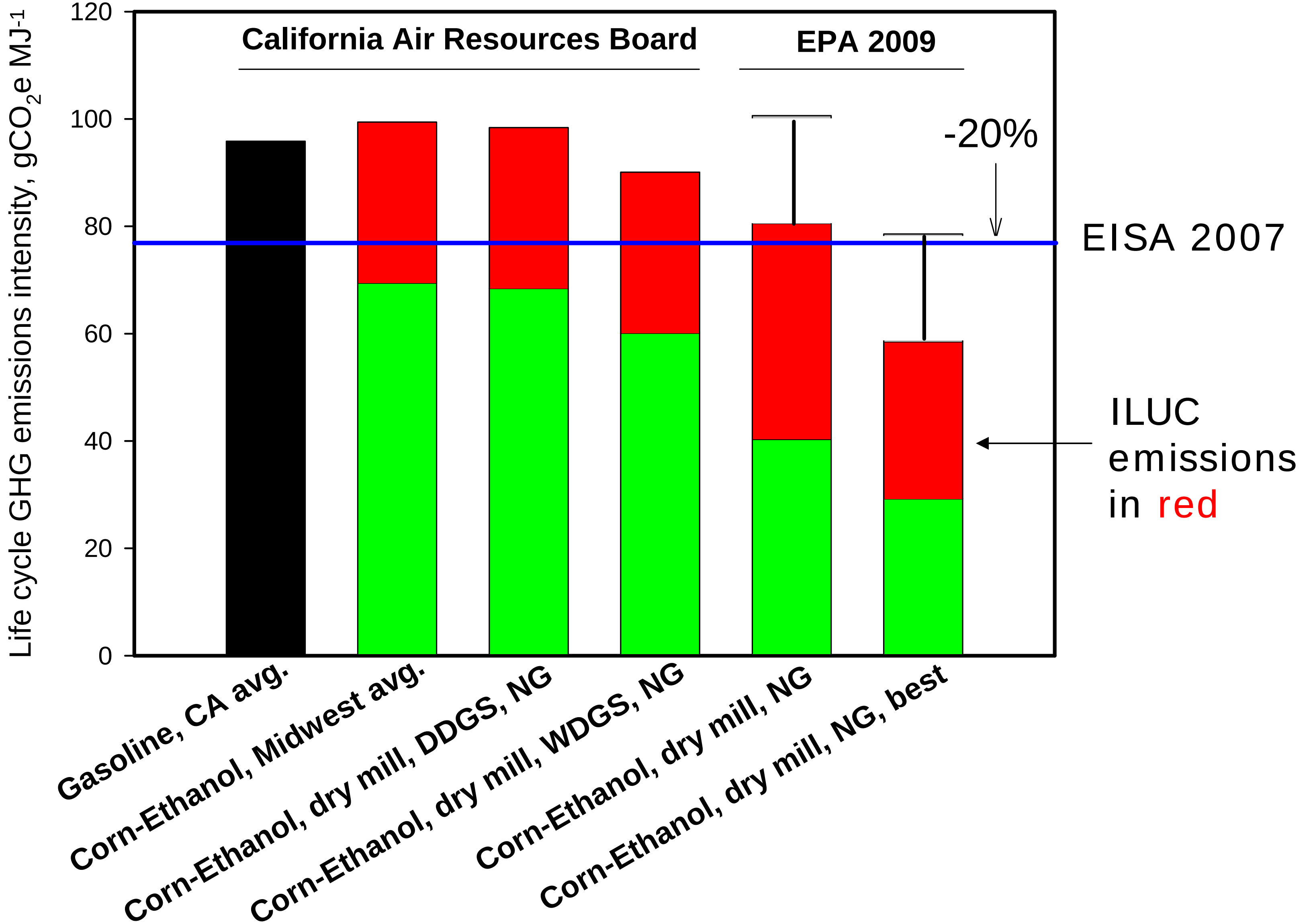
Projected average GHG emissions rates from international ILUC due to U.S. corn-ethanol production over 30 years: the ILUC concept has strong support from some in the scientific community; *most new est. between 21-30 gCO_2/MJ*



