RENEWABLE FUELS ASSOCIATION

January 16, 2024

The Honorable Tom Vilsack
Secretary
U.S. Department of Agriculture
1400 Independence Avenue, SW
Washington, DC 20250

The Honorable Michael Regan
Administrator
U.S. Environmental Protection Agency
1200 Pennsylvania Avenue, NW
Washington, DC 20460

The Honorable Jennifer Granholm
Secretary
U.S. Department of Energy
1000 Independence Avenue, SW
Washington, DC 20585

The Honorable Michael Whitaker
Administrator
Federal Aviation Administration
800 Independence Avenue, SW
Washington, DC 20591

Re: § 40B(e)(2) GREET Model for Sustainable Aviation Fuel Lifecycle Analysis Under the Inflation Reduction Act of 2022

Dear Members of the Interagency Working Group,

When guidance on the Inflation Reduction Act's (IRA) sustainable aviation fuel (SAF) tax credit was released on December 15, your organizations, as the members of the SAF Lifecycle Analysis Interagency Working Group (IWG), "commit[ted] that a modified GREET model will be available by March 1 … to calculate the lifecycle greenhouse gas emissions reduction percentage for SAF."[1,2] According to the guidance, this version of the model will be named "§40B(e)(2) GREET," referring to the section of the IRA that addresses methods for calculating the SAF emissions reduction percentage.

The Renewable Fuels Association (RFA) would like to offer the following comments for consideration during the development of "40B GREET." RFA is the leading trade association for America's ethanol industry. Its mission is to drive growth in sustainable renewable fuels and bioproducts for a better future. The development and commercial deployment of low-carbon fuels such as SAF is a vital part of this mission.

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[1] U.S. Department of the Treasury. "U.S. Department of the Treasury, IRS Release Guidance to Drive American Innovation, Cut Aviation Sector Emissions," December 15, 2023. https://home.treasury.gov/news/press-releases/jy1998.
[2] U.S. Department of Energy. "Interagency Statement by the Agencies Participating in the Sustainable Aviation Fuels Lifecycle Analysis Working Group," December 14, 2023. https://www.energy.gov/articles/interagency-statement-agencies-participating-sustainable-aviation-fuels-lifecycle-analysis.

One of the most promising forms of SAF involves the conversion of ethanol to jet fuel (ETJ). Ethanol has key advantages as a feedstock for SAF, as it is cost-competitive with petroleum-based fuels, has established production and transportation infrastructure, and is by far the largest-volume biofuel produced in the U.S, with output of nearly 16 billion gallons per year.

I. It Is Critical That Appropriate Models and Methods Be Used to Estimate Potential Indirect Emissions from Biofuels

The Environmental Protection Agency (EPA) conducted a model comparison exercise (MCE) when it set the Renewable Fuel Standard (RFS) volumes for 2023-2025. In the MCE technical document, the Agency noted, "As a general matter, when we use the term 'direct emissions' … we are referring to emissions from the fuel supply chain itself, whereas 'indirect emissions' refers to emissions that results from market-mediated impacts induced by a change in biofuel consumption."[3] As such, indirect emissions cannot be directly measured, and it is difficult to determine how, or whether, to attribute them to the use of specific biofuels. Thus, economic models are used in the estimation of such emissions, and differences in model structure, parameters, and datasets dramatically influence the results. It is important that the IWG clearly communicate to stakeholders that any indirect emissions estimates included in the final 40B GREET model are based on the results of predictive scenario analysis, not direct, empirical measurements.

a. The Existing Argonne National Laboratory (ANL) GREET Model Array Estimates Potential Emissions from Land Use Change Using the Best Available Science and Data

The core ANL GREET model is integrated with a Carbon Calculator for Land Use Change from Biofuels Production (CCLUB) module to incorporate emissions from for land use change (LUC). Within CCLUB, the results from the Global Trade Analysis Project (GTAP) economic model regarding the extent and composition of LUC are combined with emission factors to arrive at estimates of potential LUC-related emissions. By default, CCLUB uses domestic emission factors developed from a parametrized CENTURY model and international factors based on Winrock data.

