Art of Compromise
… as seen by a policy wonk, academic, and regulator (from the ivory tower to the real world)

8 Issues in Designing and Implementing Performance-Based Policies for Biofuels

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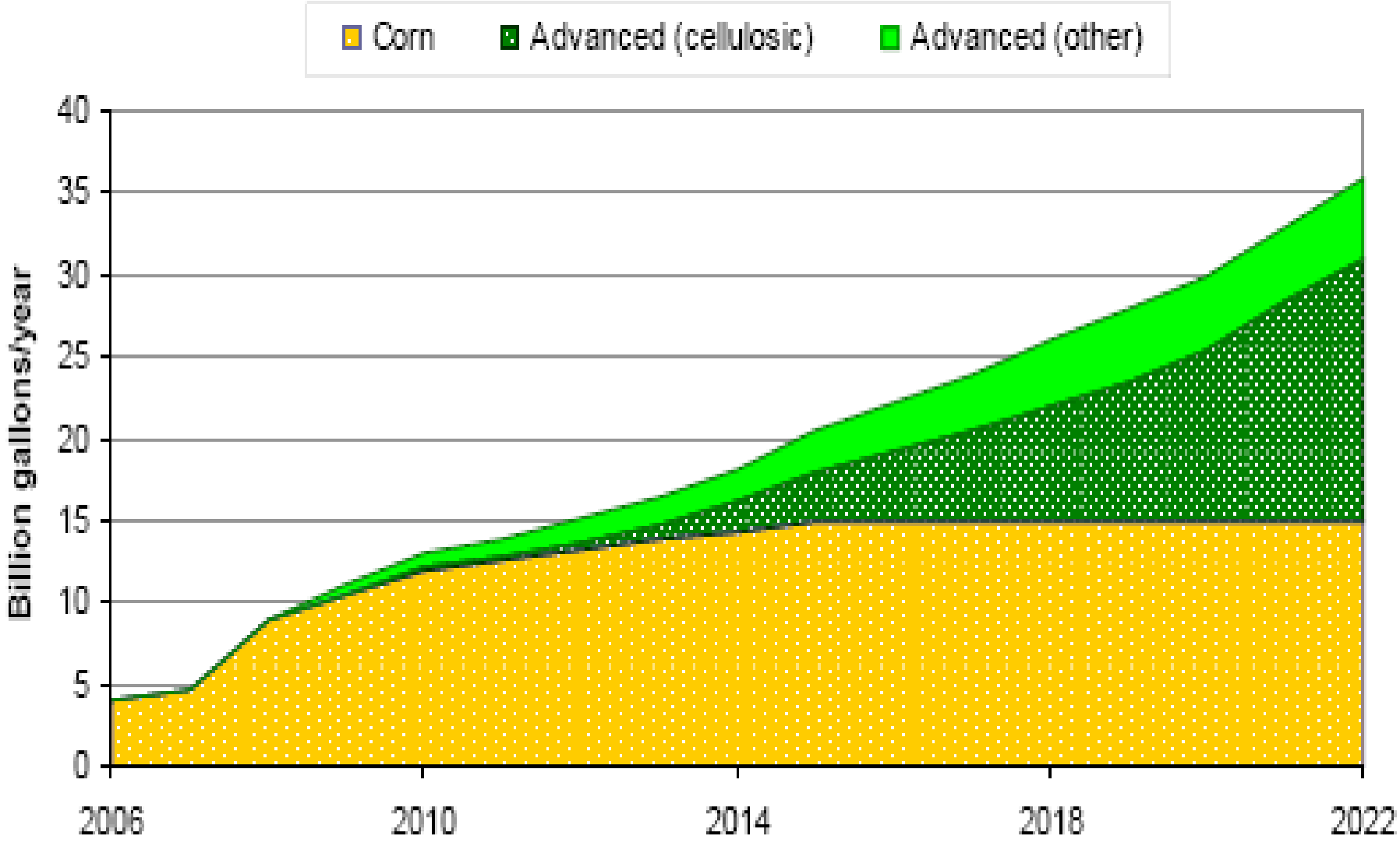
Why Performance Based Policy?