Sources: Searchinger et al. Science, 2008, Hertel et al. Bioscience, 2010, www.arb.ca.gov/fuels/lcfs/030409lcfs_isor_vol2.pdf, www.epa.gov/otaq/renewablefuels/420r10006.pdf

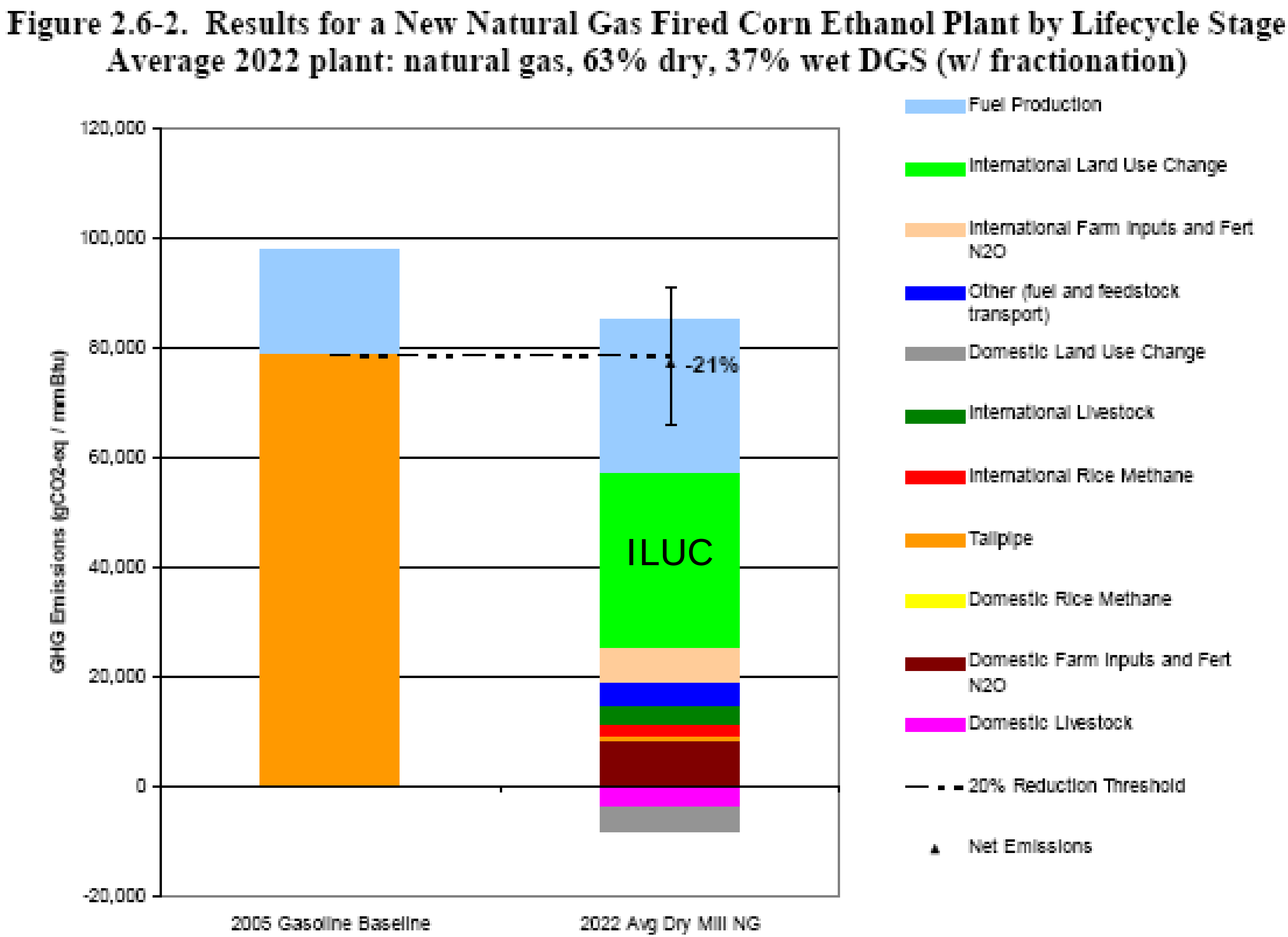
Impact of ILUC GHG emissions in the corn-ethanol life cycle