The standard GTAP model was created in the 1990s by Purdue University, and researchers there subsequently developed the GTAP-BIO version of the model to facilitate biofuels-related analysis. As the model has been used and reviewed, numerous

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[3] U.S. Environmental Protection Agency, Office of Transportation and Air Quality, Transportation and Climate Division. *Model Comparison Exercise Technical Document.* Washington, DC, June 2023. https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P1017P9B.pdf.

refinements and improvements have been made, and the underlying database has been updated periodically. As EPA noted in the MCE:

> GTAP-BIO has been updated multiple times to add features that are relevant for biofuel GHG modeling. Tyner et al. (2010) included marginal lands and productivity estimates for potential new cropland based on a biophysical model. Taheripour et al. (2012) used a biophysical model (TEM) and estimated a set of extensification parameters which represent productivity of new cropland versus the existing land by AEZ region. Taheripour and Tyner (2013) used a tuning process to differentiate land transformation elasticities by region based on FAO data. Taheripour and Tyner (2013) modified the land supply tree putting cropland pasture and dedicated energy crops (e.g., switchgrass) in one nest and all other crops in another nest, "to make greater use of cropland pasture (a representative for marginal land) to produce dedicated energy crops." Taheripour et al. (2016) altered the land use module of GTAP-BIO to include cropland intensification due to multiple cropping or returning idled cropland production, defined a new set of regional intensification parameters and determined, and defined regional yield responses to price based on analysis of regional changes in crop yields. Taheripour et al. (2017) brought all of these modifications into one version of GTAP-BIO.

Regarding emission factors, it is notable that EPA also used the CENTURY model and Winrock data when it conducted the regulatory impact analysis for the RFS in 2010, which remains the Agency's most recent lifecycle analysis of biofuels used for compliance with the program. Specifically, for domestic land use emissions, EPA updated the emission factors in the Forest and Agricultural Sector Optimization Model (FASOM) based on runs of the CENTURY model (and the related DAYCENT model). Internationally, the Agency used "GHG emissions factors prepared by Winrock following IPCC guidelines."[4] (At the time, it also used Winrock data to estimate the types of land that would be expected to be converted.)

This is important since the Department of the Treasury and Internal Revenue Service (IRS) concluded in their December 2023 guidance on the SAF credit, "The EPA's methodology for determining lifecycle greenhouse gas emissions under the RFS program was specifically designed to satisfy the statutory definition in § 211(o)(1)(H) of the [Clean Air Act]. The methodology employed by the RFS program, consistent with that definition, is similar to the [Carbon Offsetting and Reduction Scheme for International Aviation] methodology." As a result, any "synthetic blending component" (i.e., renewable fuel) for which an advanced biofuel renewable identification number (RIN) is generated under the RFS will be provided safe harbor and automatically qualify for the SAF credit. Thus, a

[4] U.S. Environmental Protection Agency, Office of Transportation and Air Quality, Assessment and Standards Division. *Renewable Fuel Standard Program (RFS2) Regulatory Impact Analysis.* Washington, DC, February 2010. https://nepis.epa.gov/Exe/ZyPDF.cgi/P1006DXP.PDF?Dockey=P1006DXP.PDF.

framework that uses domestic emission factors based on the CENTURY model and international factors based on Winrock data—which the CCLUB module integrated with GREET does by default—has already been determined to satisfy the statutory criteria and be similar to CORSIA methodology.

Meanwhile, even though the Agro-ecological Zone Emission Factor (AEZ-EF) framework developed by Plevin *et al*. for the California Air Resources Board (CARB) is used in the CORSIA methodology, neither EPA nor the Treasury have determined that the AEZ-EF emissions factors satisfy the criteria of § 211(o)(1)(H). Further, the use of the AEZ-EF emissions factors in conjunction with GTAP-BIO was hotly debated in 2015 during CARB's process to "re-adopt" the Low Carbon Fuel Standard (LCFS). We strongly encourage the IWG to review the critiques and criticisms of the AEZ-EF model that were submitted to CARB during that process.

b. Alternative Frameworks Such as the Global Change Analysis Model (GCAM) Have Shortcomings That Render Them Less Suitable for Estimating Indirect Emissions

