GHG Lifecycle Analysis and Land Use Change
EPA Renewable Fuel Standard

U.S. Environmental Protection Agency
Office of Transportation & Air Quality

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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.

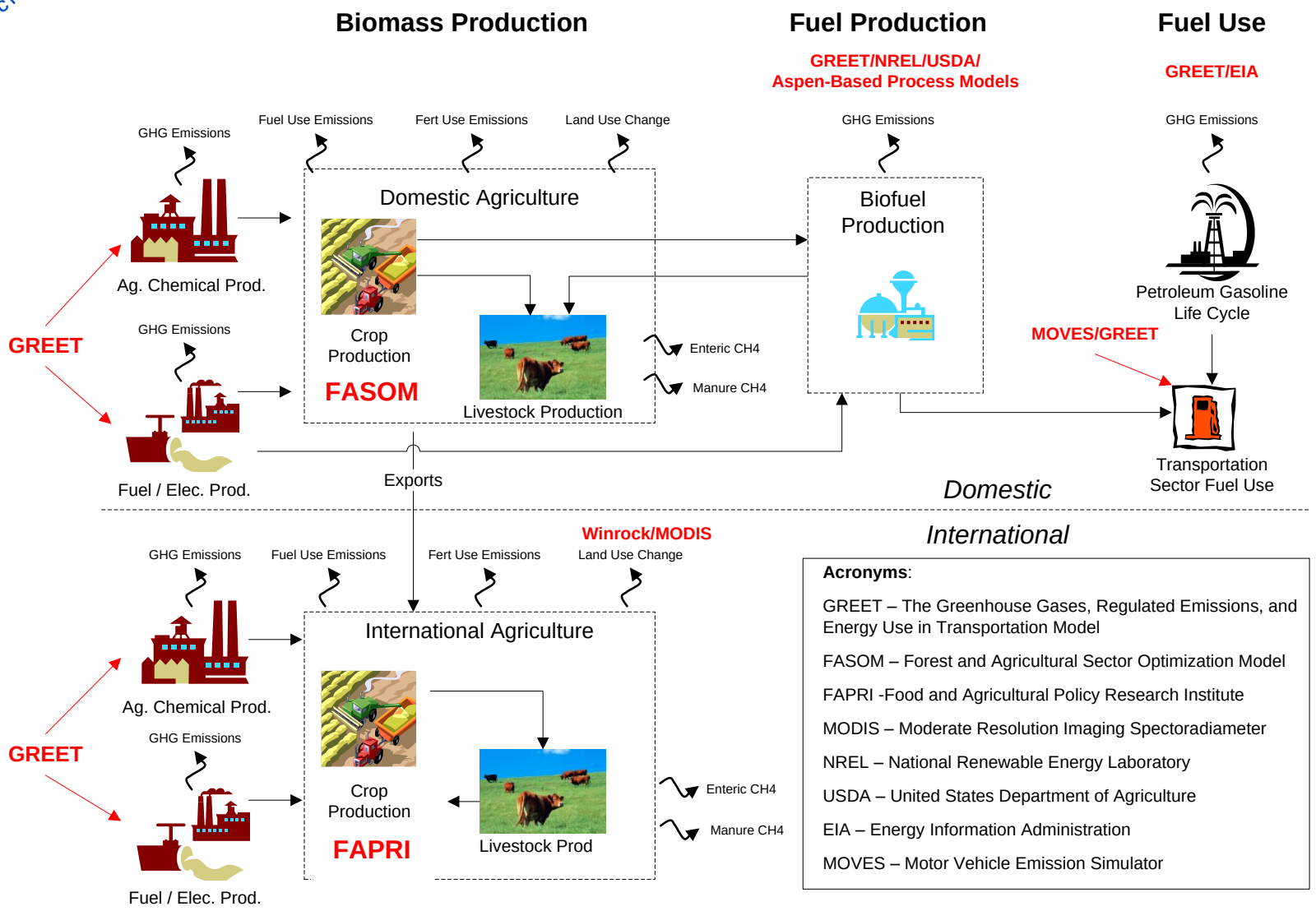
Methodology

- Scenario Comparison: Run models with different volume scenarios to isolate the impact of specific fuel
  - Consider change between baseline projected fuel volume in 2022 (i.e., without RFS2) and projected RFS2 mandated volume.
  - Hold volumes of other fuels constant at RFS2 mandated levels

