Impacts of Renewable Fuels Standard

January 2009
Transportation Research Board Meeting
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US EPA

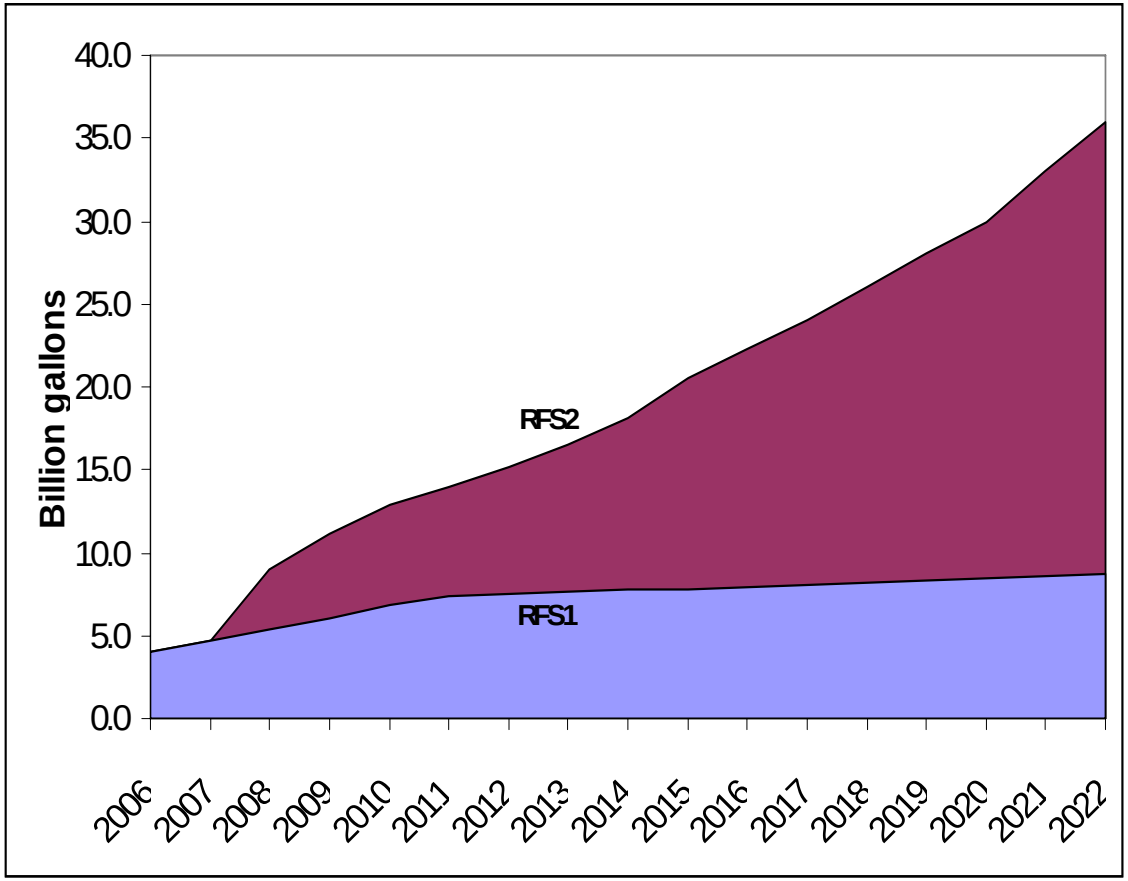
Overview

- Short Overview of Biofuel Mandates Under the Energy Independence and Security Act
- Lifecycle Assessment under the Energy Independence and Security Act
- Implications for Using All That Biofuel

Basics of the RFS2:

Energy Independence & Security Act

- **Energy Independence & Security Act (EISA) passed by Congress and signed by President in December 2007**
- **Modifies current RFS program ("RFS2")**
- **Requires Full GHG Lifecycle Assessment**

