RENEWABLE FUELS ASSOCIATION

August 31, 2022

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RE: Washington Clean Fuels Program Rule

The Renewable Fuels Association (RFA) thanks you for the opportunity to provide comments for the Clean Fuels Program (CFP) rulemaking (Chapter 173-424 WAC). These comments supplement the comments we provided during the Informal Public Comment Period which we are reattaching here to be part of the Formal Public Comment Period**.**

- **RFA strongly supports a 20 percent reduction in carbon intensity for transportation fuels by 2034 and encourages Ecology to consider even more stringent targets**

Given the success of low carbon fuels policies in California and Oregon, both states are currently considering rulemaking to strengthen the compliance curves. Both programs have resulted in significant over compliance programs to date. Oregon is proposing a 37 percent reduction in carbon intensity by 2034 and California has bracketed strengthening the 2030 target of a 20 percent reduction in carbon intensity to between a 25 and 30 percent reduction. The combination of higher blends of progressively lower carbon biofuels combined with electrification enables more stringent targets. We encourage Ecology to work with the Legislature and other stakeholders to further reduce carbon intensity compliance curves by 2034 and beyond.

- **The land use change (LUC) values in the modeling should conform to updated analytical and empirical data**

A recent analysis by a collaboration of researchers from Environmental Health Engineering, MIT, Tufts, and Harvard concluded that a LUC (direct and indirect) emissions value for corn ethanol of 3.9 g/MJ represents the most credible evolution of the science on the topic.[1] Oregon's Clean Fuels Program uses the Argonne GREET model values of 7.8 g/MJ. These lower values are supported by recent analyses of land use patterns by Purdue University, the U.S. Departments of Energy and Agriculture, University of Illinois, and other institutions. Both values are well below California LUC value of 19.8 g/MJ which have not been updated since 2014.

[1] *Carbon Intensity of Corn Ethanol in the United States: State of the Science*: Scully, M. et al., January 2021; https://iopscience.iop.org/article/10.1088/1748-9326/abde08

The Argonne GREET model is the basis for the life cycle analysis in the CFP, so it is consistent to use Argonne GREET for land use change values as well. Argonne updates its model regularly (typically on an annual basis) to incorporate the best science on all variables. Additionally, in the interest of technology neutrality and with the rapid increase in battery-electric vehicles, the land use impacts of mineral extraction for battery production should also be evaluated [2], along with the land use implications of expanded wind and solar electricity generation.[3]

- **Additional data sources and studies to consider in the analysis of crop-based biofuels**

The following are relevant and recent studies on the topic of ethanol's climate and land use change impacts to review as Washington finalizes the CFP.

- *Retrospective Analysis of the U.S. Corn Ethanol Industry for 2005-2019; Implications for Greenhouse Gas Emission Reductions;* Lee, U et al., May 2021; https://onlinelibrary.wiley.com/doi/10.1002/bbb.2225. The study, conducted by Argonne National Laboratory researchers, found that the carbon intensity of corn ethanol shrank by 23% over the 2005-2019 timeframe, from 58 to 45 gCO2e/MJ (not including the land use change value of 7.4 gCO2/MJ). By 2019, corn ethanol reduced lifecycle emissions by 44-52% compared to gasoline. The researchers determined that corn ethanol reduced transportation related greenhouse gas (GHG) emissions by a cumulative 544 million metric tons CO2e over the study timeframe. Notably they demonstrated that there has been a "downtrend in simulated (land use change) emissions" that the stated "is a result of better developed and calibrated economic models and better modeling of GHG emissions."

- *GHG Emissions Reductions due to the RFS2: A 2020 Update*; Unnasch, S. & Parida, D., February 2021; https://ethanolrfa.org/file/748. The Renewable Fuel Standard (RFS) as expanded in 2007 has resulted in significant reductions in GHG emissions, with cumulative carbon dioxide savings of 980 million metric tons to date. Most of the savings have been associated with the use of ethanol.