- EISA definition requires several models and tools
  - Including direct and indirect impacts (e.g., 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

- For areas of uncertainty, we have tested our primary approach and key assumptions with sensitivity analyses and different methods

Key Models and Data Sources



Acronyms:

GREET – The Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation Model

FASOM – Forest and Agricultural Sector Optimization Model

FAPRI -Food and Agricultural Policy Research Institute

MODIS – Moderate Resolution Imaging Spectoradiameter

NREL – National Renewable Energy Laboratory

USDA – United States Department of Agriculture

EIA – Energy Information Administration

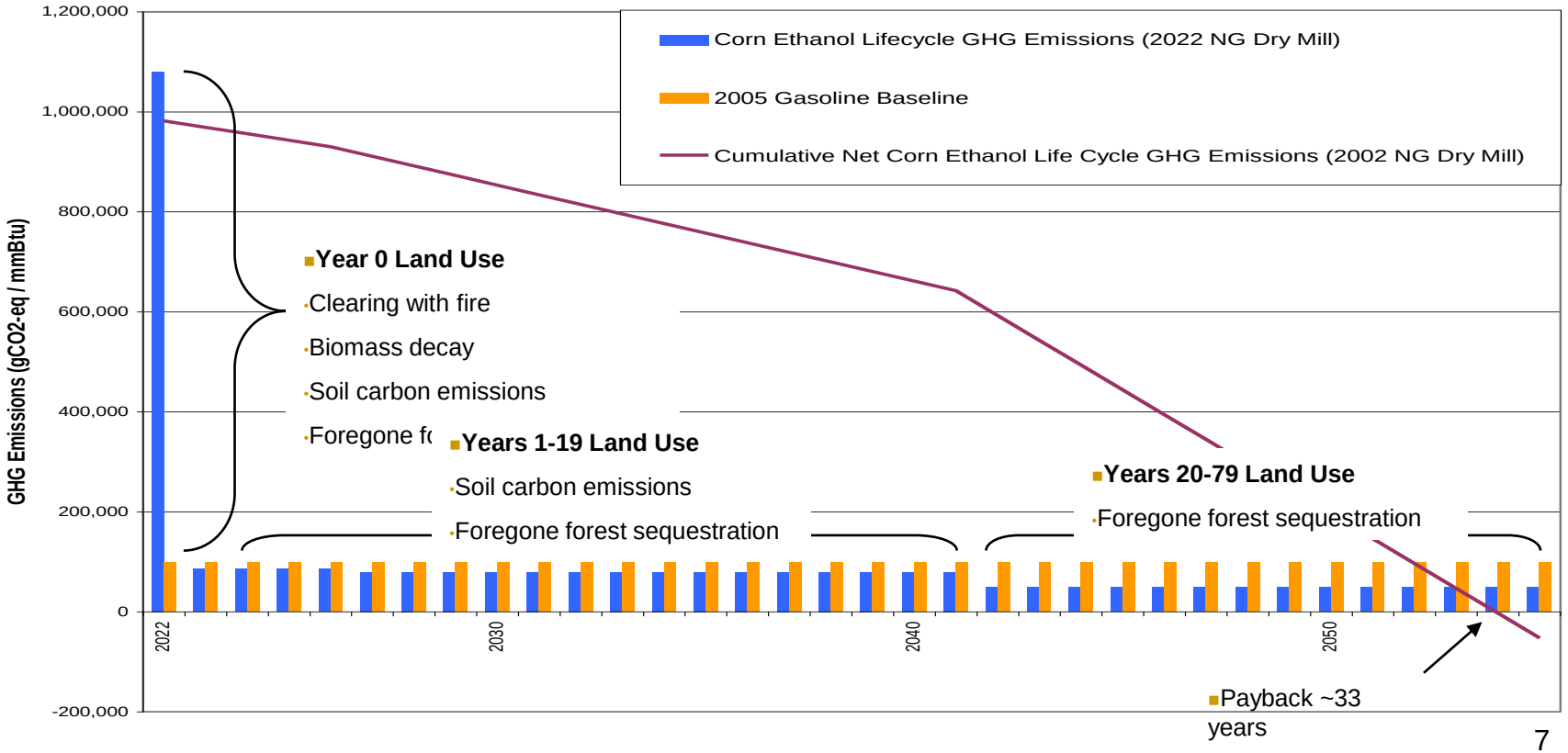
MOVES – Motor Vehicle Emission Simulator

