Technical Highlights

EPA Lifecycle Analysis of Greenhouse Gas Emissions from Renewable Fuels

As part of proposed revisions to the National Renewable Fuel Standard program (commonly known as the RFS program), EPA analyzed lifecycle greenhouse gas (GHG) emissions from increased renewable fuels use. The Energy Independence and Security Act of 2007 (EISA) establishes new renewable fuel categories and eligibility requirements. EISA sets the first U.S. mandatory lifecycle GHG reduction thresholds for renewable fuel categories, as compared to those of average petroleum fuels used in 2005. The regulatory purpose of the lifecycle greenhouse gas emissions analysis is to determine whether renewable fuels meet the GHG thresholds for the different categories of renewable fuel.

Lifecycle GHG emissions are the aggregate quantity of GHGs related to the full fuel cycle, including all stages of fuel and feedstock production and distribution, from feedstock generation and extraction through distribution and delivery and use of the finished fuel. The lifecycle GHG emissions of the renewable fuel are compared to the lifecycle GHG emissions for gasoline or diesel (whichever is being replaced by the renewable fuel) sold or distributed as transportation fuel in 2005.

EISA established specific greenhouse gas emission thresholds for each of four types of renewable fuels, requiring a percentage improvement compared to a baseline of the gasoline and diesel. EISA required a 20% reduction in lifecycle GHG emissions for any renewable fuel produced at new facilities (those constructed after enactment), a 50% reduction in order to be classified as biomass-based diesel or advanced biofuel, and a 60% reduction in order to be classified as cellulosic biofuel. EISA provides some limited flexibility for EPA to adjust these GHG percentage thresholds downward by up to 10 percent under certain circumstances. EPA is proposing to exercise this flexibility for the advanced biofuels category in this proposal.

EPA United States Environmental Protection Agency

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EPA must conduct a lifecycle analysis to determine whether or not renewable fuels produced under varying conditions will meet the greenhouse gas (GHG) thresholds for the different fuel types for which EISA establishes mandates. While these thresholds do not constitute a control on greenhouse gases for transportation fuels (such as a low carbon fuel standard), they do require that the volume mandates be met through the use of renewable fuels that meet certain lifecycle GHG reduction thresholds when compared to the baseline lifecycle emissions of petroleum fuel. Determining compliance with the thresholds requires a comprehensive evaluation of renewable fuels, as well as of gasoline and diesel, on the basis of their lifecycle emissions. EISA defines lifecycle GHG emissions as follows:

> 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.[1]

As mandated by EISA, the greenhouse gas emission assessments must evaluate the full lifecycle emission impacts of fuel production including both direct and indirect emissions, including significant emissions from land use changes. We recognize the significance of using lifecycle greenhouse gas emission assessments that include indirect impacts such as emission impacts of indirect land use changes. Therefore, in our proposal we have been transparent in breaking out the various sources of GHG emissions to enable the reader to readily detect the impact of including international land use impacts.

EPA has analyzed the lifecycle GHG impacts of the range of biofuels currently expected to contribute significantly to meeting the volume mandates of EISA through 2022, including those from domestic and international sources. In these analyses we have used the best science available. Our analysis relies on peer reviewed models and the best estimate of important trends in agricultural practices and fuel production technologies as these may impact our prediction of individual biofuel GHG performance through 2022. We have identified and highlighted assumptions and model inputs that particularly influence our assessment and seek comment on these assumptions, the models we have used and our overall methodology so as to assure the most robust assessment of lifecycle GHG performance for the final rule.

The GHG lifecycle analysis combines a suite of peer-reviewed process models and peer-reviewed economic models of the domestic and international agricultural sectors to determine direct and significant indirect emissions, respectively (see Figure 1). As required by EISA, the broad system boundaries of our analysis encompass all significant secondary agricultural sector GHG impacts, not only impacts from land use change. The analysis uses economic models to determine the area and location of land converted into cropland in each country as a result of the RFS

[1] Clean Air Act Section 211(o)(1)

program. Satellite data are used to predict the types of land that would be converted into cropland (e.g. forest, grassland).