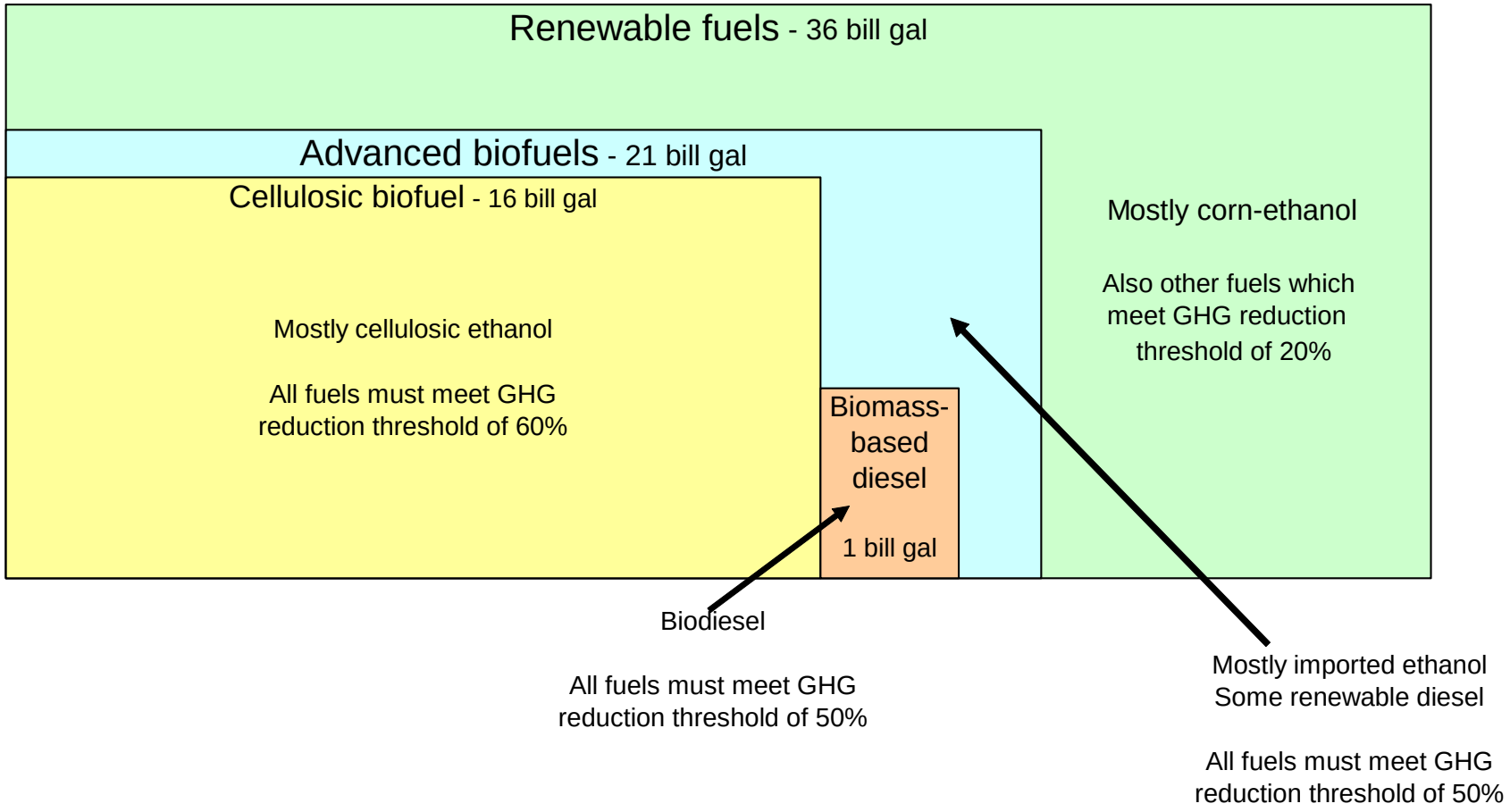


4 Separate Standards

Year	Advanced Biofuel			Total Renewable Fuel
	Biomass-Based Diesel	Cellulosic Biofuel	Total Advanced Biofuel	
2006				4.0
2007				4.7
2008				9.0
2009	0.5		0.6	11.1
2010	0.65	0.1	0.95	12.95
2011	0.80	0.25	1.35	13.95
2012	1.0	0.5	2.0	15.2
2013	1.0	1.0	2.75	16.55
2014	1.0	1.75	3.75	18.15
2015	1.0	3.0	5.5	20.5
2016	1.0	4.25	7.25	22.25
2017	1.0	5.5	9.0	24.0
2018	1.0	7.0	11.0	26.0
2019	1.0	8.5	13.0	28.0
2020	1.0	10.5	15.0	30.0
2021	1.0	13.5	18.0	33.0
2022	1.0	16.0	21.0	36.0

The Standards are Nested

Shown with 2022 volumes



EPA’s Lifecycle GHG Work

EISA Requires Lifecycle Assessment

- Each fuel category required to meet mandated GHG performance thresholds (reduction compared to baseline petroleum fuel replaced)
  - **Conventional Biofuel** (ethanol derived from corn starch)
    - Must meet 20% lifecycle GHG threshold
    - Only applies to fuel produced in new facilities
  - **Advanced Biofuel**
    - Essentially anything but corn starch ethanol
    - Includes cellulosic ethanol and biomass-based diesel
    - Must meet a 50% lifecycle GHG threshold
  - **Biomass-Based Diesel**
    - E.g., Biodiesel, “renewable diesel” if fats and oils not co-processed with petroleum
    - Must meet a 50% lifecycle GHG threshold
    - 20-50% still counts as renewable fuel
  - **Cellulosic Biofuel**
    - Renewable fuel produced from cellulose, hemicellulose, or lignin
    - E.g., cellulosic ethanol, BTL diesel
    - Must meet a 60% lifecycle GHG threshold
- EISA language permits EPA to adjust the lifecycle GHG thresholds by as much as 10%
- Baseline fuel for comparison is gasoline and diesel fuel in 2005

Definition of Lifecycle GHG Emissions

‘‘(H) LIFECYCLE GREENHOUSE GAS EMISSIONS.—The term ‘lifecycle greenhouse gas emissions’ means the aggregate quantity of greenhouse gas emissions (including direct emissions and significant indirect emissions such as significant emissions from land use changes), as determined by the Administrator, related to the full fuel lifecycle, including all stages of fuel and feedstock production and distribution, from feedstock generation or extraction through the distribution and delivery and use of the finished fuel to the ultimate consumer, where the mass values for all greenhouse gases are adjusted to account for their relative global warming potential.

Methodology

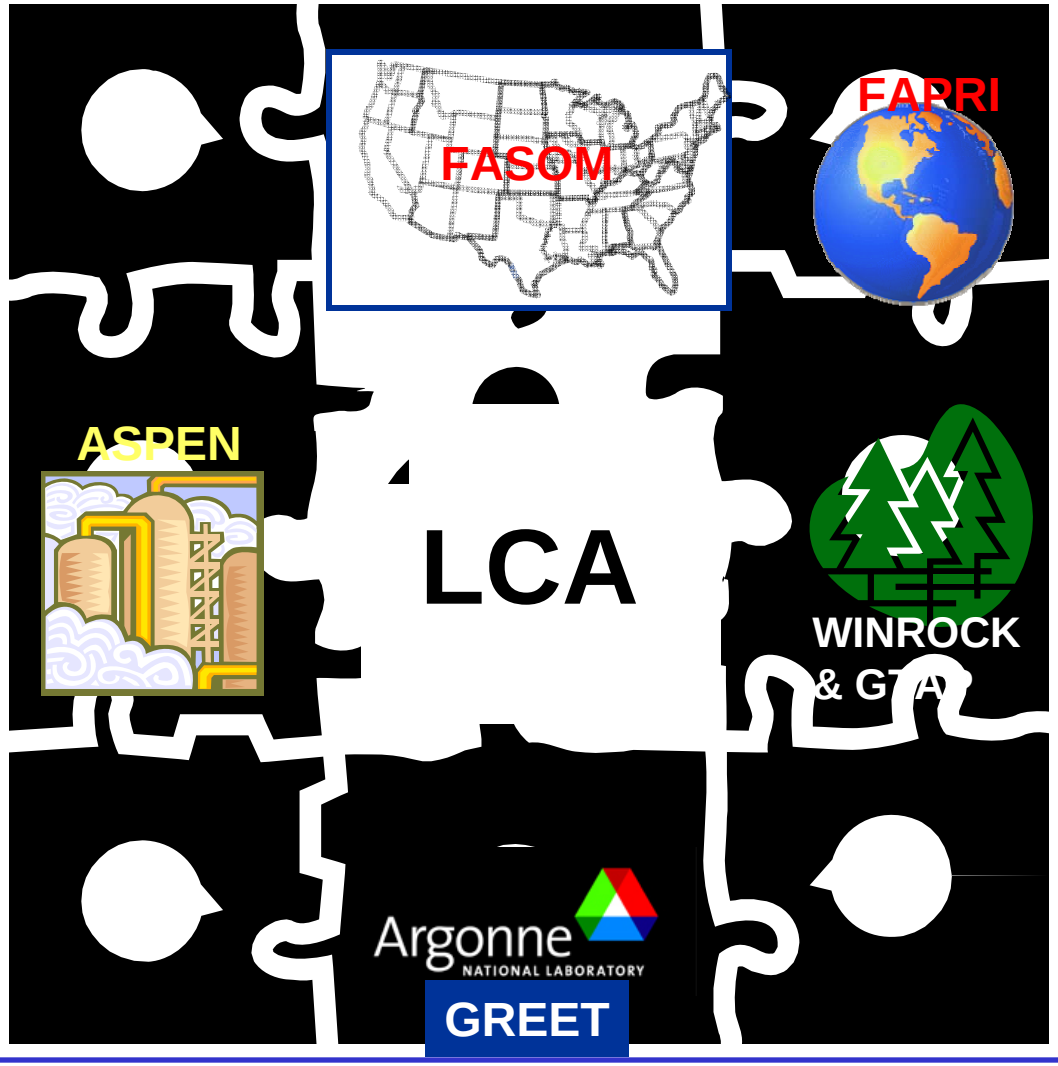
- EISA definition requires the use of a number of models and tools
  - Including direct and indirect impacts such as land use change requires analysis of markets
    - Typical life cycle analysis tools are based on process modeling
    - To capture market impacts need to use economic models
  - We are also conducting our own process and emissions modeling as part of rulemaking