- *The California Low Carbon Fuel Standard: Incentivizing Greenhouse Gas Mitigation in the Ethanol Industry*; Lewandrowski, J., Hohenstein, B., & Pape, D., November 2020; https://www.usda.gov/sites/default/files/documents/CA-LCFS-Incentivizing-Ethanol-Industry-GHG-Mitigation.pdf. The assessment, which was conducted by

[2] See, for example, International Energy Agency. "*The Role of Critical Minerals in Clean Energy Transitions*." May 2021. The report shows highly variable EV carbon intensity based on the minerals used. Mining and processing of cobalt sulfate, for example, is four times more carbon intensive than mining and processing of zinc. https://www.iea.org/reports/the-role-of-critical-minerals-in-clean-energy-transitions

[3] A recent study published in Nature, for example, found that the land cover changes, including indirect effects, associated with significant expansion in solar "…will likely cause a net release of carbon ranging from 0 to 50 gCO_2/kWh [0-180 g CO2/MJ], depending on the region, scale of expansion, solar technology efficiency and land management practices in solar parks." See: van de Ven, DJ., Capellan-Pérez, I., Arto, I. *et al. The potential land requirements and related land use change emissions of solar energy*. *Sci Rep* **11,** 2907 (2021). https://doi.org/10.1038/s41598-021-82042-5

researchers from the USDA and ICF, concluded that the value of credits toward California's Low Carbon Fuel Standard (LCFS) provides a strong financial incentive for ethanol facilities to implement GHG-reducing technologies and practices. A series of interviews with ethanol facility managers indicated that the LCFS and other policies, including the RFS, were large drivers of decisions to proceed with plant upgrades, such as process efficiency improvements, process energy modifications, changes to co-product production, and enzyme enhancements.

- *Response to Comments from Lark et al. Regarding Taheripour et al. March 2022 Comments on Lark et. al. Original PNAS Paper*; Taheripour, F. et al., May 2022; https://greet.es.anl.gov/publication-comment_environ_outcomes_us_rfs2. Researchers from the Department of Energy's Argonne National Laboratory, Purdue University, and the University of Illinois system thoroughly assessed the paper by Lark et al. "Environmental Outcomes of the US Renewable Fuel Standard," and they refuted key findings of the work. They showed that indirect land use change was overestimated, and land transitions were misinterpreted; additionally, there were significant issues with the calculation of GHG emissions associated with purported land use change. The authors concluded, "The overestimated emission factors and overestimated land conversion in Lark et al. led to overestimated [land use change] emissions for corn ethanol."

- *A Cautionary Tale: A Recent Paper's Use of Research Based on the USDA Cropland Data Layer to Assess the Environmental Impacts of Claimed Cropland Expansion*; Pritsolas, J. & Pearson, R., June 2021; https://ethanolrfa.org/file/1833/SIUE-Rebuttal-on-USDA-CDL-Use.pdf. A study by Zhang et al. assessed the environmental impacts of cropland expansion in the Midwest between 2008 and 2016, building on previous research that used the USDA Cropland Data Layer (CDL) to estimate the conversion of grassland to cropland. A review of the two studies determined, "The cropland expansion claimed … has a high potential of being false change due to poor classification certainty in the earlier CDL." This occurred since the earlier CDLs underestimated cropland area and grossly overestimated non-cropland area, but both were mapped more accurately as the CDL improved over time. The reviewers pointed out that the USDA has warned about "very low classification accuracy" of pasture and grass-related land cover categories in the CDL.