EPA's draft results suggest that biofuel-induced land use change can produce significant near-term GHG emissions; however, displacement of petroleum by biofuels over subsequent years can "pay back" earlier land conversion impacts. Therefore, the time horizon over which emissions are analyzed and the application of a discount rate to value near-term versus longer-term emissions are critical factors. We highlight two options. One option assumes a 30 year time period for assessing future GHG emissions impacts and values equally all emission impacts, regardless of time of emission impact (i.e., 0% discount rate). The second option assesses emissions impacts over a 100 year time period and discounts future emissions at 2% annually. Several other variations of time period and discount rate are also discussed in the proposed rule. Table 1 provides draft GHG emission reductions that result under two time horizon/discount rate approaches for a sample of fuel pathways evaluated in the proposed rulemaking. Figures 1 and 2 break out emissions for each of these pathways by lifecycle component (e.g. fuel production, domestic and international and use change, domestic and international agricultural inputs) for the two time horizon/discount rate approaches.

Table 1. Draft Lifecycle GHG Emission Reduction Results For Different Time Horizon And Discount Rate Approaches.

Fuel Pathway	100 year, 2% Discount Rate	30 year, 0% Discount Rate
Corn Ethanol (Natural Gas Dry Mill)	-16%	+5%
Corn Ethanol (Best Case Natural Gas Dry Mill)[2]	-39%	-18%
Corn Ethanol (Coal Dry Mill)	+13%	+34%
Corn Ethanol (Biomass Dry Mill)	-39%	-18%
Corn Ethanol (Biomass Dry Mill with Combined Heat and Power)	-47%	-26%
Soy-Based Biodiesel	-22%	+4%
Waste Grease Biodiesel	-80%	-80%
Sugarcane Ethanol	-44%	-26%
Switchgrass Ethanol	-128%	-124%
Corn Stover Ethanol	-115%	-116%

[2] Best case plants produce wet distillers grain co-product and include the following technologies: combined heat and power (CHP), fractionation, membrane separation and raw starch hydrolysis

Figure 1. Net Lifecycle Greenhouse Gas Emissions By Lifecycle Component With 100 Year Time Horizon And 2% Discount Rate.

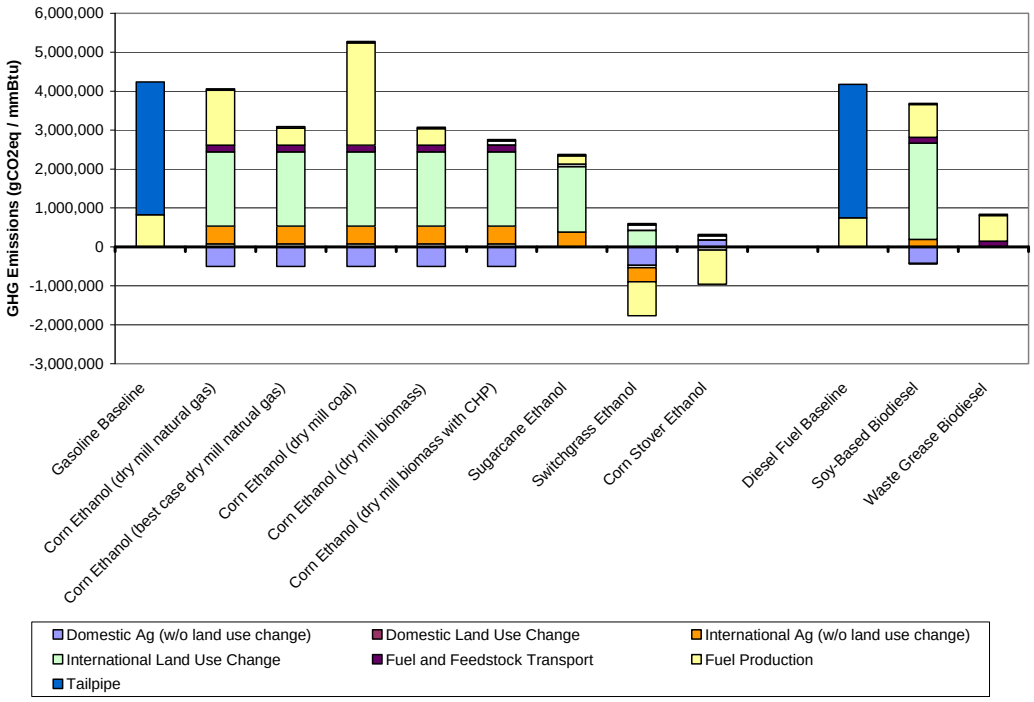
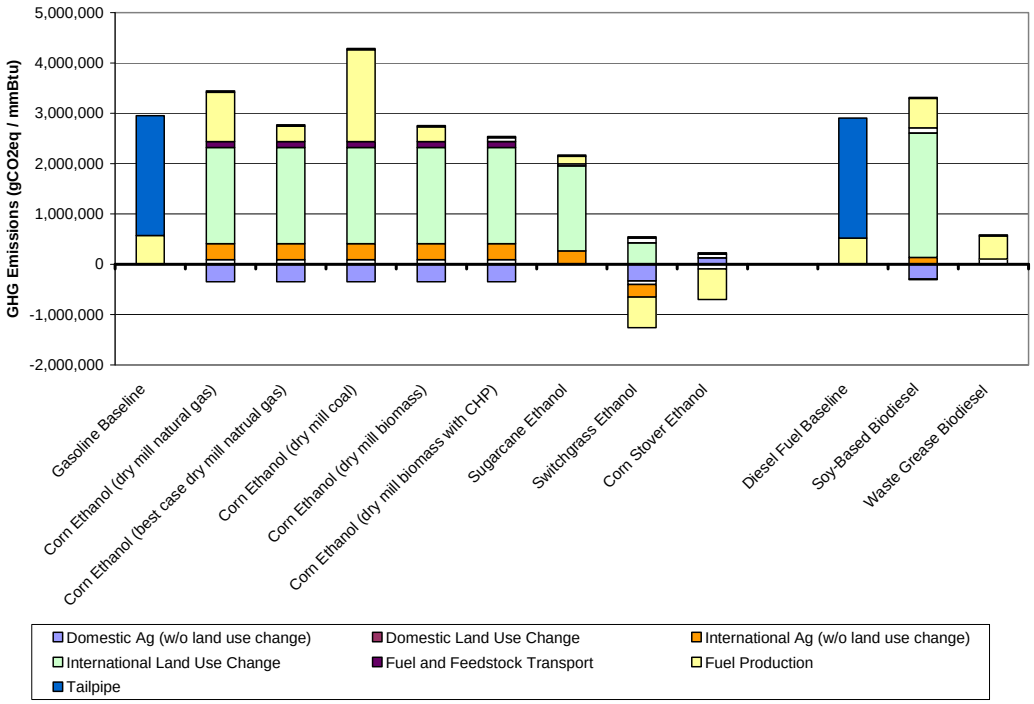