- For areas of uncertainty, we plan to test our primary approach and key assumptions with sensitivity analyses and different methods

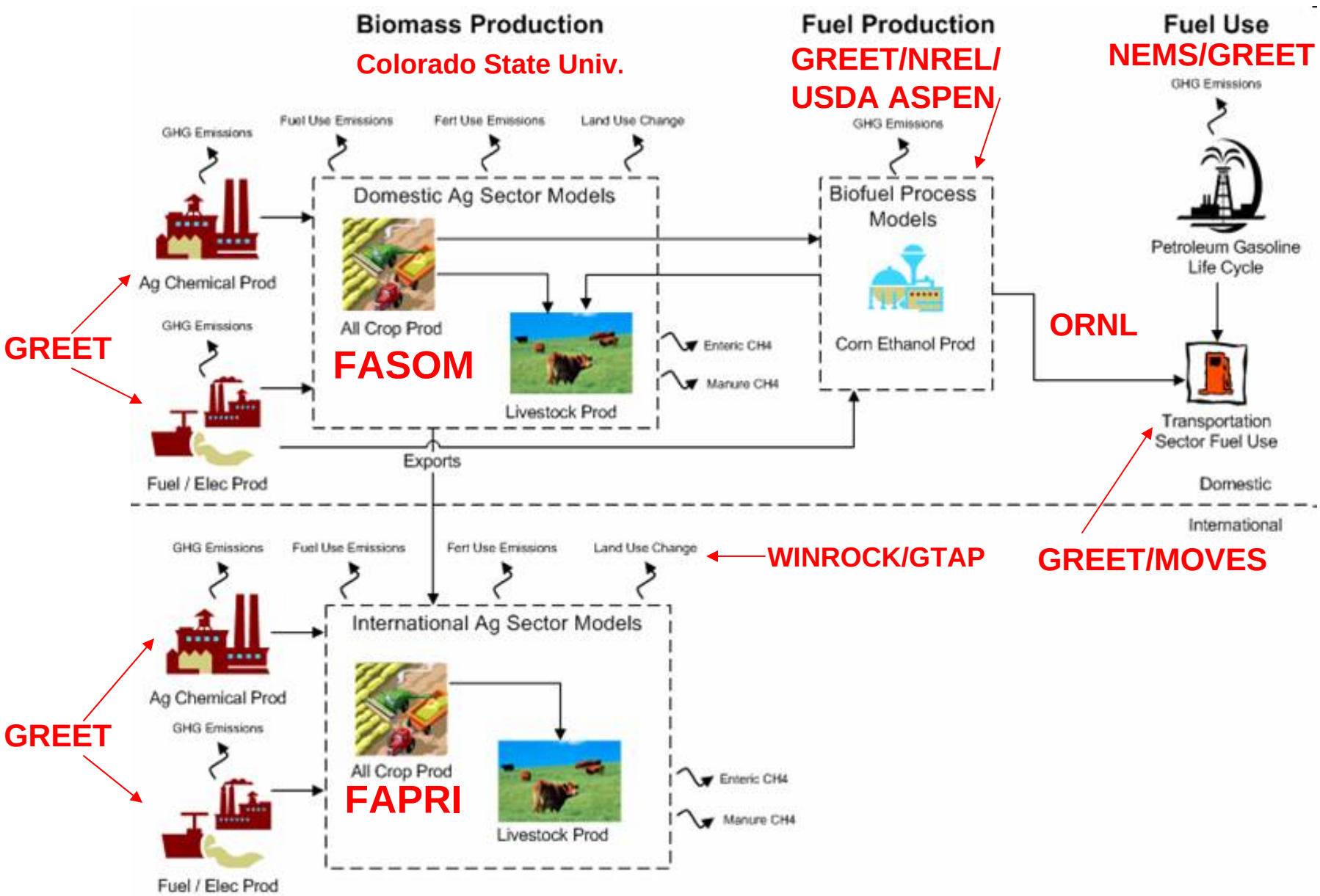
Key Models and Data Sources

- Emission factors (GREET, Winrock, Woods Hole)
- Agricultural sector models (FASOM, FAPRI, GTAP, BESS)
- Land use changes (FASOM, FAPRI, Winrock, GTAP)
- Fertilizer N_2O modeling (CSU DAYCENT/CENTURY)
- Fuel production process models (GREET, USDA & NREL ASPEN models, BESS)
- Tailpipe emissions (MOVES)
- Energy sector modeling (NEMS)