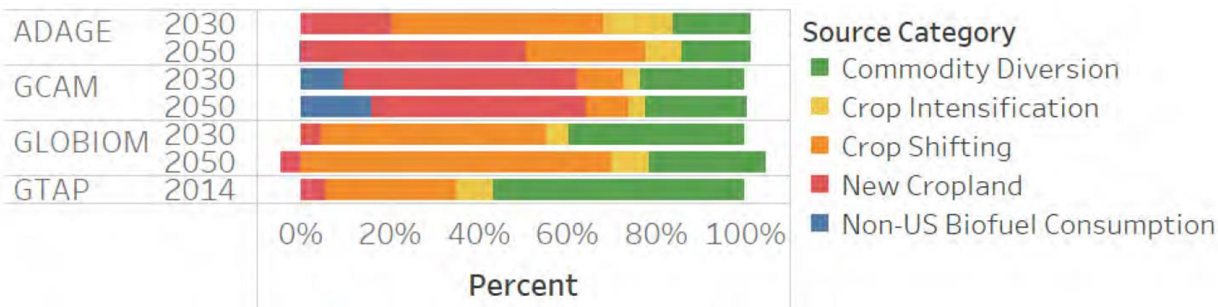
The statement issued by the SAF Lifecycle Analysis IWG indicated, "The modified GREET model will integrate … land use change emissions as informed by GTAP-BIO and/or GCAM." However, GCAM (unlike GTAP-BIO) was not specifically developed for estimating potential LUC related to biofuels expansion, and thus produces exaggerated LUC emissions estimates.

GCAM-T, a version of GCAM that was "developed as a collaboration between the Pacific Northwest National Lab (PNNL) Joint Global Change Research Institute (JGCRI) and the [EPA] Office of Transportation and Air Quality," was one of five models examined in EPA's MCE.[5] The extent to which natural lands are assumed to be protected (by law or otherwise) in GCAM is a key determinant of the LUC emissions estimated by the model.[6] Notably, only "36% of all non-commercial land is protected globally in GCAM-T" whereas "[a]ll [other] recent versions of GCAM, including GCAM v5.1 … assume by default that 90% by area of all non-commercial land classes (i.e., non-commercial pasture and forest, grassland and shrubland) are protected in each geographic land use region."[7]

[5] "GCAM-T 2020.0," April 20, 2021. https://github.com/gcamt/gcam-core.
[6] Mignone, B.K., Huster, J.E., Torkamani, S., O'Rourke, P., Wise, M., 2022. Changes in Global Land Use and CO2 Emissions from US Bioethanol Production: What Drives Differences in Estimates between Corn and Cellulosic Ethanol? *Climate Change Economics*, 13(4). https://www.worldscientific.com/doi/10.1142/S2010007822500087.
[7] Plevin, R.J., Jones, J., Kyle, P., Levy, A.W., Shell, M. J., Tanner, D. J., 2022. Choices in Land Representation Materially Affect Modeled Biofuel Carbon Intensity Estimates. *Journal of Cleaner Production*, 349. https://doi.org/10.1016/j.jclepro.2022.131477.

When EPA ran a scenario in the MCE in which an additional billion gallons of ethanol is consumed annually, GCAM-T proved to have a substantially higher propensity than other models to find that the incremental volume of corn would come from conversion of other land (mainly forest and grassland) to cropland (Figure 1). As EPA observed, "In the GCAM results, most of the new corn comes from new cropland. In the GLOBIOM and GTAP results, most of the new corn comes from shifting of cropland from other crops to corn. In the ADAGE results, there is a transition over time from more cropland shifting in 2030 to more new cropland in 2050." GCAM's implication that increased demand for crops is met primarily through cropland expansion into previous forest and grassland is inconsistent with other modeling results and approaches. It is also wholly inconsistent with real-world experience, whereby it is a demonstrable fact that increased crop production in recent decades has come primarily from intensification and crop shifting.

