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U.S. Environmental Protection Agency
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1200 Pennsylvania Avenue NW
Washington, DC 20460

February 10, 2023

Re: **Docket ID No. EPA-HQ-OAR-2021-0427**
Comments of Earthjustice and World Resources Institute

On behalf of our supporters across the country, Earthjustice and World Resources Institute submit these comments in response to the United States Environmental Protection Agency's (EPA's or Agency's) proposed rule setting renewable fuel standards for 2023 through 2025, Docket ID No. EPA-HQ-OAR-2021-0427, Renewable Fuel Standard (RFS) Program: Standards for 2023-2025 and Other Changes, 87 Fed. Reg. 80582, December 30, 2022 (Proposed Rule).

I. INTRODUCTION

In 2007, Congress passed the Energy Independence and Security Act (EISA)[1] to increase the production of renewable fuels and thereby reduce greenhouse gas (GHG) emissions, and to move the United States toward greater energy independence.[2] To ameliorate the growing threat of climate change, Congress included in EISA a new Renewable Fuel Standard (RFS) which, among other things, mandated the mixing of certain biofuels into transportation fuel.[3]

At the time of EISA's enactment, "cellulosic biofuel" – ethanol produced from agricultural waste or purpose-grown perennial energy crops such as switchgrass – was thought to be the most promising path for decarbonizing passenger vehicles. This is reflected in the volume requirements established by Congress, which were intended to ensure the use of 21 billion gallons of "advanced biofuels" in 2022. Of the 21 billion gallons of advanced biofuels, 16 billion gallons were supposed to be cellulosic biofuel. These volumes aimed to achieve at least a 50% reduction in greenhouse gas emissions compared with petroleum-based transportation fuel.

Fifteen years later the world looks fundamentally different. Cellulosic ethanol has completely failed to materialize at commercial scale, despite substantial efforts. At the same time, electric vehicle technology has advanced more rapidly than expected and is now

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[1] *See* Pub. L. No. 110-140, § 202(a)(1), 121 Stat. 1492 (2007).
[2] *See* 42 U.S.C. §7545(o).
[3] *See* 42 U.S.C. §§7545(o)(1)(A), 7545(o)(1)(I)(i).

recognized as the primary pathway for decarbonizing the transportation sector. Meanwhile the global population has reached eight billion people, dramatically increasing food demand, and global carbon dioxide emissions from land use and land-use change have increased to 6.6 billion tons per year.[4]

In this Set Rule, EPA has broad discretion to set Renewable Volume Obligations (RVOs) starting in 2023 that reflect these current realities. It is unreasonable for EPA to promulgate an RFS Set Rule for 2023 through 2025 that largely continues the program as if nothing has changed and as though the RFS program has successfully been working as originally intended.

EPA should take this opportunity to adopt a new policy framework to guide the RFS program reflective of the fundamental shifts that have occurred since 2007. To allow for this necessary reassessment, we urge the Agency to finalize a Set Rule only for 2023 at this time. We also urge EPA to recognize that when biofuels are made from crops or otherwise divert the productive capacity of land, there is a "carbon opportunity cost" to not using this land either to provide food or to store carbon. This is a direct cost that needs to be factored into lifecycle analyses (LCAs) of the GHG consequences of biofuels. Due to this high cost, to avoid exacerbating the climate and other adverse environmental impacts of biofuels made from crops or other dedicated uses of land, as discussed in detail in these comments, we further urge EPA to set the RVOs for 2023 at a level that can be supplied from waste biomass and to recognize only such biofuels as qualifying to satisfy these RVOs.

II. EPA SHOULD SET THE VOLUMES FOR ONE YEAR (2023) ONLY.

In this Proposed Rule, EPA proposes to set "volume targets and applicable percentage standards for cellulosic biofuel, BBD [biomass-based diesel], advanced biofuel, and total renewable fuel for 2023-2025."[5] EPA suggests that three years is the appropriate time period for which to set the volumes in order to balance what it sees as the need to "provide the market with the certainty of demand needed for longer term business and investment plans," with the challenge of "setting volume targets too far out into the future" and the "higher uncertainty associated with projecting supply for longer time periods and the increasing likelihood for unforeseen circumstances to upset supply."[6]

We urge EPA to set volume requirements for only one year (2023) for three reasons. *First*, as EPA itself has stated, there is great uncertainty about the biofuel market, and EPA needs more time to better project market demand for biofuel production in future years. *Second*, EPA's analytical approach leaves great uncertainty about the climate and environmental impacts of biofuel production and combustion, particularly as to the impacts of the tremendous land use associated with the RFS program, and EPA must reassess these impacts with updated models and frameworks. *Third*, EPA's own analyses demonstrate that the RFS program has failed to perform as envisioned by Congress and does not achieve the goals of EISA. Limiting this rule to one year