Application of Ag Sector Modeling to Lifecycle Analysis



EPA Lifecycle Analysis Uses Several Models



International Agriculture and Land Use Change

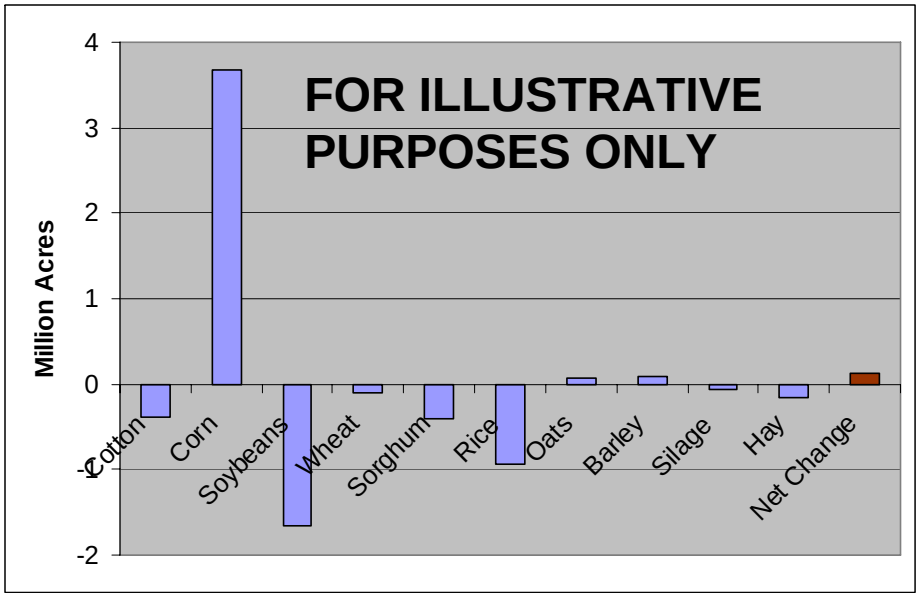
- Questions we need to address in this analysis:
  - How much land is converted internationally?
  - What are the emissions trends from international crop production?
  - Where does land use change occur?
  - What types of land are converted?
  - What are the GHG factors from that land conversion?
  - How do we account for the time dimension of GHG releases?

- In order to address uncertainty around these factors, we are performing sensitivity analyses and examining alternative approaches

A few results

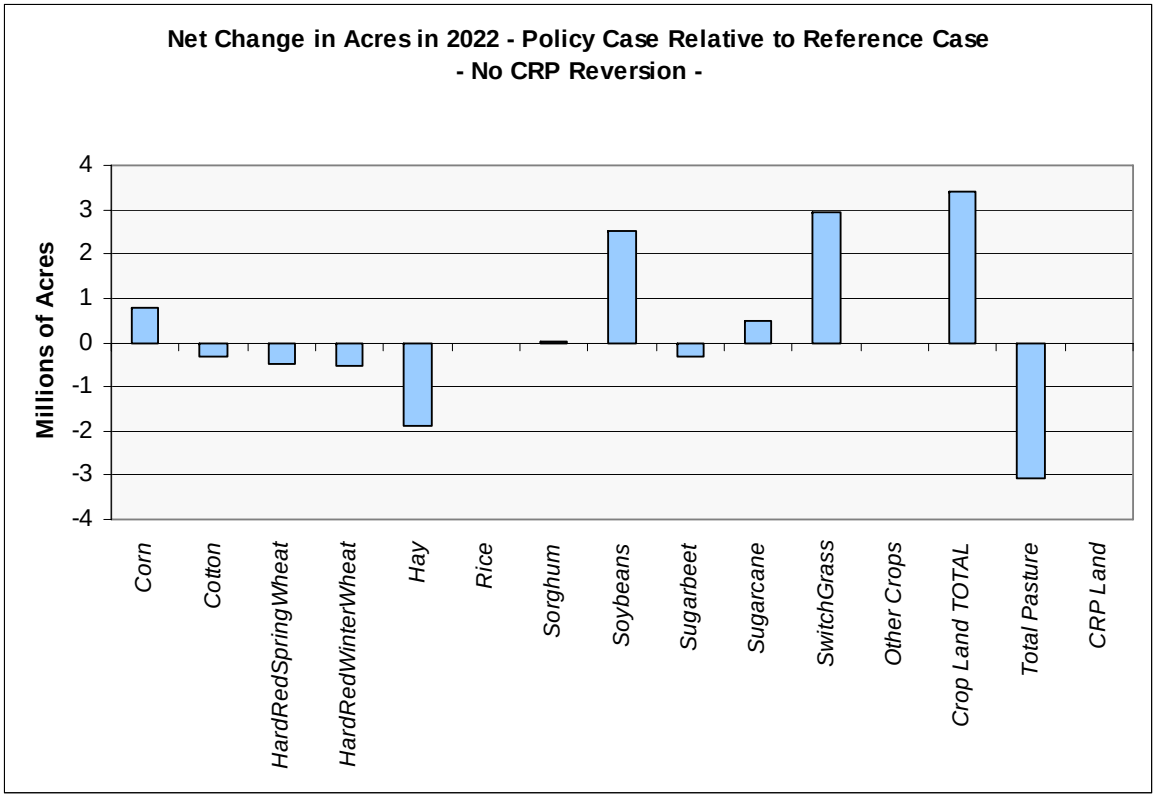
Lifecycle GHG Emissions: Example Domestic Agricultural Sector Impacts

- Increased biofuel production shifts domestic crop patterns
  - Increase in total crop acres result in land use emissions
  - Decrease in rice acres and livestock production (due to increased feed prices) provide GHG reductions
  - Corn acres, inputs, and emissions increase, but are offset by N_2O reduction from less soybeans
  - Use of corn for animal feed decreases, but is replaced by DDG and other biofuel co-products



