
Life Cycle GHG Results for EISA Analysis

U.S. EPA

Office of Transportation and 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.

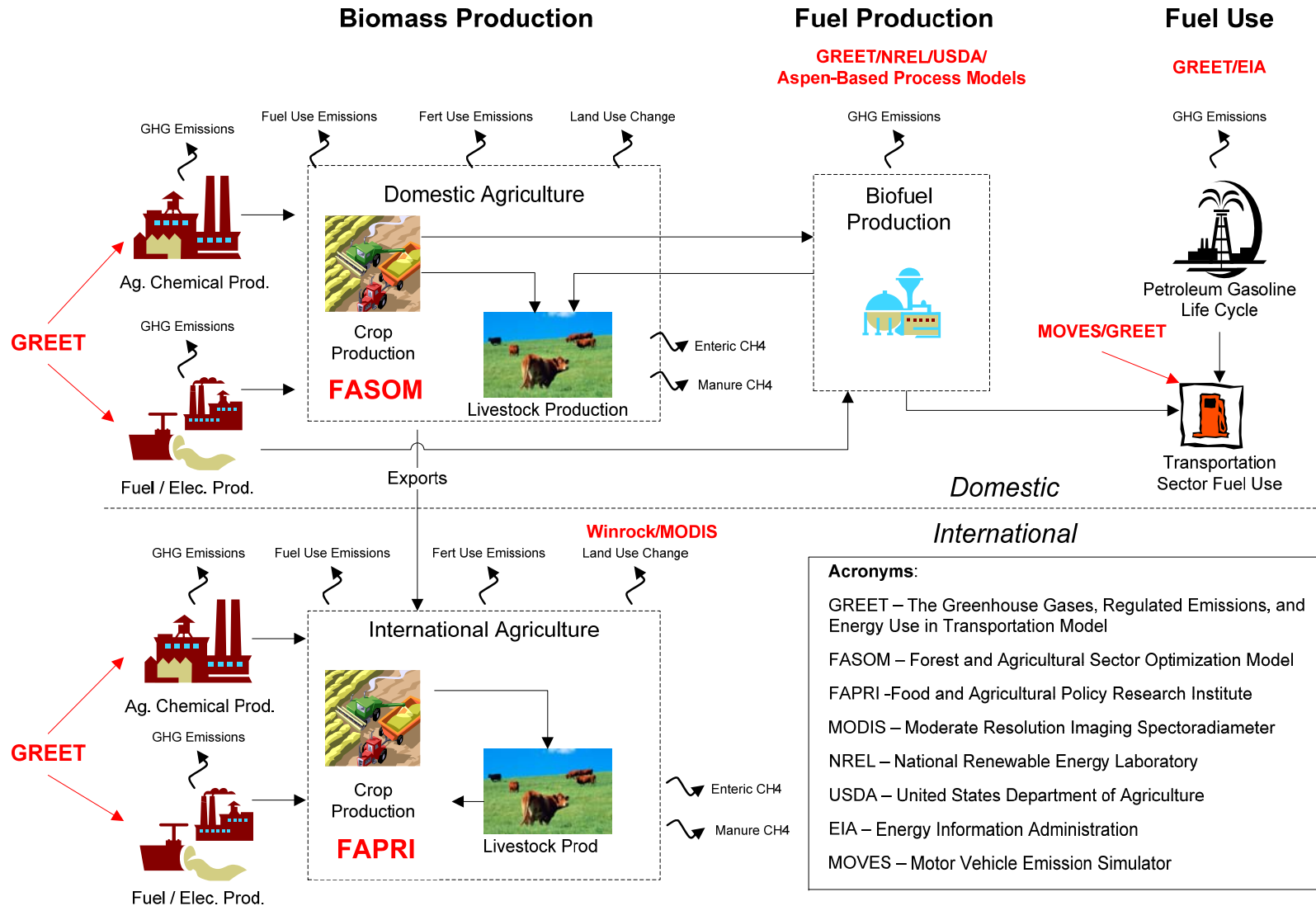
Methodology

- 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
 - Conducting our own process and emissions modeling as part of rulemaking

- 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.
 - Held volumes of other fuels constant at RFS2 mandated levels

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

Key Models and Data Sources



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, or 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