Land Use Change Methodology

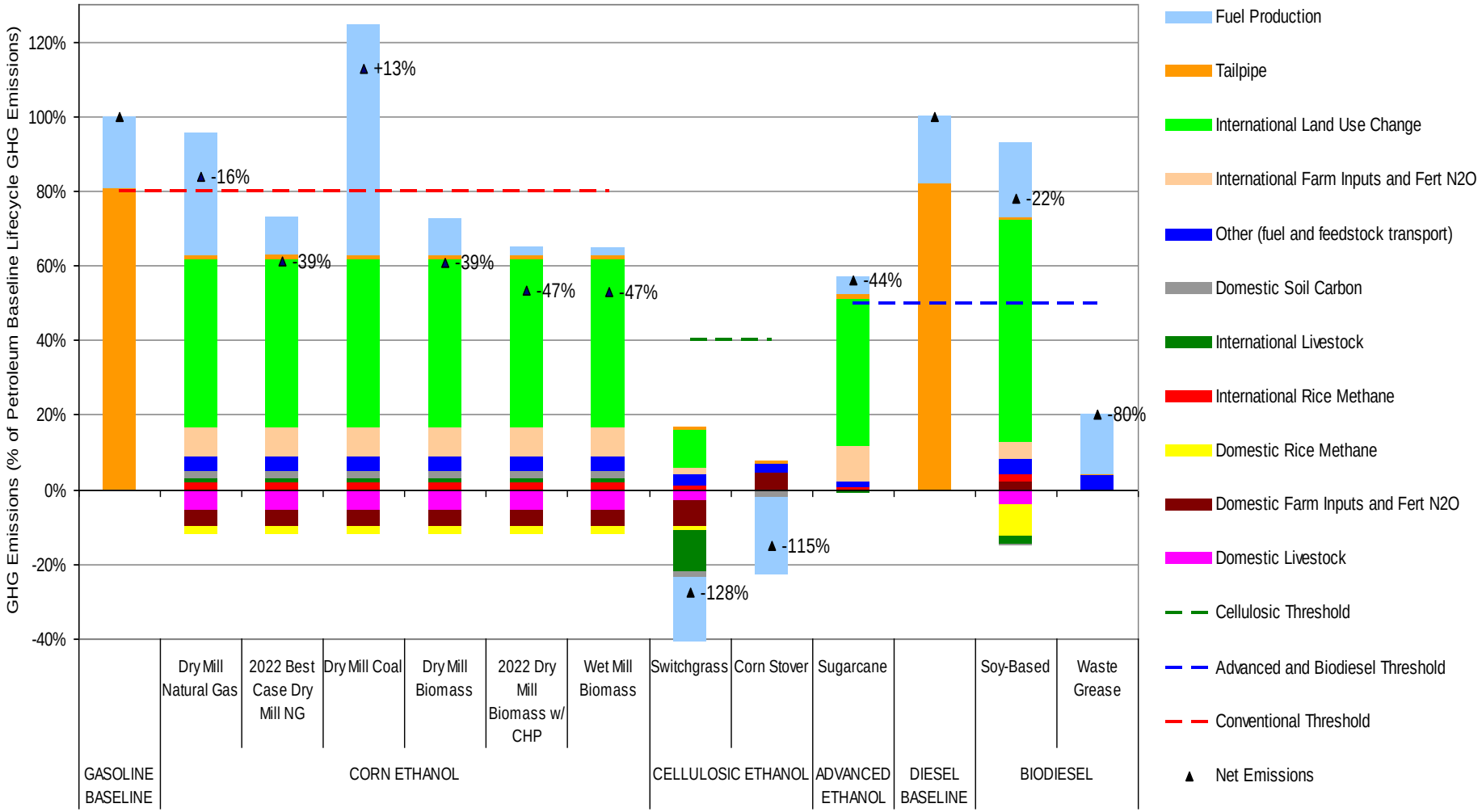
Key Question	Domestic	International
Amount, or area, of land converted?	FASOM (domestic agricultural sector model)	CARD / FAPRI (international agricultural sector model)
Location of land use changes?	FASOM (region-level)	CARD / FAPRI (country level)
Land types/biomes converted?	FASOM (modeled interactions with cropland, pasture, CRP, and forest)	MODIS Satellite Data (recent trends of land conversion between different land types)
GHG emissions from land conversion?	FASOM (e.g., DAYCENT for soil carbon changes)	Winrock / IPCC