- Need gov’t intervention for non-market goals
  - oil displacement, GHGs, environmental impacts
- Mandates restrain innovation
  - No incentive to exceed mandated quality or quantity
- Fuel/carbon taxes do not overcome market barriers (and are politically unpopular)
  - Something stronger needed
- Performance stds provide flexibility to industry and stimulate innovation (and can be matched with credit trading to increase flexibility and innovation)

US Renewable Fuels Standard (RFS)

- **RFS mandates volumes of biofuels in different categories with assigned carbon intensities (CI) for each category:**
  - **Existing corn ethanol — 0% CI reduction**
  - **New corn facilities — 20% CI reduction**
  - **Other biofuels (biodiesel) — 50% CI reduction**
  - **Cellulosic biofuels — 60% CI reduction**

National Requirements for Biofuels (EISA 2007)



(California) LCFS Regulatory Design

- Performance standard (measured as carbon intensity) assigned to oil companies
- Measured as GHG emissions per unit of energy (gCO_2-eq/MJ)
- 10 percent reduction required by 2020
- Applies to on-road transport fuels (but can generate credits from low-carbon fuels used in off-road vehicles)
- Separate standards for gasoline and diesel (10% reduction for each)
- Credit trading allowed
- Biofuels are expected to be principal means of compliance (thru 2020)
  - Other likely fuels are electricity, natural gas and eventually hydrogen

Science vs Practice

8 Issues in Designing Biofuel Performance Std

1. Multiple objectives?

- GHGs, oil reduction, “sustainability”

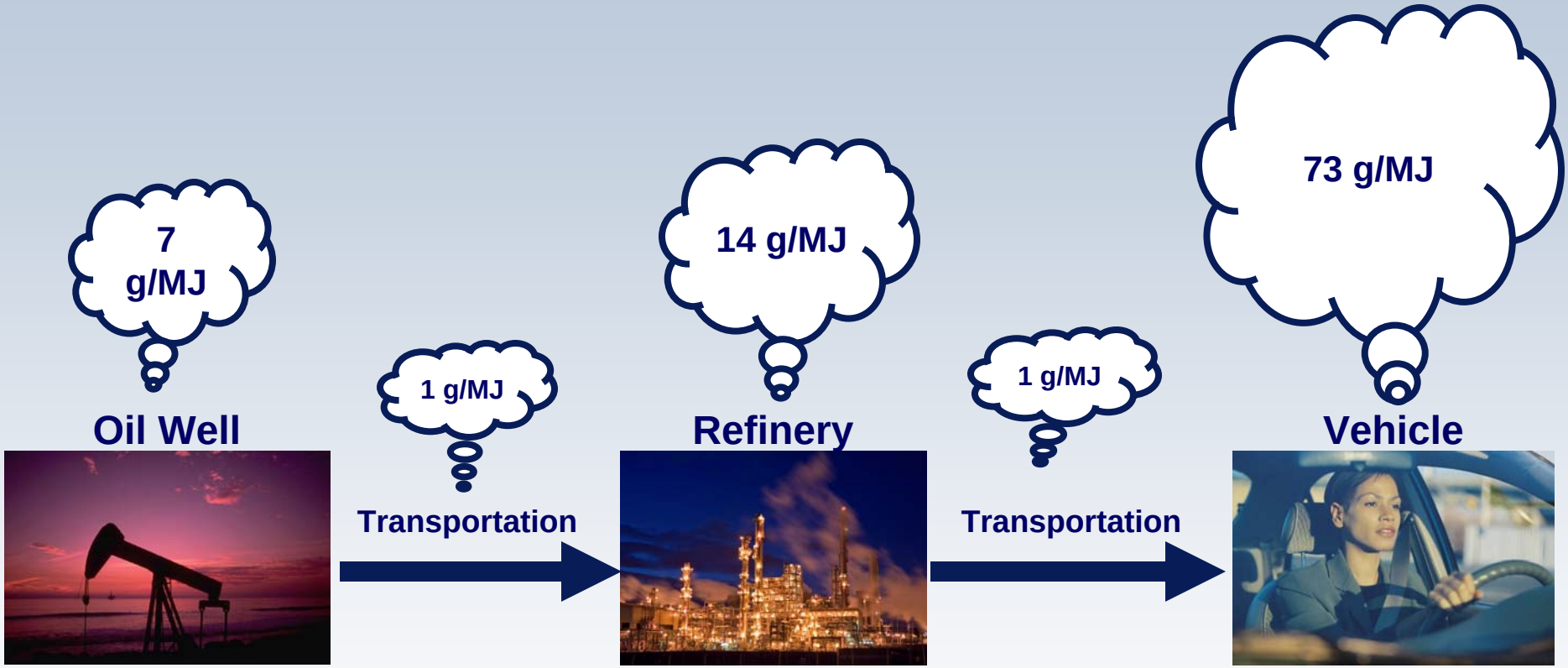
2. **Environmental and Social Impacts** (aka "Sustainability")