Key Factors in Land Use Assessment

- This analysis has revealed which factors have the most significant impact on the final results
 - What Type of Land is Converted?
 - For example, historic satellite data suggests that in some countries significant amounts of forest would be converted to cropland
 - However, we are looking at sensitivities around these assumptions that would show varying degrees of forestry impact
 - 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
- We conducted sensitivity analyses around these factors

Biofuel Production Modeling

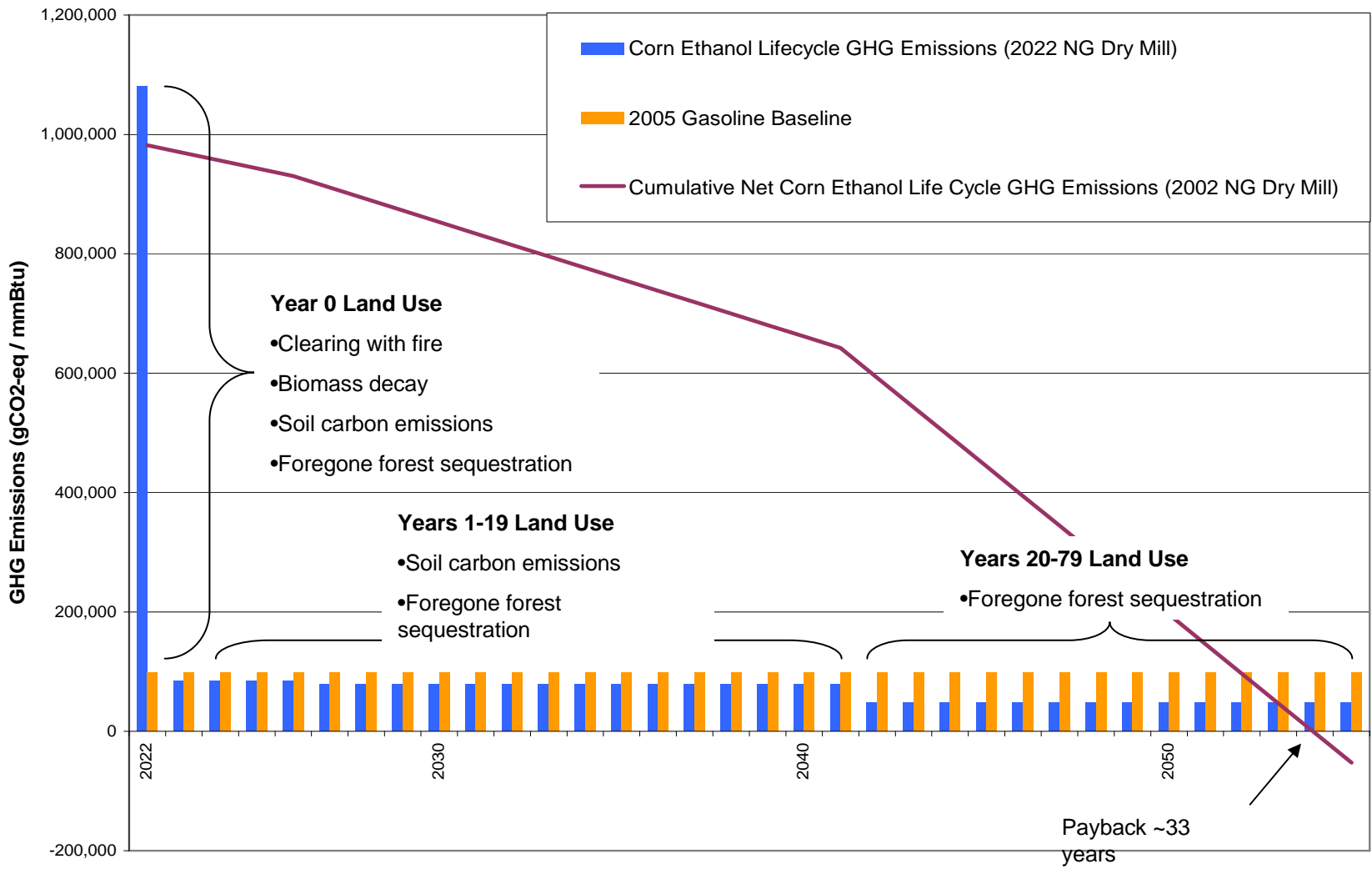
- Corn ethanol
 - Working with USDA and industry
 - Considering different configurations (fuel source, technologies, carbon capture)
- Cellulosic ethanol
 - Looking at modeling by NREL & GREET that projects use of biomass lignin for process energy, enabling plants to sell electricity to the grid
 - Offsets grid electricity production and results in GHG benefits
- Imported Sugarcane Ethanol Production
 - Like cellulosic, can produce excess electricity from burning bagasse