Where reductions aren't met, biofuel markets and subsidies are at risk



Sources:
http://www.epa.gov/otaq/renewablefuels/420f09024.pdf,http://www.arb.ca.gov/fuels/lcfs/121409lcfs_lutables.pdf

EPA's new life cycle emissions results (Feb. 2010)

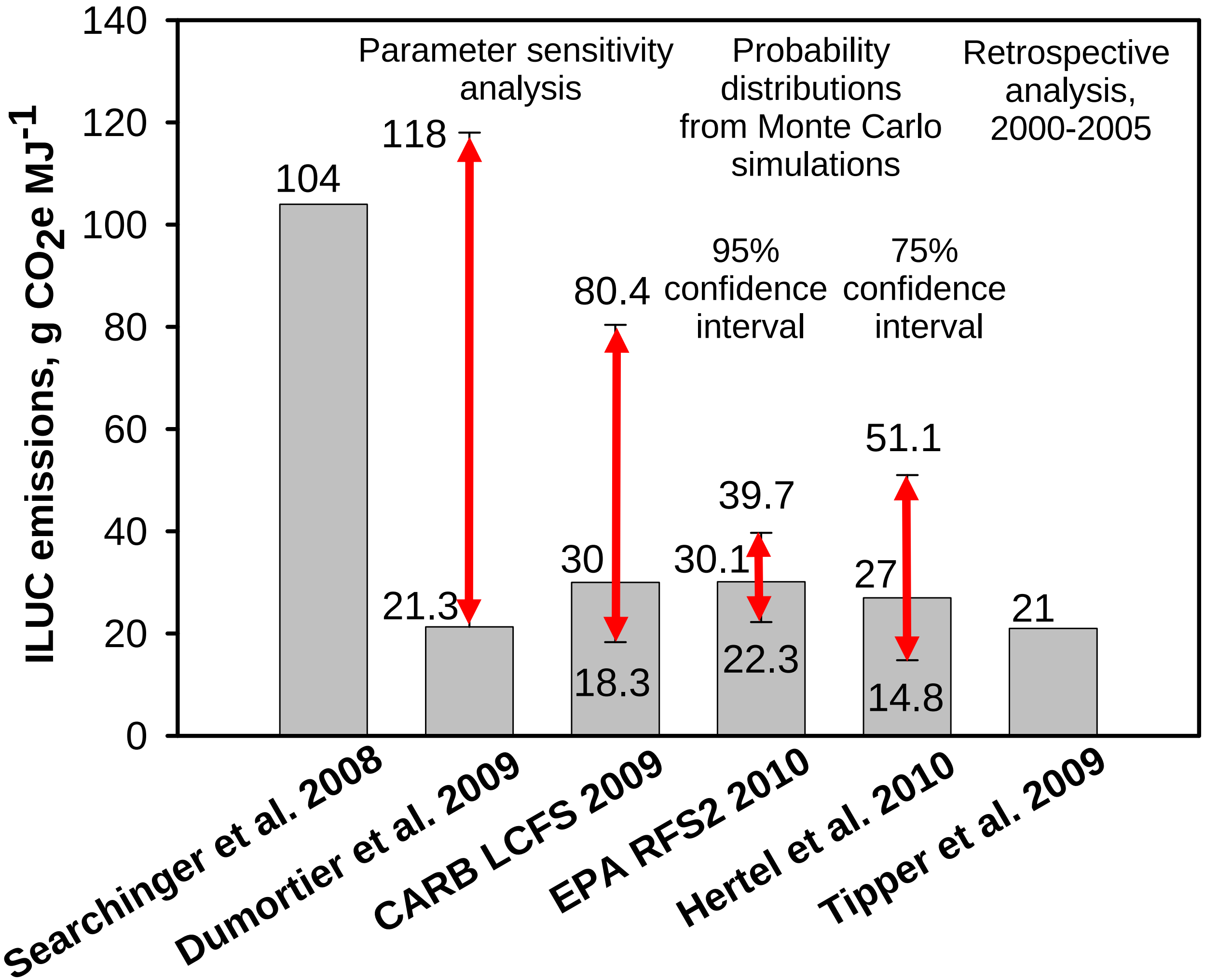


Source: http://www.epa.gov/otaq/renewablefuels/420r10006.pdf

Theory behind ILUC emissions from biofuels

- Land use change released **1/5** of global anthropogenic GHG emissions in the 1990's, and **1/3** since 1750 (IPCC 2007)
- Higher prices for agricultural products due to biofuels are likely to drive agriculture expansion abroad (Morton et al. PNAS, 2006)
- There is no scientific consensus for measuring market-mediated ILUC using models for associated emissions from grain or biomass-based biofuels (ILUC is relevant for both)
- ILUC estimates are a projection of *what could happen* in an uncertain future by projecting past trends
- Uncertain parameters include crop yield response, trade substitutions, and land use responses from higher prices
- **Example of uncertainty and its implications:** Future global cap-and-trade policy could dramatically slow future land use conversion rates and ILUC from biofuels, thus dramatically reducing ILUC estimates used today (Liska and Perrin, 2009)

Uncertainty in parameters for GHG emissions from ILUC due to U.S. corn-ethanol production over 30 years



Sources: Searchinger et al. Science, 2008, Hertel et al. Bioscience, 2010, www.arb.ca.gov/fuels/lcfs/030409lcfs_isor_vol2.pdf, www.epa.gov/otaq/renewablefuels/420r10006.pdf

Note: A. Liska, from book chapter in progress for Cambridge University Press (March 2010)

Regulation of one indirect effect (ILUC) does not accurately account for changes in net GHG emissions: *Direct & indirect emissions from gasolines and biofuels need to be compared*

Table 1. Additional factors and uncertainties that determine net changes in indirect greenhouse gas emissions from transportation fuel production. Emissions units in $TgCO_2e\ yr^{-1}$.