- *Response to "How Robust Are Reductions in Modeled Estimates from GTAP-BIO of the Indirect Land Use Change Induced by Conventional Biofuels?"*; Taheripour, F., Mueller, S., & Kwon, H., May 2021; https://www.sciencedirect.com/science/article/abs/pii/S0959652621016504. The paper was a response to criticisms by Malins et al. regarding the Global Trade Analysis Project model for biofuel analysis (GTAP-BIO) and the Carbon Calculator for Land Use Change from Biofuels Production (CCLUB). The authors compared early versus recent results of GTAP-BIO, discussed the treatment of cropland pasture, the yield-to-price elasticity and harvest frequency in the model, and they commented on the CCLUB emissions model. They asserted that as data and models have improved over time, estimates of the emissions associated with induced land use change from biofuels have decreased. It was noted that in the past, the "exclusion of market mediated responses, poor characterization of agricultural supply responses, poor reflection of real-world data, and using models and data not well-suited for addressing ILUC-related questions contributed to over-estimation of land use changes due to biofuels".

- *Effects of Ethanol Plant Proximity and Crop Prices on Land-Use Change in the United States*; Yijia, L., Miao, R., & Khanna, M., December 2018; https://onlinelibrary.wiley.com/doi/10.1093/ajae/aay080. The analysis showed that land use is inelastic to changes in corn ethanol production capacity. A 1% increase in the effective ethanol capacity in a county led to an increase in corn acreage in that county by about 0.03% to 0.1%, and an increase in total acreage of only 0.02% to 0.03%. The effect of the corn price and aggregate crop price on acreage change from 2008 to 2012 was more than twice as large. The results implied that the effect of changes in corn price on land use was largely at the intensive margin rather than at the extensive margin. Corn prices are influenced by several factors, not only ethanol, and it was noted that the effect of crop prices on land use was largely reversed as a result of the downturn in prices after 2012 and was close to negligible by 2014 relative to 2008.

- *Carbon Calculator for Land Use Change from Biofuels Production: Users' Manual and Technical Documentation*; Dunn, J. et al., December 2017; https://greet.es.anl.gov/files/cclub-manual-r4. The Carbon Calculator for Land Use Change from Biofuels Production calculates carbon emissions from land use change for ethanol production pathways, including corn ethanol. It is used in connection with Argonne National Laboratory's GREET model. For corn ethanol, land use change emissions were estimated to be 7.8 g CO_2e/MJ.

- *Lessons Learned from US Experience with Biofuels: Comparing the Hype with the Evidence*; Khanna, M., Rajagopal, D., & Zilberman, D., March 2021; https://www.journals.uchicago.edu/doi/pdf/10.1086/713026. The paper reviews projections that were made about the impacts of biofuels during the initial expansion in the 2000s and presents empirical evidence and modeling results about the effects of increased production on crop and fuel prices, land use change and GHG emissions. Biofuels were one of several significant factors that contributed to the increase in agricultural commodity prices through 2012, but the impact has dissipated over time. Regarding indirect land use change, the authors concluded that "the high initial estimates of the effect of biofuels on ILUC were driven largely by stringent model assumptions and have not been supported by either recent models (that have more advanced features) or the empirical evidence that has emerged over time."

- *Economic Impacts of the U.S. Renewable Fuel Standard: An Ex-Post Evaluation*; Taheripour, F., Baumes, H., & Tyner, W., June 2020; https://www.frontiersin.org/articles/10.3389/fenrg.2022.749738/full. The GTAP-BIO model was used to evaluate the extent to which the RFS and other factors affected commodity markets in the medium to long run, focusing on two time periods: 2004-2011 and 2011-2016. The analysis determined that coarse grain prices were 0.6% higher during the first period and 0.9% higher during the second period due to the RFS. This was supplemented with a partial equilibrium model, which determined that on a short-term basis the price of coarse grains was 6.7% higher during the second period due to the RFS. Overall, the study concluded that the RFS made major contributions to the agriculture sector, raising U.S. annual farm incomes by $1.4 billion in the first period and by $2.4 billion in the second period. In both periods, the long-run effects of biofuel production and policy on food prices were negligible.