- Biodiversity and ecosystem integrity
- Effects on natural ecosystems, parks, or national forests
- Depletion of fresh water
- Agricultural practices (e.g. maintain soil fertility and avoid runoff)
- Invasive species
- Increases in local air pollution from new production facilities
- Disproportionate impact on disadvantaged communities (environmental justice)
- Impact on indigenous peoples
- Effect on local employment
- Competition with food and feed

3. Where to draw the analytical boundary?

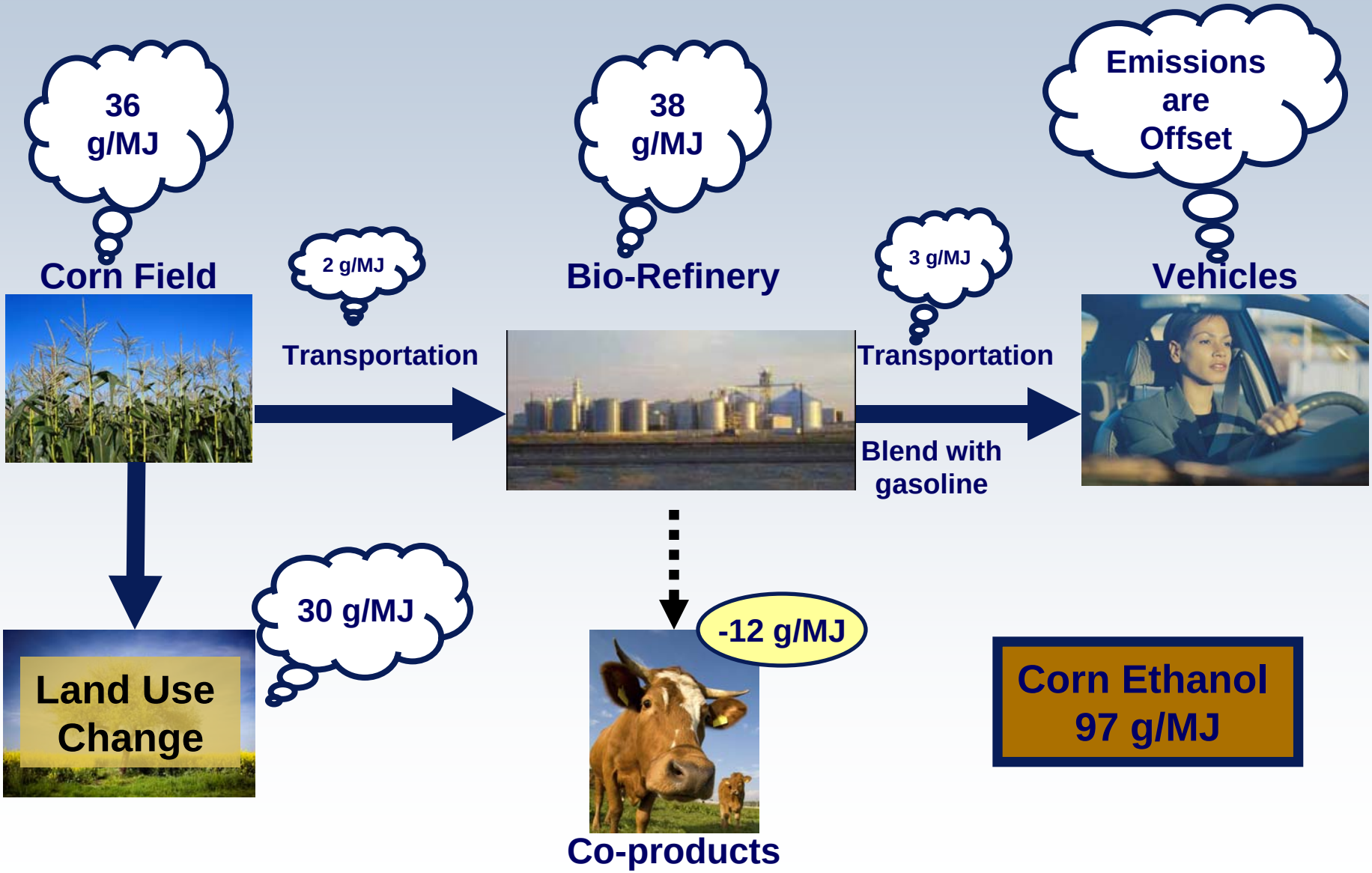
- Co-products
- Indirect land use impacts
- Embodied energy in materials