Figure 1: Model Results Showing Percentage of the Corn Ethanol Shock That Is Met by Different Categories in 2030 and 2050

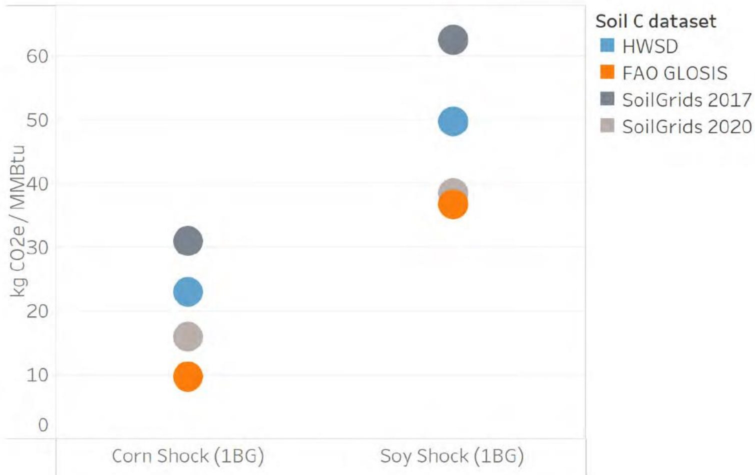


Source: EPA Model Comparison Exercise Technical Document

Additionally, GCAM-T utilizes an old version of a soil carbon database. EPA notes that "SoilGrids 2020 is an update of SoilGrids 2017." However, it acknowledges that the "GCAM results presented in the core scenarios … use globally gridded soil carbon stock data from SoilGrids 2017" since the 2017 version is the default dataset in GCAM.

EPA conducted a sensitivity analysis to determine the impact on LUC emissions from using different soil carbon datasets in GCAM-T, including both SoilGrids 2017 and SoilGrids 2020. Notably, EPA found that "SoilGrids 2017 produces the highest emissions and SoilGrids 2020 produces the lowest emissions." Addressing the process that was used, the Agency clarified that "the quantity and location of land use change did not vary across the runs, and differences in emissions are entirely based on differences in soil carbon stock assumptions." As a result, the carbon intensity (CI) of LUC emissions estimated using SoilGrids 2017 is by far the highest of the four datasets examined—roughly twice as large as SoilGrids 2020—as reflected in the MCE (Figure 2).

Figure 2: Carbon Intensity from LUC Emissions for the Corn Ethanol Shock and the Soybean Oil Biodiesel Shock Using a Range of Soil Carbon Datasets



Source: EPA Model Comparison Exercise Technical Document
Note: HWSD is the Harmonized World Soils Database. FAO GLOSIS is the Food and Agricultural Organization's Global Soil Information System map.

EPA subsequently observed, "A parameter sensitivity analysis with different soil carbon datasets in GCAM indicates that the initial steady state soil carbon conditions have a relatively large influence on land use change GHG estimates. This suggests that estimates from the same model are likely to change over time as science evolves and new data sets become available."

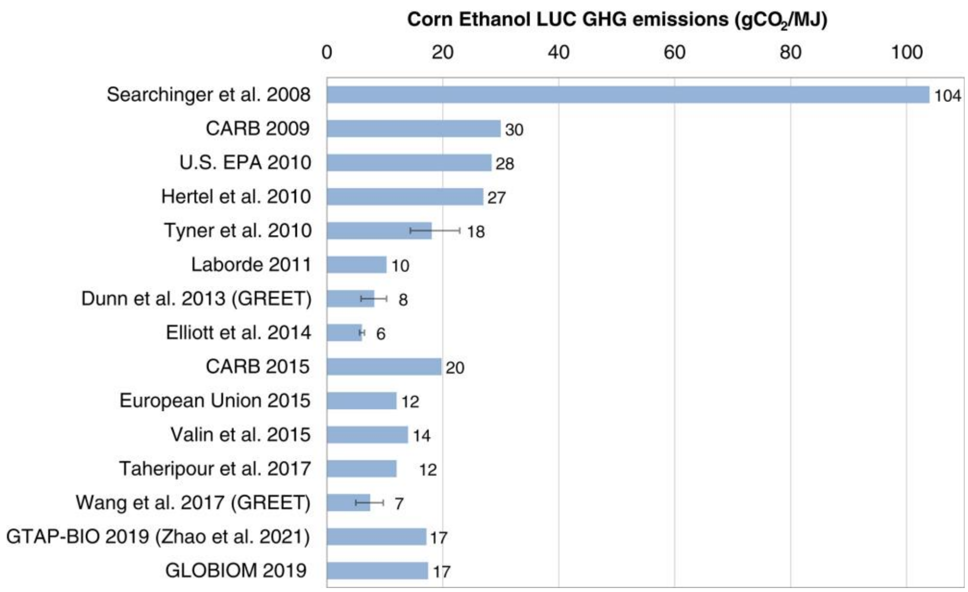
Thus, the combination of the tendency of GCAM-T toward land conversion and the use of a dataset that accentuates soil carbon loss has a compounding effect on the model's estimates of LUC emissions. EPA concluded, "We can compare 'Agriculture, forestry and land use change emissions' across four of the models (ADAGE, GCAM, GLOBIOM, GTAP). … For this category, the GCAM results include the highest emissions, driven by the land use change emissions." In an MCE scenario in which an additional billion gallons of ethanol is consumed annually, GCAM-T estimated LUC emissions at 31 kgCO_2eq/MMBTU, whereas the others estimated such emissions at between -1 kg (ADAGE) and 13 kg (GLOBIOM).