- *Food Versus Fuel: An Updated and Expanded Evidence*; Filip, O. et al., August 2019; https://www.sciencedirect.com/science/article/pii/S0140988317303742. The study was segmented into three time periods, centering around the commodity price escalation that occurred during the second half of the 2000s. The analysis determined that ethanol did not affect agricultural commodity prices prior to June 2008, that it explained approximately 15% of the variance in corn prices and 5% of the changes in other commodity prices from July 2008 to February 2011, and that it contributed to approximately 10% of the variance in commodity prices from March 2011 to May 2016. The authors concluded that the results served as an ex-post correction of early studies that found biofuels had more substantial effects.

- *The Impact of Ethanol Industry Expansion on Food Prices: A Retrospective Analysis*; Informa Economics IEG, November 2016; https://ethanolrfa.org/file/975/Retrospective-of-Impact-of-Ethanol-on-Food-Prices-2016.pdf. A retrospective statistical analysis determined that retail food prices were not impacted in any demonstrable way by the expansion of U.S. corn ethanol production under the RFS. In fact, the study found that food price inflation slowed during the "ethanol era." While corn prices were positively impacted by ethanol expansion, the link between corn prices and consumer food prices was shown to be weak.

RFA looks forward to continued engagement with the Department of Ecology and other stakeholders in finalizing and implementing a successful Clean Fuels Program for the State of Washington.

Sincerely,

Kelly Davis
VP of Regulatory Affairs

Attachment follows.

April 25, 2022

Joel Creswell
Washington Department of Ecology
300 Desmond Drive SE
Lacey, WA 98503

RE: Washington Clean Fuels Program Rule

The Renewable Fuels Association (RFA) thanks you for the opportunity to provide comments for the Informal Public Comment Period for Chapter 173-424 WAC, Clean Fuels Program Rule**.**

The RFA is the leading national trade association representing U.S. fuel ethanol producers. Its mission is to advance the development, production, and use of low-carbon fuel ethanol by strengthening America's ethanol industry and raising awareness about the benefits of renewable fuels. Founded in 1981, RFA serves as the premier forum for industry leaders and supporters to discuss ethanol policy, regulation, and technical issues. RFA's 300-plus members are working daily to help America become cleaner, safer, more energy secure, and economically vibrant.

The RFA is an enthusiastic supporter of the Washington Clean Fuels program. We also are working around the country in collaboration with other stakeholders to implement similar programs in other states. The following comments offer RFA's perspective on the program design to date.

- **RFA supports a 20% reduction of carbon intensity targets by 2034**.

This goal is achievable and necessary given our climate crisis. This attainable target sends the appropriate longer term market signal for innovation and investment. The RFA membership is committed to producing ethanol at net zero full life cycle GHG emissions no later than 2050 and will be active participants in helping the State of Washington meet the Clean Fuel Program goals.

- **The integrity of the Clean Fuels Program depends on technology neutrality.**

The key to success of a Clean Fuels Program is its market-based technology neutral approach that is driven by the carbon intensity scores of all fuels whether generating credits or deficits. Consistent adherence to the principle of technology neutrality ensures broad support for the program going forward. Achieving the goals of the Clean Fuels Program will require a broad portfolio of low and zero carbon fuel solutions. Any new policies that are introduced to incentivize new innovations and technology development should be available to all low carbon fuels.

- **RFA supports using Argonne GREET as the basis for indirect and direct emissions**.

RFA has enthusiastically supported low-carbon fuel programs that use fair, consistent, and scientifically robust methods for evaluating the lifecycle carbon intensity (CI) of all transportation fuel options. The Argonne GREET model is widely accepted as the gold standard for full life cycle analysis of the GHG emissions from transportation fuels. Argonne updates its model regularly (typically on an annual basis) to incorporate the best science on all variables.

A critical aspect of a program's ability to meet these criteria is whether and how it incorporates theoretical greenhouse gas (GHG) emissions from indirect land use change (ILUC). Although estimates of ILUC-related emissions have been reduced significantly over the last decade, there remains substantial uncertainty inherent in the methods used to quantify them.