Fuel Lifecycle – Gasoline



Gasoline
96 g/MJ

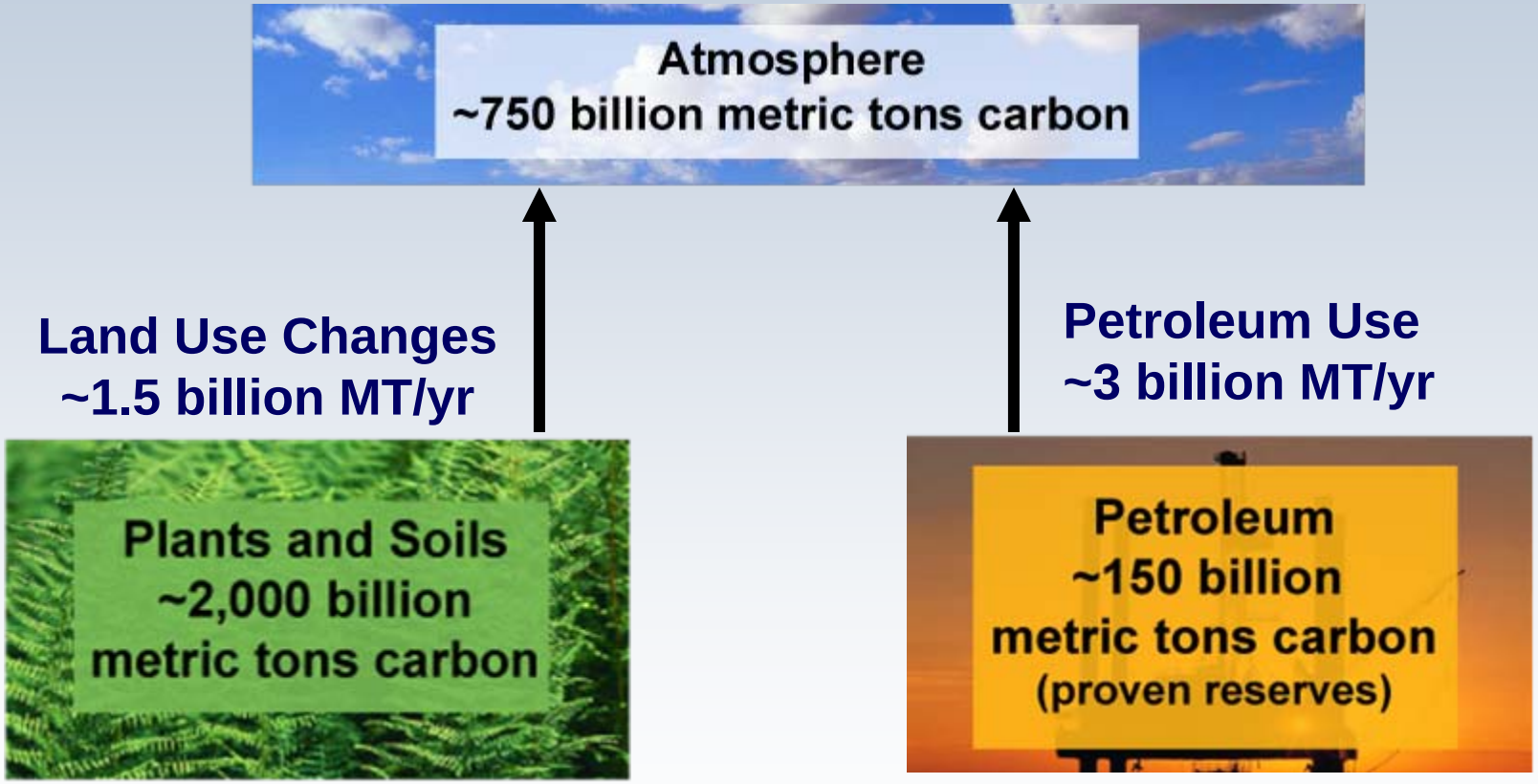
Fuel Lifecycle – Corn Ethanol