Payback Period For Corn Ethanol

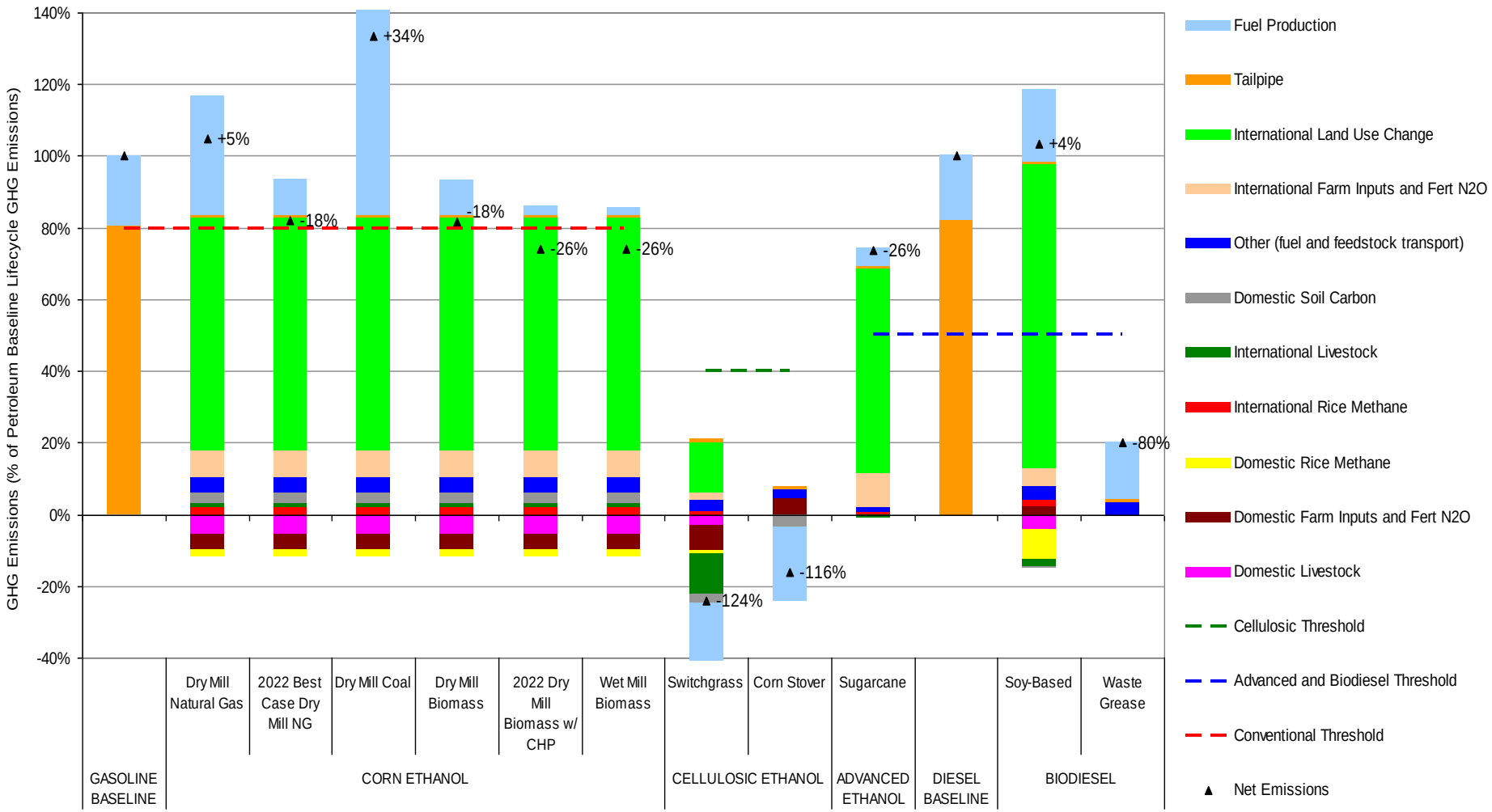
- Treatment of Time Related Land Use Changes?
  - Land use change results in stream of emissions that are changing over time
  - We need to define a life cycle GHG value that is applicable to all gallons across time
  - We are looking at a range of approaches for treating the land use changes over time
  - Aspects to consider
    - Length of program
    - Discount rate