Although we believe that indirect effects should be excluded from low-carbon fuel programs until there is scientific agreement on methodology, considering all the research that has been conducted, the ILUC estimate incorporated into the GREET model is the best available. Given that the ILUC value used for Oregon's Clean Fuels Program is similar in magnitude to the GREET estimate and that the two states are adjoining, the recommendation by Life Cycle Associates that Washington adopt the same value of 7.6 g CO_2e/MJ is appropriate.

Attached to this letter is a more detailed review from RFA in support of the analysis by Life Cycle Associates prepared for the Department of Ecology recommending an ILUC value of 7.6 gCO_2e/MJ for corn ethanol.

- **The use of Book and Claim accounting should be expanded.**

Consistent with technology neutrality, book and claim accounting should be allowed in the production of all low carbon fuels utilizing the offsite production of renewable electricity and renewable natural gas for onsite process energy.

- **RFA strongly supports incorporating site specific agricultural inputs into fuel pathways**.

A significant portion (roughly half) of the full life cycle carbon intensity of ethanol is from the agricultural production of the feedstocks. With the increasing employment of no till, cover cropping, and other modern precision agricultural practices, farmers have quantified the ability to significantly lower the carbon intensity of feedstock production while also increasing soil carbon levels. Providing site specific input analysis will further incentivize these carbon efficient agricultural practices, resulting in lower carbon ethanol production and contributing to a more successful Clean Fuels Program.

The RFA looks forward to continued engagement with the Department of Ecology and other stakeholders in developing and implementing a successful Clean Fuels Program for the State of Washington.

Sincerely,

Kelly Davis
VP of Regulatory Affairs

RENEWABLE FUELS ASSOCIATION

April 25, 2022

RFA Review of iLUC Considerations in Development of Washington Clean Fuels Program

While indirect land use change (ILUC) remains a hypothetical concept, the most scientifically robust model-derived estimates of corn ethanol ILUC emissions are integrated into the Greenhouse gases, Regulated Emissions, and Energy use in Technologies (GREET) model developed by the Department of Energy's Argonne National Laboratory, which is considered the gold standard for estimating the greenhouse gas (GHG) emissions from transportation fuels. The Carbon Calculator for Land Use Change from Biofuels Production (CCLUB) is used to estimate ILUC emissions within the GREET/CCLUB/Global Trade Analysis Project (GTAP-BIO) modeling array. The use of CCLUB within this array has advantages over other approaches since CCLUB's LUC estimates are taken from the latest version of Purdue University's GTAP model and its emission factors are based on actual field measurements incorporated into the CENTURY/DAYCENT tools for measuring site-level carbon fluxes.

Based on these enhancements, the latest version of GREET/GTAP/CCLUB estimates that ILUC emissions from corn ethanol are approximately 5.4 grams of carbon dioxide equivalent per megajoule (g CO2e/MJ), while total emissions from LUC (including domestic LUC) are 7.4 g CO2e/MJ.

As researchers from Argonne explained in a 2021 study, "The LUC GHG emissions from large-scale corn production for corn ethanol have been simulated since 2008. Early studies showed extremely high LUC emissions (*e.g.*, Searchinger et al.), and recent studies show significantly lower LUC emissions. 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 [GTAP-BIO] are much improved in addressing land intensification (i.e., existing lands are managed to be more productive) versus land extensification (i.e., croplands extend into new areas of pasture and forest), 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 (e.g., restriction of public forest land for conversion to croplands), price elasticities for crop yield responses, and food demand responses to price changes."[1]

In a report prepared for the Washington Department of Ecology, Life Cycle Associates recommended that an ILUC value of 7.6 g CO2e/MJ be adopted for corn ethanol under the

[1] 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.* https://doi.org/10.1002/bbb.2225

Clean Fuel Standard (CFS), which would be consistent with the Oregon Clean Fuels Program and is similar in magnitude to the GREET estimate.