Petroleum Baseline

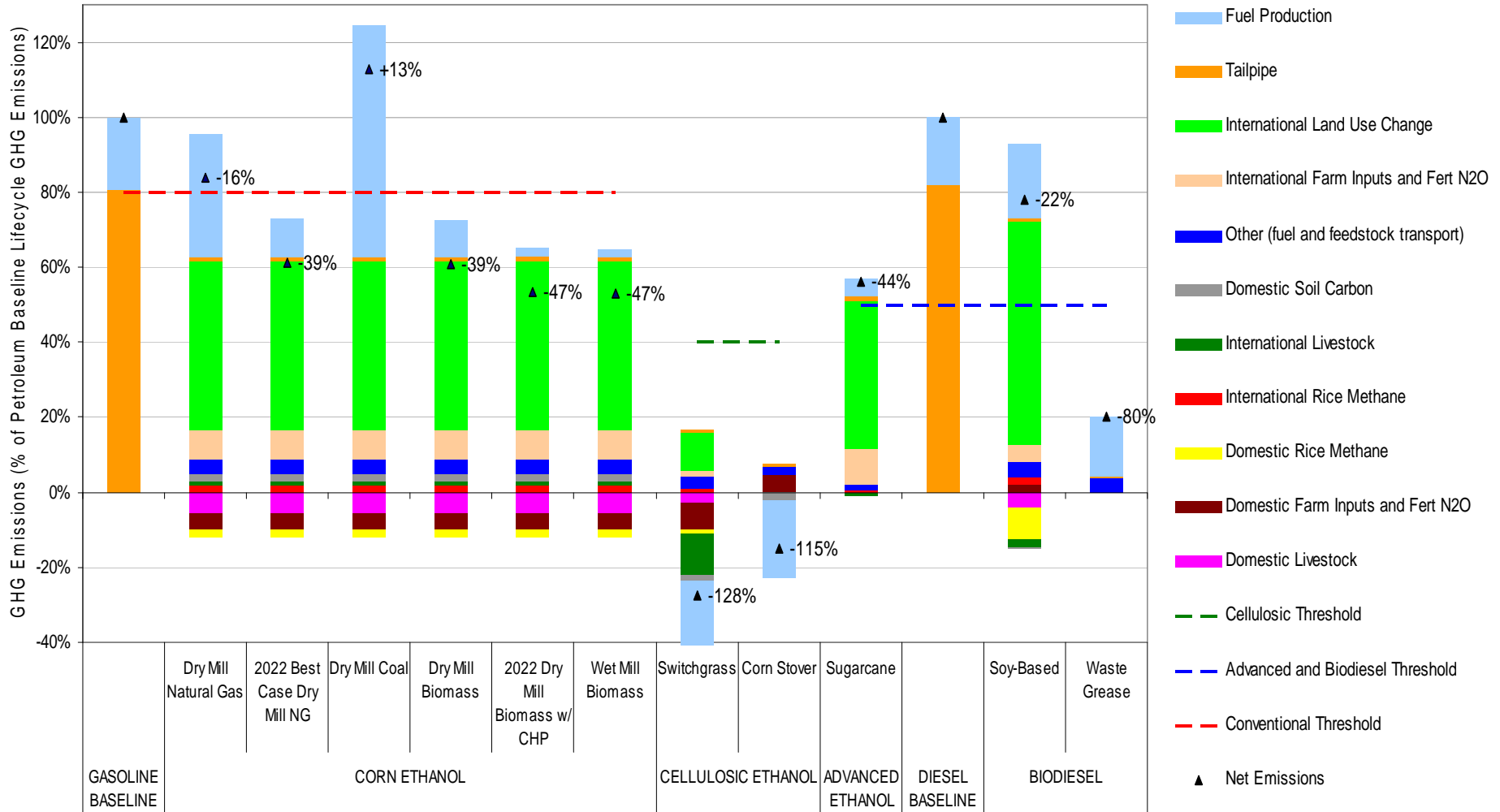
- We use updated version of GREET and EIA data
 - Energy efficiency of refining and crude extraction (GREET)
- Assuming 2005 mix of crude
 - Tar Sands
 - Included Venezuela extra heavy and heavy crude
 - Developed emissions factors for those crude types (not currently included in GREET)
- Also considering new DOE/NETL report
 - Similar overall results within 2% of EPA estimates
- Also working to include energy sector impacts