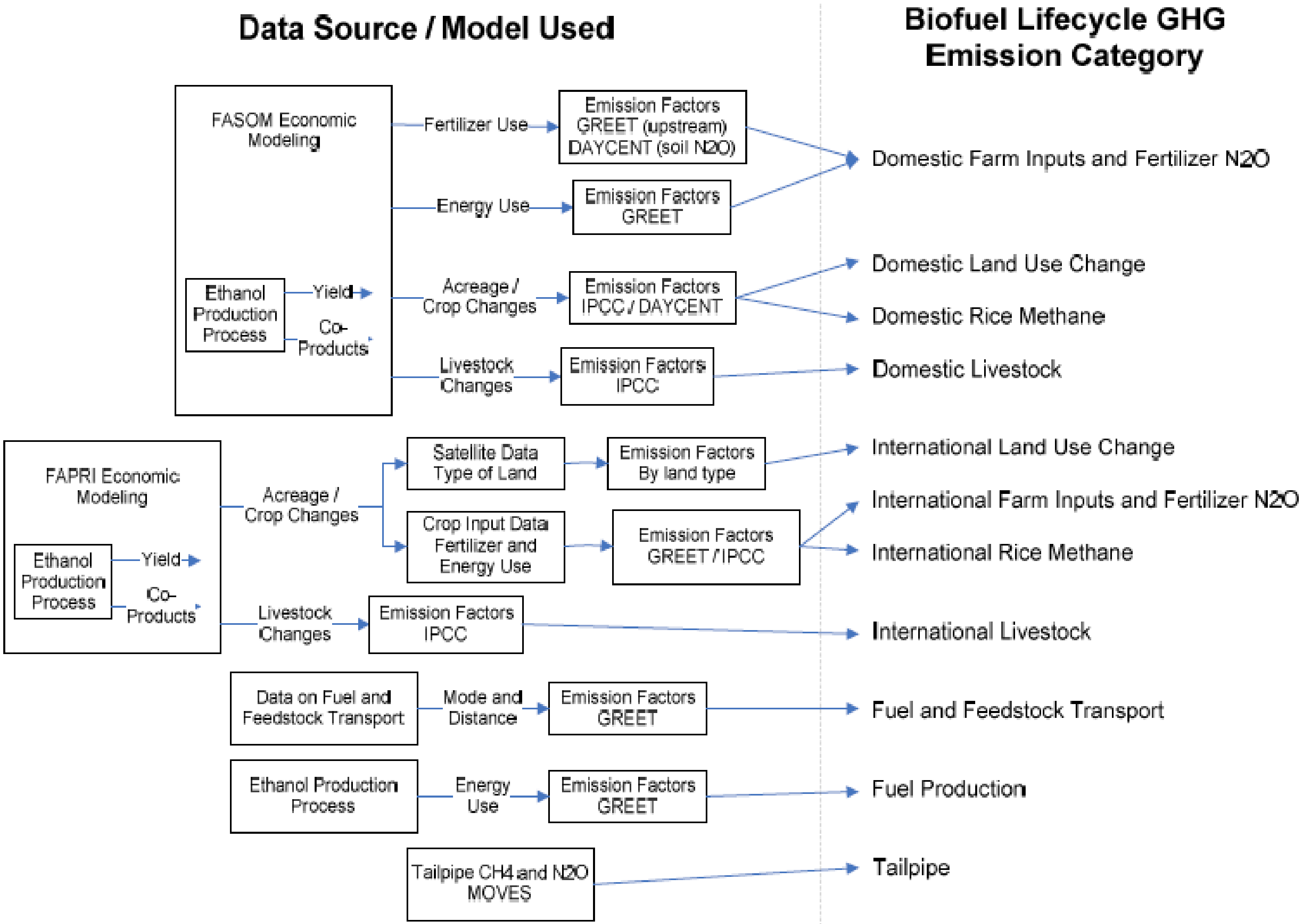
Factors Influencing Indirect GHG Emissions	Contribution to Atmospheric GHGs
Biofuels	Marginal Changes Upon Biofuel Production
Deforestation and Grassland Conversion	+ (127[†])
Rice Expansion[a]	+
Livestock Decline	– (58[†‡])
Reclamation of Dry and Degraded Lands[b]	–
Substitution of Corn for Soybean and Wheat[c]	–
Geographic Pattern of Land Conversion[d]	+/–
Climate Policies for Forest Maintenance[e]	–
Petroleum	Additional & Marginal Emissions Not Currently Included
Tar Sands and Unconventional Fuels[f]	+
Indirect Military Fuel Use and Infrastructure[g]	+ (187[§])
Processing and Transportation Losses[h]	+

US military fuel use & infrastructure to secure acquisition of foreign oil costs ~$100 billion per year, our updated estimate of indirect military emissions (IME) for Middle East-derived gasoline is about ~11-23 gCO_2e/MJ, unpublished results, to be submitted.

Source: Liska and Perrin, *Biofuels, Bioproducts, Biorefining* 3, 318-328 (2009)

EPA's macro modeling framework (Feb. 2010) tries to capture most significant indirect effects

Figure 2.2-1 System Boundaries and Models Used



Source: http://www.epa.gov/otaq/renewablefuels/420r10006.pdf

Modeling complexity in biofuel life cycle emissions

- ***Problem:*** Most biofuel LCA's use one (1) model that has 300-400 parameters, *yet lengthy controversy* over the accuracy of these models still exists due to inconsistent use of *data sources* and *system boundaries*
- *Highly controversial* Searchinger study of indirect land use emissions combined 2 complex models: GREET & FAPRI
- EPA's LCA methodology combines 6 highly complex models to capture *direct* & *indirect* emissions:

  GREET, ASPEN, DAYCENT, FASOM, FAPRI, MOVES

  in total having *tens of thousands of parameters*

  No similar LCA is found in the scientific literature
- *EPA's approach will likely still not capture all significant indirect emissions (Liska & Perrin 2009), and a reasonable level of accuracy by this method is nearly unattainable due to uncertainty in projected parameters values (Kim, Kim, Dale, ES&T 2009)*

Transparency & complex indirect effects in regulations

- ***Problem:*** *When using tens of thousands of parameters, can regulatory LCA be 100% transparent? Likely No.*

- ***Recommendations:***

  --Evaluating all indirect effects in one LCA is excessively complex, particularly for contentious EPA regulation

  --EPA's LCA methods should only be as complex as can be practically & transparently reviewed & supported by accurate data, within acceptable uncertainty limits

  --<u>If sufficient transparency & accuracy are not achieved for all indirect effects, then all indirect effects should be excluded from the regulatory LCA (not only eliminating ILUC from biofuels)</u>

Proposed **Land Grant Biofuel LCA Working Group**

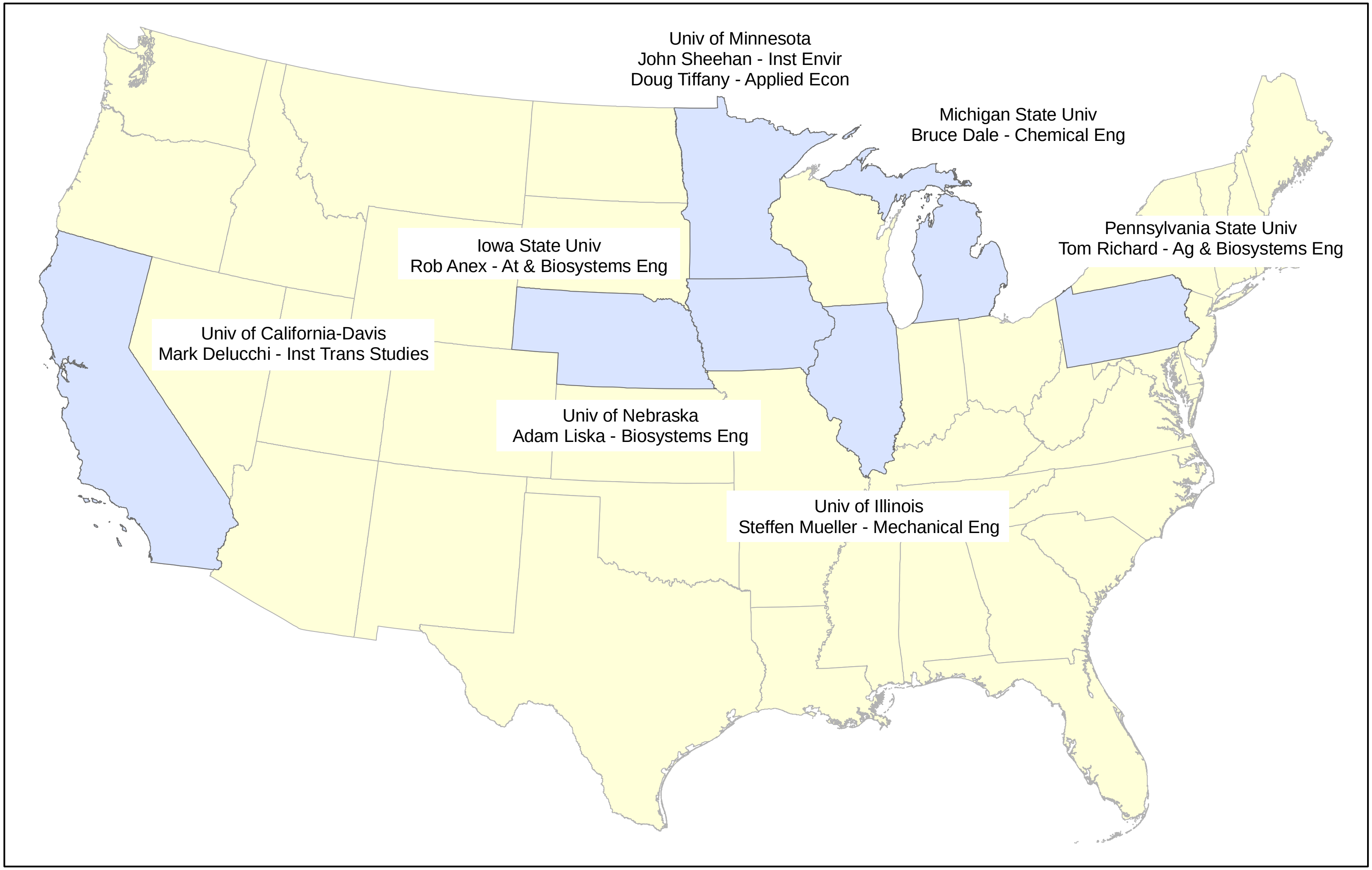
- Provide integrated scientific leadership & assistance in regulatory LCA to help *ensure accuracy*, *rigor* and *fairness* by building consensus in modeling approaches, integrate information from stakeholders, parallel working groups
- Proposed requirements for research participants:
  - *Land Grant universities*