The International Council on Clean Transportation (ICCT) conducted a "peer review" of materials developed by Life Cycle Associates, including the report on ILUC. The ILUC recommendation was singled out for particular scrutiny, and ICCT's criticisms of the GTAP-BIO and CCLUB models underlying the Oregon ILUC value largely track those in a 2020 paper by Malins *et al.* that is cited at least a half-dozen times.[2] Perhaps this is not surprising since Stephanie Searle of ICCT has coauthored several papers with Malins, including one that critiqued GTAP and CCLUB.[3]

A detailed response to the 2020 paper by Malins *et al.,* which also addressed references to the paper by Searle and Malins, was published by leading researchers involved in the development of GTAP-BIO and CCLUB.[4] Rather than repeating their rebuttal to the criticisms here, the RFA would refer the Department of Ecology to that response as it considers what ILUC value is appropriate for the CFS.

It is worth noting that the authors ended by saying, "The existing literature has reached the conclusion that early research in this area significantly overstated the land use implications of biofuels. Following early overstated projections for ILUC—which are in sharp conflict with actual observations and were estimated from improper modeling practices and/or hypothetical biased assumptions inconsistent with actual observations—will diminish our capability to effectively reduce GHG emissions using agricultural resources."

The ICCT recommended that Washington adopt the ILUC value used for the California Low Carbon Fuel Standard (LCFS) rather than the one for Oregon's program, However, the California estimate was developed in 2014 and does not reflect updates to models (including GTAP-BIO) and data that have occurred since then.

Additionally, California's ILUC factor was based on the predicted land use effects of expanding national corn ethanol production from 2004 levels to 15 billion gallons (i.e., current levels). In other words, the California Air Resources Board's (CARB) analysis penalizes current biofuels for hypothetical ILUC emissions that might or might not have actually occurred in the past as ethanol production expanded to this level. Thus, the CARB ILUC factor did not reflect the

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[2] Malins, C., Plevin, R. & Edwards, R. (2020). How Robust Are Reductions in Modeled Estimates from GTAP-BIO of the Indirect Land Use Change Induced by Conventional Biofuels? *J. Clean. Prod., 258,* 120716. https://doi.org/10.1016/j.jclepro.2020.120716

[3] Searle, S., & Malins, C. (2016). *A Critique of Soil Carbon Assumptions Used in ILUC Modeling* (Working Paper 2016-13). International Council on Clean Transportation. https://theicct.org/sites/default/files/publications/ICCT_soil-carbon-assumptions-ILUC_20160613.pdf

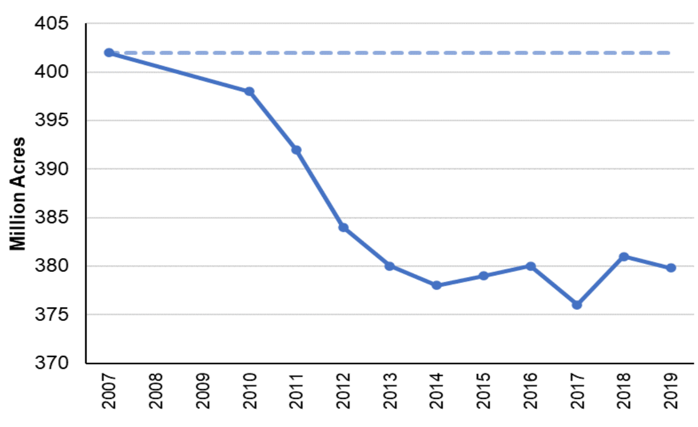
[4] Taheripour, F., Mueller, S., & Kwon, H. (2021). Response to "How Robust Are Reductions in Modeled Estimates from GTAP-BIO of the Indirect Land Use Change Induced by Conventional Biofuels?" *J. Clean. Prod.*, *310,* 127431. https://doi.org/10.1016/j.jclepro.2021.127431

expected land use emissions of specifically implementing the re-adopted California LCFS starting in 2016, and it certainly does not simulate the land use effects of implementing the Washington CFS in the future.