c. Any Model Used to Estimate Land Use Change Needs to Reflect Actual Observations

RFA urges the IWG to rely on empirical data, actual observations, and the real-world experience of the past 25 years when developing any methodology for estimation of LUC emissions. Rather than basing important policy decisions exclusively on modeling results from hypothetical scenarios, we encourage the IWG to carefully examine what has actually occurred in the U.S. and global agriculture sector as biofuel volumes have significantly expanded in recent decades. Indeed, in its MCE report, EPA itself stated, "It is…important to compare model results and parameters to historic observation." When viewed in the context of actual observations and empirical data, estimations of LUC conducted shortly after the establishment of the RFS proved to be greatly exaggerated. ANL researchers addressed this in a 2021 journal article:

> Early studies showed extremely high LUC emissions (e.g., Searchinger et al.), and recent studies show significantly lower LUC emissions. [Figure 3] The downtrend in simulated LUC emissions is a result of better developed and calibrated economic models and better modeling of GHG emissions from LUC. Economic models such as the Global Trade Analysis Project (GTAP) model are much improved in addressing land intensification … versus land extensification …, crop yield increases over time, crop yield differentials in existing croplands and in newly cultivated croplands, double cropping in regions such as Asia, availability and restriction of certain land conversions …, price elasticities for crop yield responses, and food demand responses to price changes.[8]

Figure 3: Trend of Simulated LUC GHG Emissions for U.S. Corn Ethanol



Source: Lee *et al.*

Taheripour elaborated on the downtrend in ILUC emissions over time. He reviewed research conducted using the GTAP-BIO, GLOBIOM, MIRAGE and CARD/FAPRI models, and showed that estimates of indirect land use change (ILUC) from corn ethanol have decreased over time based on each model.[9]

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[8] Lee, U., Kwon, H., Wu, M., Wang, M., 2021, Retrospective Analysis of the U.S. Corn Ethanol Industry for 2005–2019: Implications for Greenhouse Gas Emission Reductions. *Biofuels, Bioprod. Bioref.*, 15: 1318-1331. https://doi.org/10.1002/bbb.2225.

[9] Taheripour, F. "Induced land use changes and emissions due to biofuel production and policy: Theory, assessments, and observations." ASCENT 2023 SAF Meeting, Seattle, WA, April 25, 2023.

This demonstrates that it is imperative that any model(s) used in connection with 40B GREET should incorporate parameters and data that are recent enough to reflect what has occurred in the agriculture sector following the initial build-out of the ethanol industry, represent all the sectors of the economy impacted by the production and use of biofuels (including energy), and fully incorporate market-mediated responses to biofuel developments—including the functionality noted above by the ANL researchers. Moreover, land use-related outputs (i.e., predicted values) should be reviewed to ensure they sufficiently align with actual observations over the period since the RFS was established. As the EPA stated in the executive summary of the MCE, "We now have over a decade of historic observations to compare with model results and parameters and to use in model calibration."

d. Other Indirect Emissions Need to Be Properly Incorporated Into the Lifecycle Analysis of Biofuels