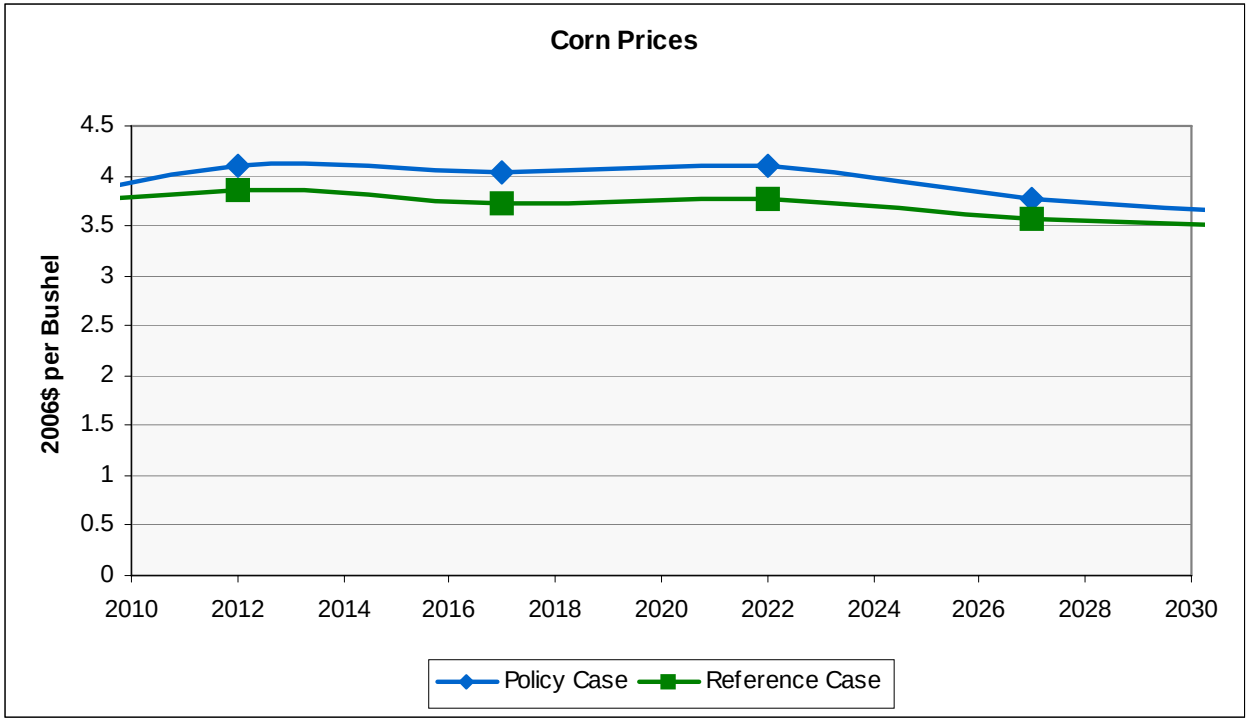
Summary of Agricultural Sector Modeling Results

- Modeling the change in several domestic crops as increased demand for certain crops (i.e., corn, switchgrass, and soybeans) economically competes for land and other resources against other crops (i.e., cotton, hay, and rice)



Summary of Agricultural Sector Modeling Results

- FASOM also models commodity prices (e.g., corn)



Lifecycle GHG Emissions: Example International Agricultural Sector Impacts

- Decrease in U.S. exports results in increased crop production internationally
  - Not all export losses are made up with production – shifts in crops and decrease in demand
- Changes in crop acres based on yields in different countries
- Assume net increase in all crop acres results in land use change

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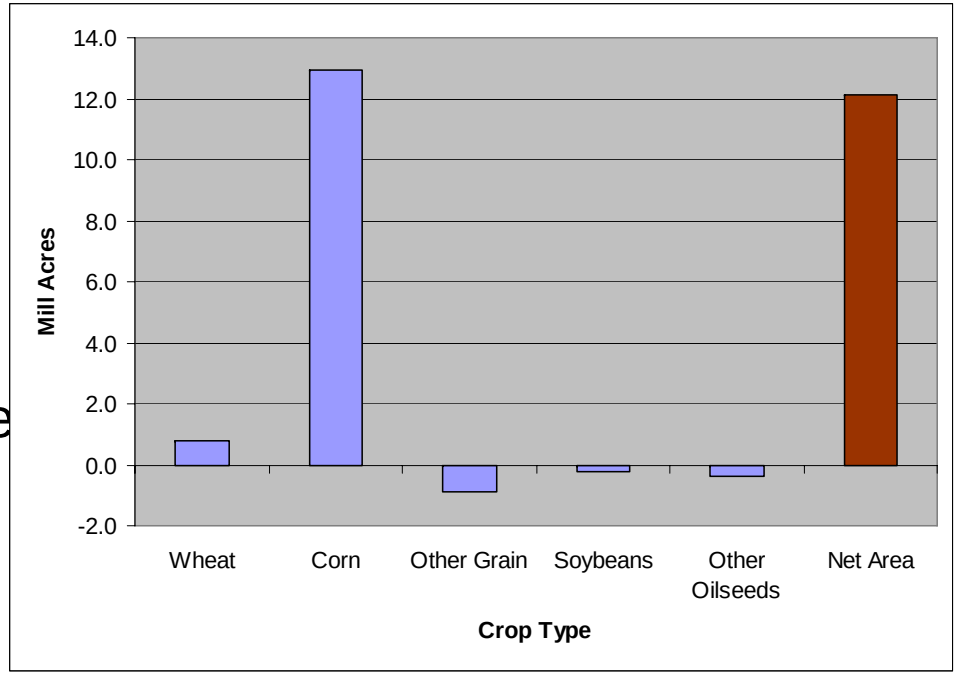