In reality, U.S. ethanol production peaked in 2018 and slumped in 2020 and 2021 as a result of the COVID-19 pandemic, and the U.S. Energy Information Administration forecasts that production will only be 1% above the 2018 level in 2030 and 4% higher in 2035.[5] The increase is actually due to the expectation that exports will increase, as domestic consumption in 2030 and 2035 is forecast to be less than occurred in 2018 and 2019, since overall gasoline consumption is projected to decline. Accordingly, it is illogical to suggest that implementation of the CFS would induce additional corn ethanol ILUC emissions. If the purpose of including ILUC in the CFS program is to account for any potential unintended environmental impacts of the policy, adopting the CARB ILUC factors is plainly the wrong approach.

The concept of land use change should also be considered in the context of empirical data. When the Environmental Protection Agency (EPA) initially implemented the Renewable Fuel Standard, as amended by the Energy Policy Act of 2007 (EISA), it estimated that 402 million acres of U.S. agricultural land were available for production of crops and crop residue in 2007 that would meet EISA's definition of renewable biomass. This encompassed total cropland, pastureland, and Conservation Reserve Program land. The agency conducts annual assessments to ensure this number of acres is not exceeded, which clearly show that U.S. agricultural land has receded since passage of EISA. In recent years, it has been 20-25 million acres (5-6%) lower than in 2007 (Exhibit 1).[6]

Exhibit 1: U.S. Agricultural Land Area



Source: EPA

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[5] U.S. Energy Information Administration. (2022). *Annual Energy Outlook 2022.* https://www.eia.gov/outlooks/aeo/index.php
[6] Data for 2020 and 2021 have not yet been published by EPA.

Finally, it is worth noting that a recent paper by Lark et al., "Environmental outcomes of the US Renewable Fuel Standard,"[7] which makes allegations about GHG emissions related to land use change, has been refuted thoroughly by the Renewable Fuels Association[8] and a separate group of experts from Argonne, Purdue University, and the University of Illinois system.[9] The latter group determined, "After a detailed technical review of the modeling practices and data used by Lark et al., we conclude that the results and conclusions provided by the authors are based on several questionable assumptions and a simple modeling approach that has resulted in overestimation of the GHG emissions of corn ethanol." Rather than detailing the rebuttals here, we would refer the Department of Ecology to those documents.

In summary, considering all of the research that has been conducted, the ILUC estimate incorporated into the GREET model is the best available. Given that the ILUC value used for Oregon's Clean Fuels Program is similar in magnitude to the GREET estimate and that the two states are adjoining, the recommendation by Life Cycle Associates that Washington adopt the same value of 7.6 g CO2e/MJ is appropriate.

[7] Lark, T. J., Hendricks, N. P., Smith, A., Pates, N., Spawn-Lee, S. A., Bougie, M., Booth, E. G., Kucharik, C. J., & Gibbs, H. K. (2022). Environmental Outcomes of the US Renewable Fuel Standard. *Proceedings of the National Academy of Sciences*. https://doi.org/10.1073/pnas.2101084119

[8] Renewable Fuels Association. (2022). Rebuttal to the Lark et al. Report "Environmental Outcomes of the US Renewable Fuel Standard." https://ethanolrfa.org/file/2191/RFA%20Rebuttal%20to%20Lark%20et%20al%20PNAS%20Report%20FINAL.pdf

[9] Taheripour, F., Mueller, S., Kwon, H., Khanna, M., Emery, I., Copenhaver, K., & Wang, M. (2022). *Comments on "Environmental Outcomes of the US Renewable Fuel Standard."* https://greet.es.anl.gov/publication-comment_environ_outcomes_us_rfs