4. Scientific Uncertainty

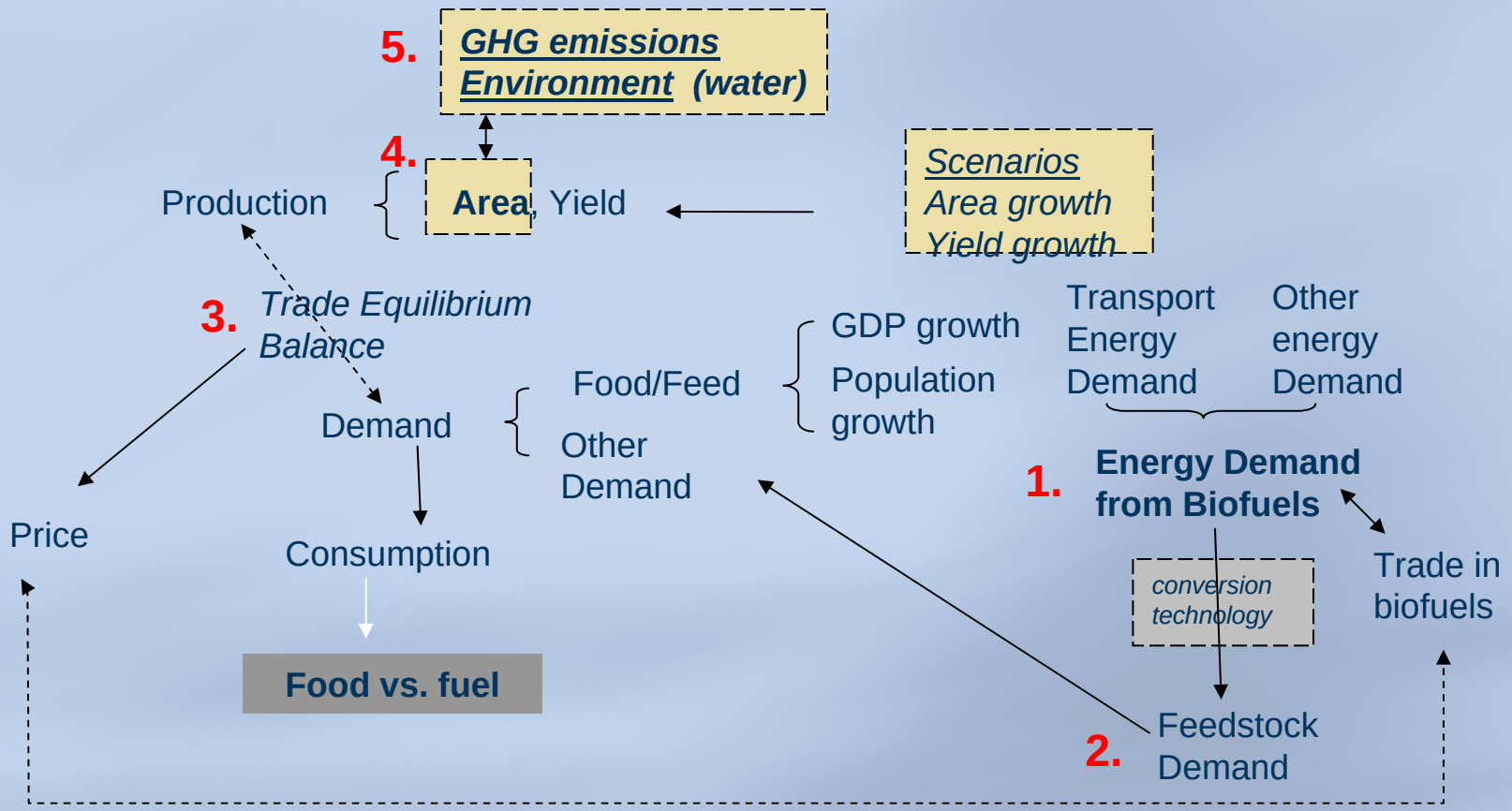
- Minimal, except for land use, N_2O??