The SAF credit guidance stated that "the Treasury Department and the IRS conclude that the ANL-GREET model and other existing GREET-based models do not satisfy the applicable requirements" to qualify under IRA § 40B(e)(2) as a "similar methodology which satisfies the criteria under section 211(o)(1)(H) of the Clean Air Act." A letter from EPA to the Department of the Treasury in connection with the guidance referred to the 2010 RFS rulemaking, saying, "The EPA explained that, in the context of the RFS program, the lifecycle analysis methodology must capture not only indirect/induced land use change emissions, but also other potentially significant indirect emissions such as crop inputs, N_2O emissions, rice methane emissions, and livestock emissions."[10]

The use of corn for ethanol has supported corn prices. According to economic models, this can be expected to have resulted in modestly lower rice acreage and livestock production, both of which would reduce methane emissions. As noted in the EPA letter, these indirect effects should be taken into account in estimating the GHG emissions from ethanol across the full lifecycle.

Meanwhile, the IWG must take great care to ensure that introducing new potential sources of indirect emissions does not result in "double-counting" of GHG emissions. For example, using the existing ANL GREET model, emissions related to "crop inputs [and]

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https://s3.wp.wsu.edu/uploads/sites/2479/2023/04/1430-04_25_ASCENT_QuadCharts_ILUCI_Final-1.pdf. *Note that Dr. Taheripour is a research professor of agricultural economics at Purdue University and member of its Center for Global Trade Analysis, developers of GTAP.*

[10] Letter from Joseph Goffman, Principal Deputy Assistant Administrator for the Office of Air and Radiation, U.S. Environmental Protection Agency, to Lily Batchelder, Assistant Secretary for Tax Policy, U.S. Department of Treasury (December 13, 2023), https://home.treasury.gov/system/files/136/Final-EPA-letter-to-UST-on-SAF-signed.pdf.

N_2O emissions [related to fertilizer use]" on new cropland would already be captured both as direct supply-chain emissions *and* indirect emissions as part of a lifecycle CI analysis for crop-based biofuels. Adding these emissions again as a purported additional source of indirect emissions would result in double-counting and gross exaggeration of the CI of crop-based biofuels. Taheripour *et al*. discuss the risks of double-counting in their extensive rebuttal to Lark *et al*., especially as it related to N_2O emissions.[11]

II. The Nitrogen Emissions Estimates in ANL GREET Reflect the Best Available Science and Data

Emissions associated with the use of nitrogen fertilizer in feedstock production are a significant component of the total CI of corn ethanol. In 2019, researchers at ANL went through an extensive process to update the direct nitrous oxide (N_2O) emission factor (EF) used for GREET. They conducted a meta-analysis of U.S.-based studies published between 1990 and 2019, identifying 263 journal articles that were screened further. Data points for core Corn Belt states were then analyzed. The researchers found, "The mean N_2O EF (1.02%) is almost identical with the default direct N_2O EF (1%) for mineral fertilizers (Tier 1) reported in the 2006 IPCC report. … Given that 1% is within the uncertainty range of the direct N_2O EF estimated in this study, we adopted 1% as the updated direct N_2O emission factor. N_2O EF for studies outside the Midwestern states are relatively lower."[12]

As noted in a separate publication from ANL, "In addition to the direct N_2O emissions, N_2O can also be produced through indirect processes, which include the volatilization of nitrogen fertilizers, and the leaching and runoff of nitrate from fertilizers. GREET and [the Feedstock Carbon Intensity Calculator] adopt the indirect N_2O EFs from [Intergovernmental Panel on Climate Change] (2019) refinements."[13] In other words, indirect N_2O emissions are already captured in the ANL GREET model as part of the normal lifecycle CI analysis for crop-based biofuels.

Additionally, USDA has been working with ANL to update data in GREET on fertilizers and other inputs, presumably taking into account greater efficiencies achieved

[11] Taheripour, F., et al., May 2020. *Response to comments from Lark et al. regarding Taheripour et al. March 2022 comments on Lark et al. original PNAS paper*. https://greet.anl.gov/files/comment_environ_outcomes_us_rfs2

[12] Xu, H., Cai, H., Kwon, H., 2019. *Update of Direct N_2O Emission Factors from Nitrogen Fertilizers in Cornfields in GREET 2019.* Argonne National Laboratory, Energy Systems Division, Systems Assessment Center. https://greet.anl.gov/publication-n2o_update_2019.