Land Conversions from Winrock

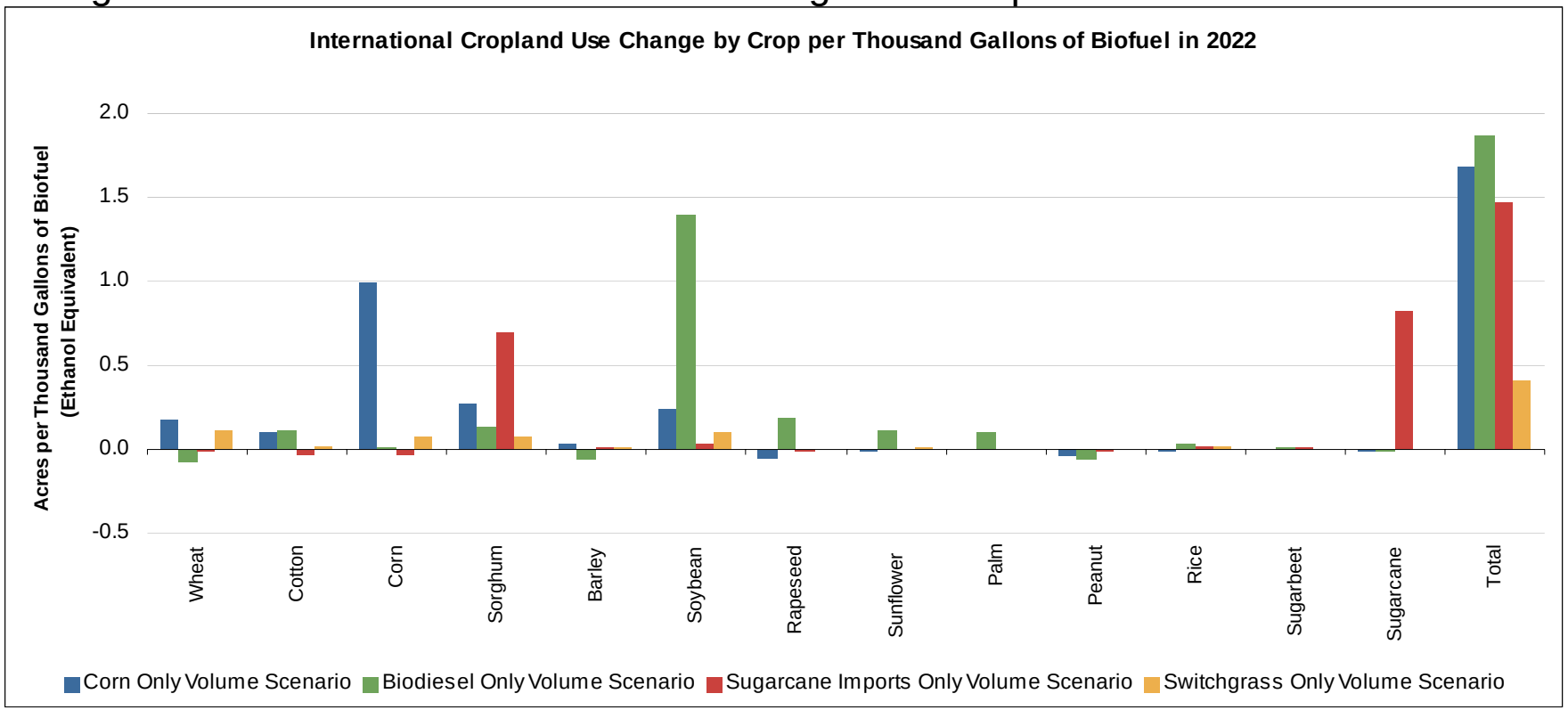
Types of Land Converted to Cropland By Country

COUNTRY	Forest	Grassland	Savanna	Shrub
Argentina	8%	40%	45%	8%
Brazil	4%	18%	74%	4%
China	17%	38%	23%	21%
EU	27%	16%	36%	21%
India	7%	7%	33%	53%
Indonesia	34%	5%	58%	4%
Malaysia	74%	3%	19%	3%
Nigeria	4%	56%	36%	4%
Philippines	49%	5%	44%	3%
South Africa	10%	22%	53%	15%

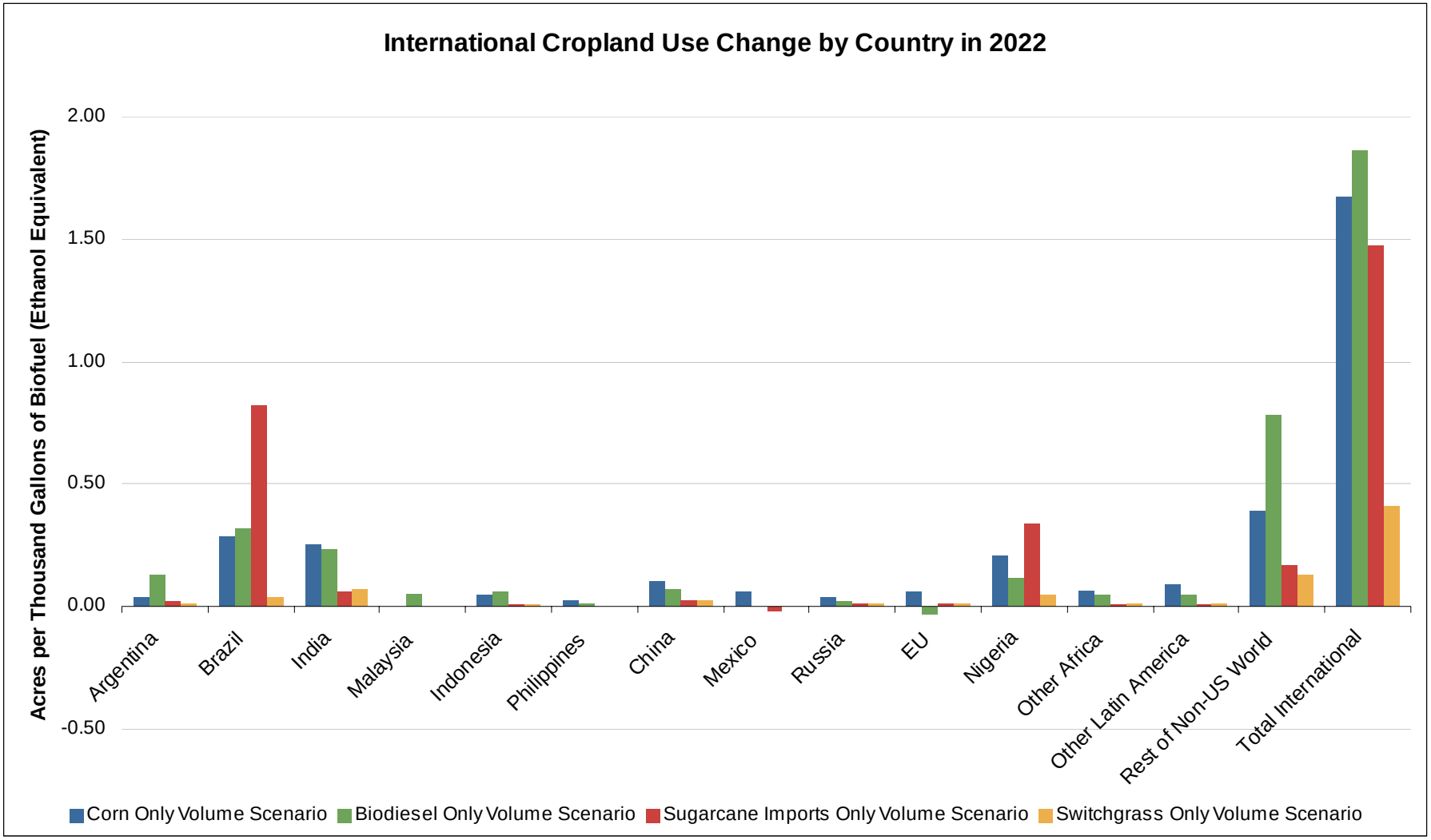
Source: Winrock Satellite Data (2001-2004)