Biofuel Lifecycle GHG Results *Different Pathways with 2% Discount Rate – 100 years*



Biofuel Lifecycle GHG Results *Different Pathways with 0% Discount Rate – 30 years*



Sensitivity of Results to Land Types

- Proposed methodology predicts that new crop acreage converted from a range of land types

SENSITIVITY EXAMPLE

- Some studies suggest Brazilian agricultural production can increase by relying on existing excess pasture lands without significant impacts on other land types
- Current analysis assumes that grassland (pasture) converted to cropland needs to be replaced by other land
- Livestock production could be more intensively developed on the remaining pasture eliminating need to replace pasture

- Sugarcane Ethanol GHG Emission Changes Under Varied Land Use Assumptions and Varied Discount Rates and Time Horizons Relative to 2005 Petroleum Baseline

Land Use Change Scenario Description	(100 yr 2%)	(30 yr 0%)
Estimate with pasture replacement	-44%	-26%
Estimate with no pasture replacement in Brazil	-59%	-45%
Only grassland conversion in Brazil; no pasture replacement in Brazil	-64%	-52%

Formal Peer Review

- **Conducting a formal peer review (between proposal and final rule) of key elements of our lifecycle analysis:**
  1. Land use modeling (use of satellite data/ land conversion GHG emission factors)
  2. Our estimates of GHG emissions from foreign crop production
  3. Methods to account for the variable timing of GHG emissions
  4. How the models we've relied upon are used together to provide overall lifecycle estimates
- **We are following EPA peer review guidelines (developed by an internal advisory group in order to ensure consistent Agency-wide implementation of peer review).**
  - EPA's guidelines also incorporate OMB's government-wide peer review bulletin
- **In accordance with this guidance, we are using an independent, third-party contractor to conduct an external peer review**
  - Contractor identifies list of expert reviewers, checking for possible conflict of interest
  - Also conducts meetings, teleconferences, etc, in order to clarify technical components of the product and develops the peer review record
- **The peer review record will be available to the public, including:**
  - Materials provided to the peer reviewers
  - List of names and affiliations of the peer reviewers
  - Summary of comments, as well as comments attributable to individual reviewers
- **Timeframe**
  - The plan is for the peer reviews to be completed by the end of June; experts have at least one month to complete their review

Summary and Next Steps

- In developing the lifecycle methodology, our approach has been to use the best models, tools and resources available
  - Using sensitivity analysis and examining multiple approaches to address key areas of uncertainty
- The Notice of Proposed Rule-making (NPRM) provides an important opportunity for EPA to present our work and to seek comment on proposed approaches and alternative approaches
  - 60-day public comment period commences at publication of NPRM in U.S. Federal Register
  - Public hearing on proposal (June 9, Washington, DC)
  - Two-day lifecycle workshop to help ensure a full understanding of our lifecycle analysis, the major issues identified, and the options discussed (June 10-11, Washington, DC)
- Conducting Peer Reviews on key lifecycle methodology components
  - Land use modeling
    - Our use of satellite data to project future the type of land use changes
    - The land conversion GHG emissions factors estimates we have used for different types of land use
  - Our estimates of GHG emissions from foreign crop production
  - Methods to account for the variable timing of GHG emissions
  - How the several models we have relied upon are used together to provide overall lifecycle GHG estimates
- This input along with the additional analysis we will be conducting between now and the final rule will further improve our methodology
- Anticipate 3-5 year cycles for updating the analysis

RFS Notice of Proposed Rulemaking Documents and Fact Sheets

http://www.epa.gov/OMS/renewablefuels/#regulations