[13] Liu, X., Cai, H., Kwon, H., Wang, M., 2019. *Feedstock Carbon Intensity Calculator (FD-CIC) Users' Manual and Technical Documentation.* Argonne National Laboratory, Energy Systems and Infrastructure Analysis Division, Systems Assessment Center. https://greet.anl.gov/publication-fd-cic-tool-2023-user-guide.

in recent years.[14] This, combined with the EF revisions, should ensure that GREET continues to accurately estimate N_2O emissions.

III. 40B GREET Should Reflect Known Improvements, Efficiencies, and Adoption of Climate-Smart Agriculture Practices by U.S. Farmers

As noted elsewhere in these comments, the emissions related to crop feedstock cultivation account for a large portion of the overall lifecycle CI of corn-based ethanol and other crop-based biofuels. Therefore, it is critically important that the 40B GREET model accurately represents the emissions from the various stages of crop production and properly accounts for on-farm improvements and efficiencies achieved in recent years that have lowered feedstock CI.

RFA was encouraged by the IWG's statement that "…the modified GREET model will integrate key greenhouse gas emission reduction strategies such as…Climate-Smart Agriculture practices." As shown by Emery, the combination of climate-smart agricultural practices (such as the use of cover crops, green ammonia, "4R" fertilization practices, and reduced tillage) can significantly reduce the overall CI of corn ethanol.[15] In many cases, U.S. corn farmers are already employing these practices on the farm; yet, existing lifecycle CI models, including ANL GREET, do not accurately account for the carbon impacts of these practices.

Thus, we encourage the IWG to ensure the 40B GREET model includes the most up-to-date data and information regarding climate-smart agricultural practices. However, the methods used for practically integrating these practices into the model must be carefully considered. Given the short timeframe available for completion of the 40B GREET model and the potential complexities involved with recordkeeping and verification, we encourage the IWG to consider simplified, streamlined methods of including climate-smart agricultural practices at higher spatial scales (i.e., national or regional averages).

IV. It Is Critical That There Be Opportunities for Stakeholder Engagement

It does not appear that there will be an opportunity for stakeholders to review and comment on the 40B GREET model before it is released (by March 1), which is unfortunate, especially given that the model will be used to determine eligibility for highly consequential tax credits. This is unlike other situations in which GREET has

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[14] O'Hara, J. "Conceptual Issues for GREET in Biofuel CI Calculations." CRC Workshop on Life Cycle Analysis of Transportation Fuels, Lemont, IL, October 3, 2023.

[15] Emery, I. Feb. 14, 2022. *Pathways to Net-Zero Ethanol: Scenarios for Ethanol Producers to Achieve Carbon Neutrality by 2050.* https://d35t1syewk4d42.cloudfront.net/file/2146/Pathways%20to%20Net%20Zero%20Ethanol%20Feb%202022.pdf.

been used in connection with government programs, most notably the California LCFS, where there has been a formal process for public input.

If 40B GREET or elements of the model are adapted for use in connection with the Clean Fuel Production Credit established in IRA § 45Z, we would urge the Department of Treasury and IRS, in collaboration with ANL, to initiate a formal process for stakeholder engagement and comment. This should commence soon after the issuance of the initial 40B GREET model, given that the IRA states, "Not later than January 1, 2025, the Secretary [of the Treasury] shall issue guidance regarding implementation of this section [i.e., 45Z], including calculation of emissions factors for transportation fuel."

Additionally, if 40B GREET continues to be used after December 31, 2024, we would ask that an updated version be issued in connection with the annual update of the main ANL GREET model (now referred to as R&D GREET), which typically occurs in October, and that there be a formal process for stakeholder comment in time for consideration by ANL staff.

V. Conclusion

In order for the full potential of the IRA to be realized, it is imperative that the proper lifecycle analysis modeling framework be adopted by the Treasury and IRS. The components of the ANL GREET modeling array meet the standards discussed in this letter, and once any significant indirect emissions from rice and livestock production have been incorporated, the resulting 40B GREET should be determined to satisfy the CAA section 211(o)(1)(H) criteria.

Thank you in advance for your consideration of these comments. Please do not hesitate to contact me should you have any questions.

Sincerely,

Geoff Cooper

Geoff Cooper
President and CEO

cc:

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