Figure 2. Net Lifecycle Greenhouse Gas Emissions By Lifecycle Component With 30 Year Time Horizon And 0% Discount Rate.



We believe that our lifecycle analysis is based on the best available science, and recognize that in some aspects it represents a cutting edge approach to addressing lifecycle GHG emissions. Because of the varying degrees of uncertainty in the different aspects of our analysis, we conducted a number of sensitivity analyses which focus on key parameters and demonstrate how our assessments might change under alternative assumptions. By focusing attention on these key parameters, the comments we receive as well as additional investigation and analysis by EPA will allow narrowing of uncertainty concerns for the final rule. In addition to this sensitivity analysis approach, we will also explore options for more formal uncertainty analyses for the final rule to the extent possible.

Because lifecycle analysis is a new part of the RFS program, in addition to the formal comment period on the proposed rule, EPA is making multiple efforts to solicit public and expert feedback on our proposed approach. EPA plans to hold a public workshop focused specifically on lifecycle analysis during the comment period to assure full understanding of the analyses conducted, the issues addressed and the options that are discussed. We expect that this workshop will help ensure that we receive submission of the most thoughtful and useful comments to this proposal and that the best methodology and assumptions are used for calculating GHG emissions impacts of fuels for the final rule. Additionally, between this proposal and the final rule, we will conduct peer-reviews of key components of our analysis. As explained in more detail in the section VI of the proposal, EPA is specifically seeking peer review of: 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; and how the several models we have relied upon are used together to provide overall lifecycle GHG estimates.

Each component of our analysis is discussed in detail in the preamble and the Draft Regulatory Impact Analysis that accompany the Notice of Proposed Rulemaking. The proposed rule is an important opportunity to seek public comment on EPA's entire lifecycle GHG analysis, including questions about land use modeling, and the choice of which time horizon and discount rate is most appropriate for this analysis.

For More Information

For more information on this proposal, please contact EPA's Office of Transportation and Air Quality, Assessment and Standards Division information line at:

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