[4] *See* IPCC, *2022: Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* 59 (2022).
[5] *See* Renewable Fuel Standard (RFS) Program: Standards for 2023-2025 and Other Changes, 87 Fed. Reg. 80582, 80583 (Dec. 30, 2022).
[6] *Id.* at 80584.

only will allow EPA time to both reconsider its analytical framework and examine additional studies on the numerous factors affecting the renewable fuels market, as well as the impacts of the RFS program, and would thus allow it to set volumes for future years with greater certainty and less climate and environmental harm.

A. There is great uncertainty related to market and other factors that will affect renewable fuel production and demand in future years.

Throughout the Proposed Rule, EPA recognizes the great uncertainty surrounding the production of and demand for renewable fuel. It notes that it is "unable to quantitatively compare all of the evaluated impacts when assessing the overall costs and impacts of this proposed rulemaking."[7] Indeed, EPA states that "[t]his proposed rule comes at a time when major policy developments and global events are affecting the transportation energy and environmental landscape in unprecedented ways."[8] Given these uncertainties, EPA acknowledges that "[s]etting percentage standards several years in advance . . . could result in less accurate gasoline and diesel projections being used in calculating the percentage standards."[9]

The inaccuracy of longer-term projections is especially acute in the renewable fuels market, which over the past two decades has experienced tremendous unpredictability. As EPA itself explains:

> [O]ur experience with the RFS program since its inception is that unforeseen market circumstances involving not only renewable fuel supply but also relevant economics mean that fuels markets are continually evolving and changing in ways that cannot be predicted. These facts affect all supply-related elements of biofuel: projections of production capacity, availability of imports, rates of consumption, availability of qualifying feedstocks, and the gasoline and diesel demand projections that provide the basis for the calculation of percentage standards. Greater uncertainty in future projections means a higher likelihood that those future projections could turn out to be inaccurate, leading to the potential need to revise them after they are established through, for instance, one of the statutory waiver provisions. Such actions to revise applicable standards after they have been set could be expected to increase market uncertainty.[10]

EPA similarly recognizes the uncertainties associated with the renewable fuel market in its draft Third Triennial Report to Congress on Biofuels and the Environment. EPA acknowledges that "the likely future effects of the RFS Program are highly uncertain," as factors

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[7] 87 Fed. Reg. at 80586.
[8] *Id*.
[9] *Id*. at 80589.
[10] *Id*. at 80591–92; *see* EPA, Draft Regulatory Impact Analysis: RFS Standards for 2023-2025 and Other Changes 5 (Dec 13, 2022) ("DRIA"), www.regulations.gov at EPA-HQ-OAR-2021-0427-0267 (explaining the many factors that lead to uncertainty in EPA's ability to set volume requirements, including, for example, "the difficulty in projecting the future market's ability to make available and consume renewable fuel").

such as “ongoing recovery from the global COVID-19 pandemic, uncertainty in the penetration of E15 in the marketplace, competition with other technologies such as electric vehicles, and continued slow growth of cellulosic ethanol production from agricultural or marginal lands” all contribute to ongoing uncertainty.[11]

In light of these real, ongoing, and significant uncertainties, EPA’s ability to project volumes beyond one year become increasingly questionable. Any volumes set beyond 2023 risk artificially inflating or deflating the market depending on how these many contributing factors play out. Accordingly, EPA should focus this proposal on setting volumes for just one year.

B. EPA believes there is great uncertainty in the climate and other environmental impacts of the RFS Program, and this cautions against setting volumes beyond 2023.

Not only is there uncertainty surrounding the production of and demand for biofuels, but EPA also recognizes that its approach leaves great uncertainty around the overall climate and environmental impact of the RFS program. For this reason too, EPA should set the volumes for one year only at this time.

1. EPA needs additional time to develop its climate modeling framework and to incorporate additional studies on lifecycle GHG emissions from biofuels.

Congress made clear that in setting renewable fuel volumes, EPA must include “an analysis of . . . the impact of the production and use of renewable fuels on the environment, including on . . . climate change.”[12] Below we demonstrate that EPA’s current approach fails to adequately consider the full land use impact of biofuel production and offer an alternative approach. *See infra* Section IV. Given that EPA itself admits that the models it has used to analyze lifecycle emissions associated with various stages of biofuel production and use are “old, and that an updated framework is needed,”[13] EPA should set the volumes for only one year while it continues to assess and develop better approaches.