FAPRI International Acreage Change

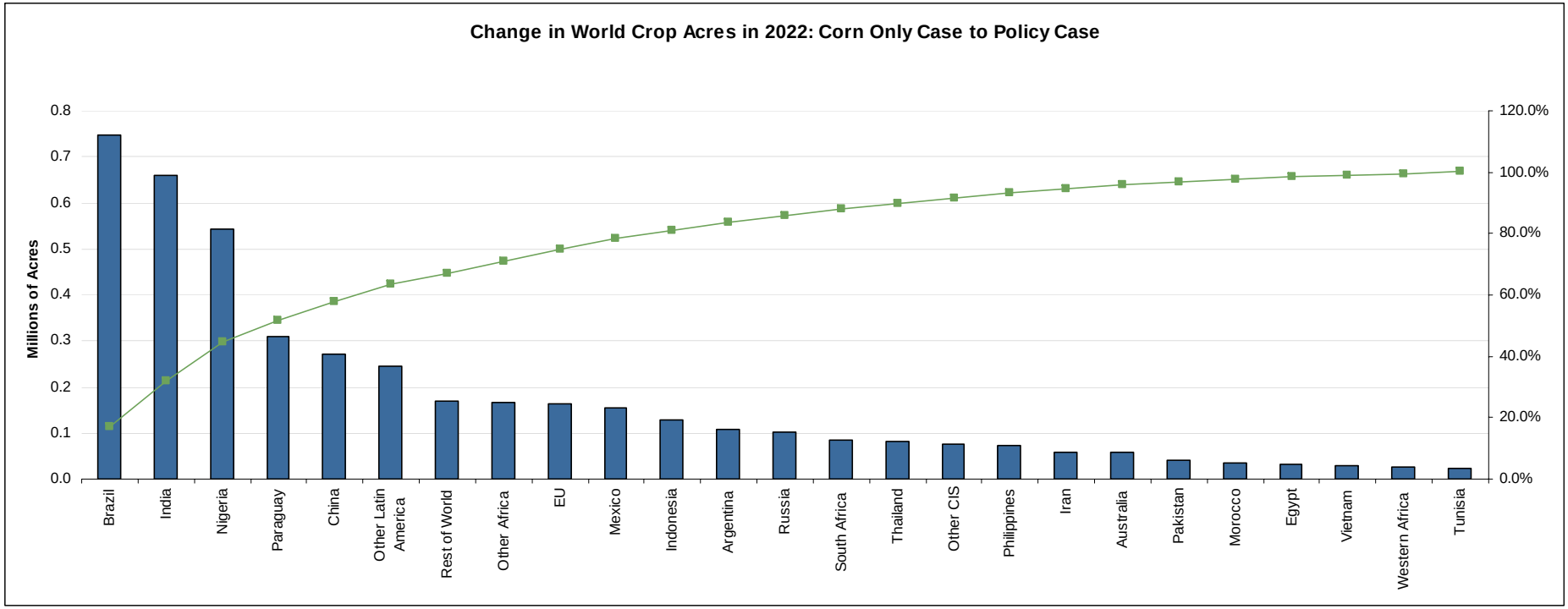
- Decrease in U.S. exports result in increased crop production internationally
  - Although not all export losses are made up with production – shifts in crops and decrease in demand also occur
- Changes in crop acres based on yields in different countries
  - No price induced yield changes or decrease from marginal yields
- Assume the net increase in all crop acres results in land being converted into agriculture with associated land use change GHG impacts



Summary of International Land Use Change by Fuel



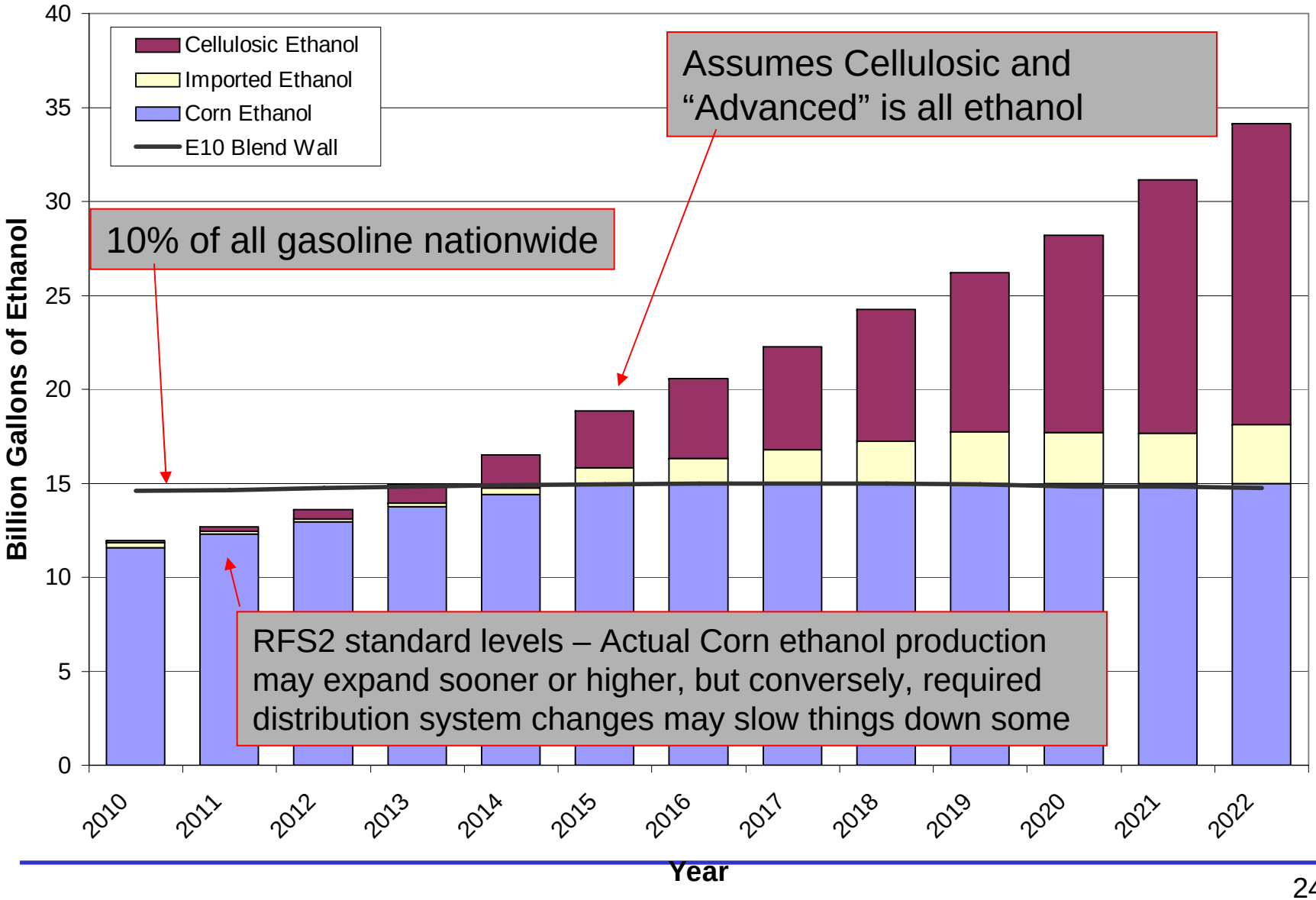
International Land Use Change – By Country