Land Conversions Can Release Huge Amounts of Carbon



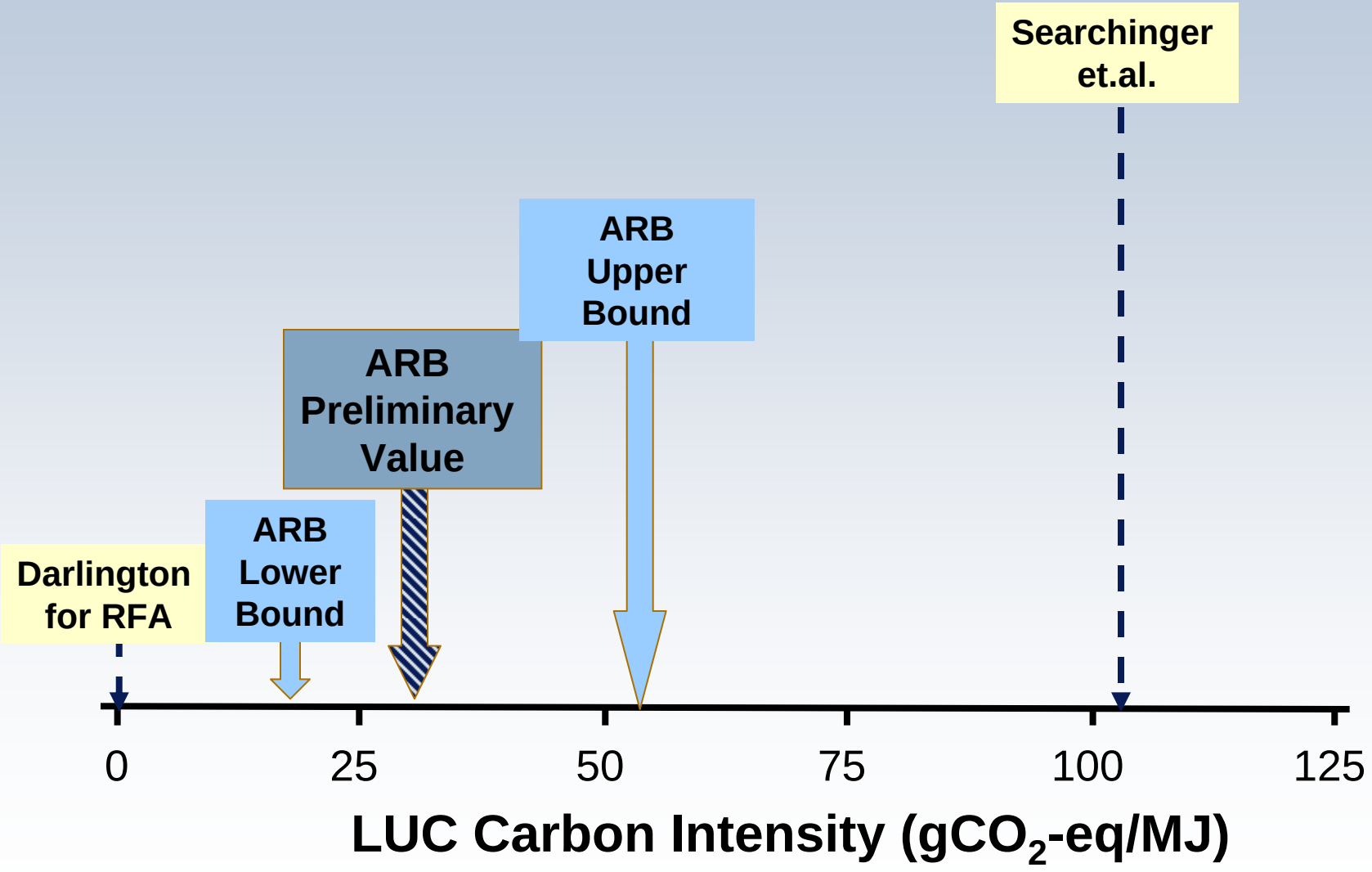
Plants and soils contain approximately 15 times the carbon in proven oil reserves.