    (non-industry perspective with broad research resources)
  - *Published scientific articles on biofuel LCA & related issues*

    (experience in nuances of LCA research)
  - Agricultural research & closely related disciplines

    (experience in systems directly—as *corn-ethanol is the dominant fuel under scrutiny*, those with direct experience in these systems will have best insight)

Proposed **Land Grant Biofuel LCA Working Group**



In total, this group has published 80+ scientific articles directly on LCA of biofuels and closely related issues

Land Grant Biofuel LCA Working Group

Proposed collaborators:

- Research resources at Land Grant universities
- USDA, DOE, EPA, DOT
- Midwestern Governors' Association — *LCFS Working Group*
- National Research Council
- Industry
- Roundtable on Sustainable Biofuels

Why is our approach different?

- Critical mass of academic researchers that have: 1) <u>*direct experience with biofuel LCA*</u>, 2) *could provide sustained efforts (~5 yrs),* 3) independent from *oil* or *biofuel* industry

Funding support

- Western Governor’s Association
- US Department of Agriculture
- US Department of Energy
- Environmental Defense Fund
- University of Nebraska Center for Energy Sciences Research
- University of Nebraska Agricultural Research Division

Research Collaborators

- Prof. Kenneth Cassman, Agronomy, Univ. Nebraska
- Prof. Richard Perrin, Ag. Econ., Univ. Nebraska
- Profs. Terry Klopfenstein & Galen Erickson, Animal Science, Univ. Nebraska