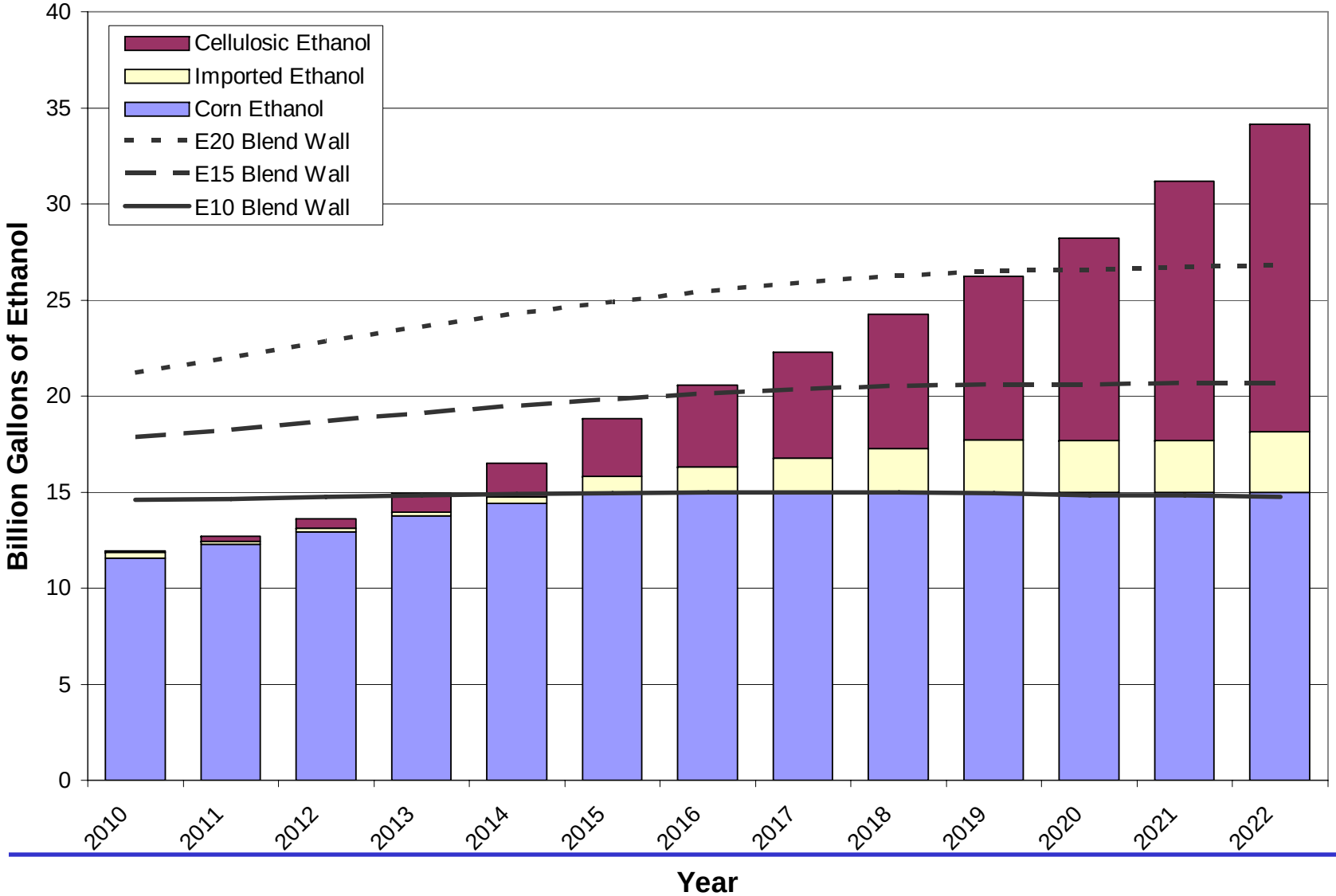
Can We Absorb All That Biofuel ?

- Blend Wall: how much ethanol can be used in E10 and E85 ?

Nationwide RFS2 Blend Wall



Change in Blend Wall Timing (If E15 and E20 Approved)



Summary and Next Steps

- The Notice of Proposed Rulemaking provides an important opportunity for EPA to present our work and to seek comment
  - Key assumptions and issues with our lifecycle methodology identified; alternatives highlighted
  - Implementation issues flagged for comment
- Final rule anticipated to be in place by January 2010