Estimating GHG Emissions from LUC



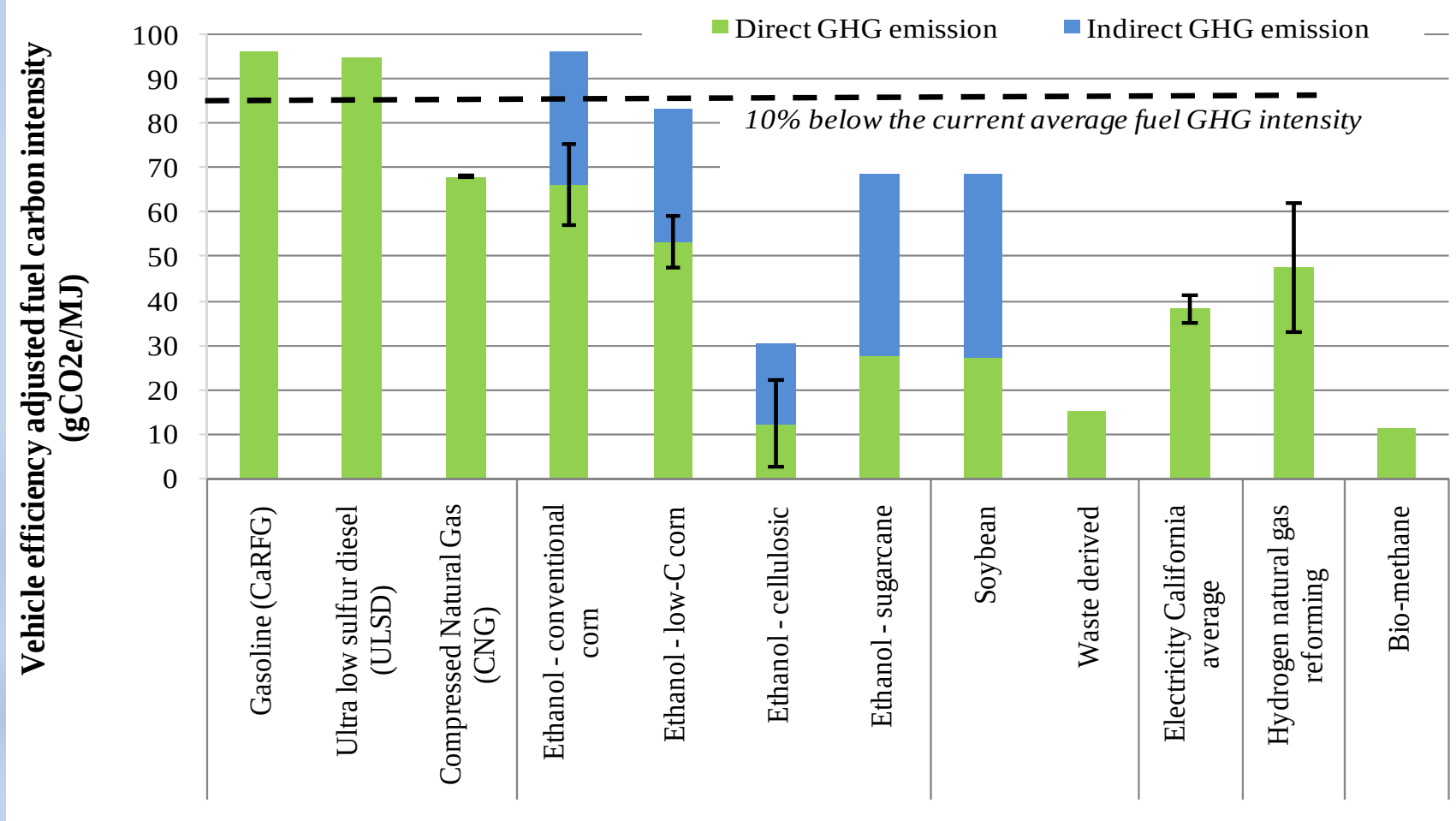
Energy Demand from Biofuels → Feedstock Demand → Trade Balance → Area of Lands Converted → GHG Emissions

Range of LUC Carbon Intensity Values for Corn Ethanol



ILUC Effects Can Be Large for Crop-Based Fuels

(Preliminary CARB Estimates)



Error bars represent range of direct lifecycle emissions using different technologies, feedstocks, and energy sources. Uncertainty of iLUC emissions are not shown, but are much larger than uncertainties of direct emissions.

Issues (cont'd)

5. Variability

- From one processing plant to another; from one corn field to another (esp N_20)
- Can be addressed by