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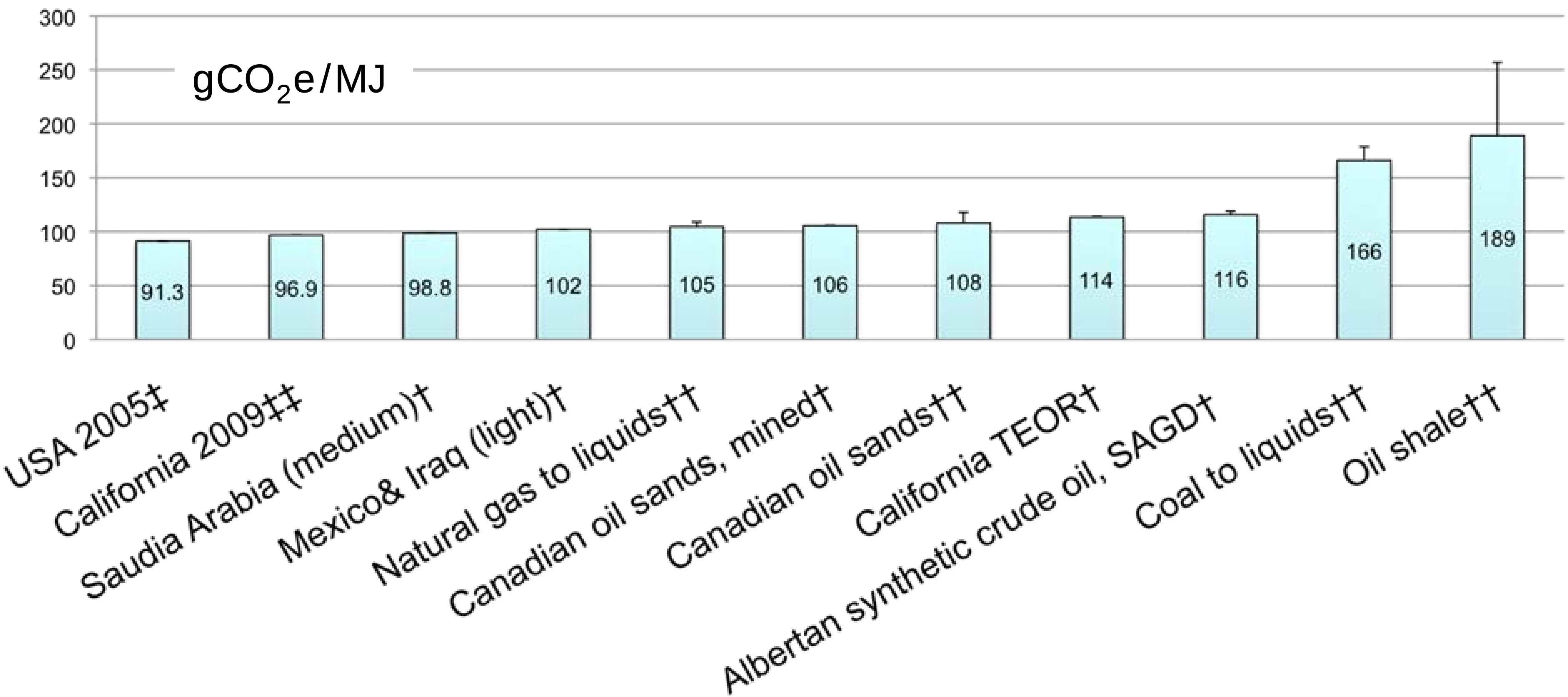
GHG emissions from gasoline depend on source

Future gasoline will rely more on unconventional sources of petroleum & will be more GHG intense

needs to be accurately handled by regulatory legislation



†Jacobs Consultancy, Alberta Energy Research Institute
‡NETL 2009
‡‡ CARB 2009
††Brandt and Farrell 2007

TEOR = thermally enhanced oil recovery
SAGD = steam assisted gravity and drainage

Session Question: Is policy moving faster than the science that supports it?

ABSTRACT

Current EPA life cycle analysis (LCA) of greenhouse gas (GHG) emissions from corn-ethanol will be the foundation for regulations for advanced biofuels. It appears regulatory policies that include emissions from indirect land use change (and other indirect emissions) in the biofuel life cycle are moving faster than the underlying science; there is no comparable scientific study that approaches the complexity in methods currently used by the EPA. There is substantial uncertainty in quantifying direct and indirect emissions from fuels, as evidenced by conflicting results from state and federal regulators and from within the scientific community. If indirect emissions from land use change are quantified in regulations, then all major indirect emissions for both biofuels and gasoline must to be quantified. Unfortunately, such an approach (as taken by the EPA) is excessively complicated, not completely transparent, and likely to lead to even greater uncertainty. Until these regulations more closely approach scientific consensus, and while some regulations show certain biofuels to not comply with GHG emissions standards, continued development of the biofuel industry may be weakened.