Results

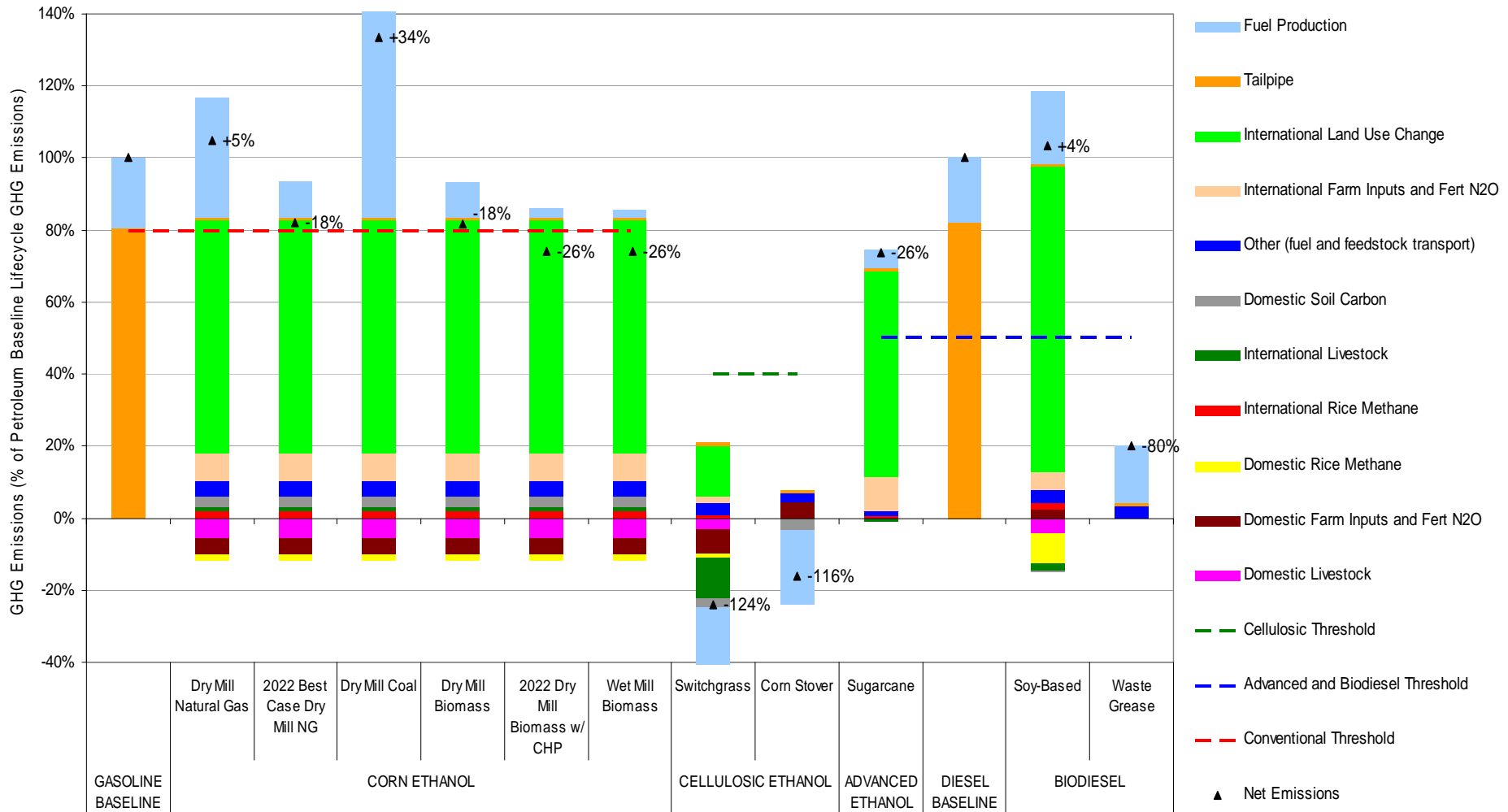
Payback Period For Corn Ethanol



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



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



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
 - Planning to hold workshops on lifecycle analysis following release of the NPRM
- Engage experts between proposal and final to ensure expert-level feedback especially of key elements:
 - 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