  i) Segmenting steps in energy cycle

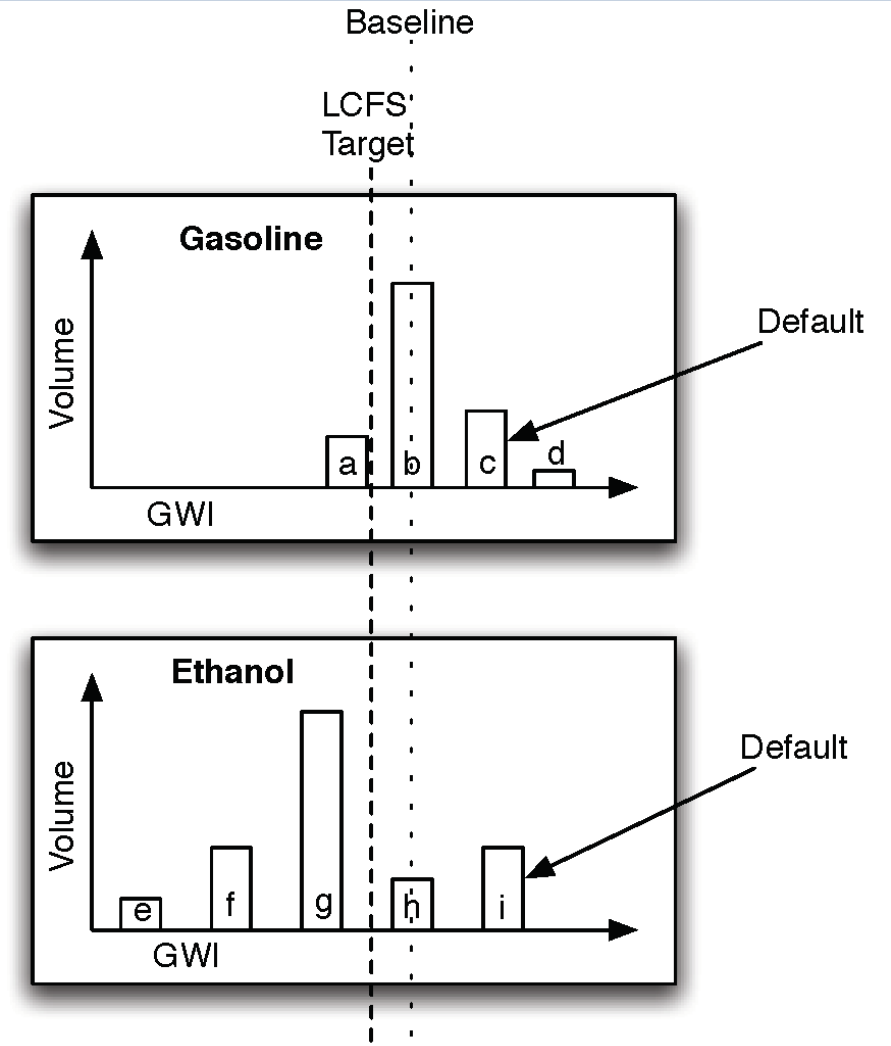
  ii) Segmenting geographically

How to Segment Activities in Energy Cycle to Reduce Variability (with defaults)

- Feedstocks
  - Gasoline: conventional oil, oil with flaring, heavy oil, oil sands, coal-based
  - Ethanol: Midwestern corn, California irrigated corn, Brazilian sugar, U.S. switchgrass
- Processing
  - Gasoline: conventional refineries, refineries with CCS, heavy oil, heavy oil with cogeneration, efficient oil sands, etc.
  - Ethanol: U.S. wet mill, coal-fired dry mill, Brazilian sugar with cogeneration, etc.

To address variability by segmenting activities…

Default and Opt-in Approach



Issues (cont'd)

6. **Attributional vs consequential methods**
   - **LCA vs market mediated changes**
   - **If biofuel supply changes because of regulation, then a rolling set of other changes happen—with prices, relative demand for competing products (corn for food), use of land, etc**
   - **Market-mediated (indirect/consequential) effects are difficult to anticipate and regulate**
7. **Implementable and enforceable?**
   - **Ease of administration (data and models, transparency, institutional capacity)**
   - ***If you can't measure it you can't regulate it…***
8. **Equity (between companies, regions, socio-demographic groups)**
   - **e.g., LCFS has separate stds for gasoline and diesel because otherwise refineries with large diesel product shares would gain windfall**

Summarizing

Issues in Designing and Implementing Performance Standards for Biofuels

1. **How to handle multiple objectives?**
2. **How to account for environmental and social impacts?**
3. **Where to draw the analytical boundary?**
4. **Scientific uncertainty—esp land use impacts**
5. **Variability (across space, feedstocks, process technologies, etc)**
6. **Attributional vs consequential methods**
7. **Implementable and enforceable?**
8. **Equity**

Why Scientists and Professors Are Necessary But Not Sufficient

- Hubris
- Science and “facts” are just the starting point
- Many compromises
  - Politics and equity
  - Ease of implementation
  - Legal (WTO, interstate commerce)
- Good science vs good outcomes
  - Reward good land use practices?