EPA explains that, rather than using admittedly outdated models for the Proposed Rule, it instead relied on “an extrapolation of lifecycle GHG analyses,” using “a range of LCA estimates that are in the literature” and based on this literature review, provided “a high and low estimate of the potential GHG impacts.”[14] Yet, as EPA acknowledges, “[t]he range of values in the literature for different types of renewable fuels varies considerably, particularly for crop-based biofuels,” and that therefore, its “compilation of the current literature reveals a wide range of estimates of the lifecycle GHG emissions associated with renewable fuels,” with particularly wide ranges for fuels made from crop-based feedstocks.[15] Thus, EPA believes there is

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[11] EPA, Biofuels and the Environment Third Triennial Report to Congress External Review Draft (ERD), at ES-4 (Jan. 2023)(“Third Triennial Report”).
[12] 87 Fed. Reg. at 80609.
[13] *Id.* at 80610.
[14] *Id*.
[15] *Id*. at 80610–11.

considerable "ongoing uncertainty associated with the science of analyzing biofuel GHG effects,"[16] This counsels against setting volumes for years beyond 2023.

Notably, EPA "has initiated work to develop a revised modeling framework of the GHG impacts associated with biofuels."[17] Yet it asserts that "crop-based biofuel lifecycle GHG emissions are inherently uncertain to a large degree," and it intends to use its modeling comparison exercise to "identify[] future priorities for updating and aligning particular assumptions across models," among other things.[18] And it intends to "consider the broad range of new science related to biofuel LCA, including insights from the model comparison exercise."[19] EPA indicates similar uncertainty in its Third Triennial Report to Congress.[20]

Research by the National Academies of Science, Engineering and Medicine (NAS) likewise concludes that the Agency needs new analytical approaches to determine lifecycle GHG emissions related to renewable fuel. In a recently published study entitled "Current Methods for Life Cycle Analyses of Low-Carbon Transportation Fuels in the United States," NAS notes:

> Though the study of induced land use changes from biofuels has been the topic of intense study over the last decade, substantial uncertainties remain on many key components of economic models used to assess these impacts. Further work is warranted to update these estimates of market-mediated land use change and the models so as to inform the development and implementation of an LCFS [low carbon fuel standard].[21]

EPA should thus allow additional time to incorporate this and other studies into its analysis and projections of volumes for years beyond 2023.

2. EPA's own analysis shows the needs for additional time to understand the environmental impacts of renewable fuels, including the impacts on threatened and endangered species.

In addition to EPA's uncertainty around climate impacts, so too does it express uncertainty related to other environmental impacts of the RFS program. For example, though prior litigation made clear that the RFS program may affect threatened and endangered species and thus requires consultation with Fish and Wildlife Service and National Marine Fisheries

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[16] *Id*. at 80611.
[17] *Id*. at 80610.
[18] *Id*. at 80611.
[19] DRIA at 115.
[20] *See* Third Triennial Report at 2-17–2-18, Box 2.2 (recognizing "the need to update EPA's analytical work" related to assessing the lifecycle GHG emissions from biofuel production and use, and noting that "[s]ignificant analytical work has been undertaken since EPA laid out its lifecycle methodology in the 2010 RFS rulemaking, with work in this area continuing").
[21] Nat'l Academies of Sci., Eng'g & Medicine. *Current Methods for Life Cycle Analyses of Low-Carbon Transportation Fuels in the United States,* at 10 (2022).

Service,[22] EPA has not yet completed this requisite step but rather continues to be "engaged in informal consultation including technical assistance discussions with the Services regarding this rule."[23] In its Draft Regulatory Impact Analysis, EPA notes that it "is in the process of conducting a Biological Evaluation which will evaluate impacts on endangered species from the RFS Program," and that "[m]ore information on the estimated impact to species in the affected region on the RFS program will be available when the evaluation is concluded."[24]

Similarly, in its Triennial Report to Congress, EPA notes that the impact of the RFS Program on endangered and threatened species "is unknown."[25] It admits that it has not yet estimated specific areas affected by the RFS program finer than the county level and thus "historical effects on threatened and endangered (T&E) species cannot be estimated with any reasonable degree of certainty."[26]

For all these reasons, EPA should give itself additional time to get more clarity on the climate and environmental impacts of the RFS program. It should set volumes for 2023 only so that it is able to incorporate additional studies into future volume-setting.

C. To date, the RFS has not advanced Congress's climate and environmental goals and EPA cannot justify a longer-term continuation of current RVOs.

As discussed above, through EISA, Congress intended to address the growing threat of climate change and other environmental harms associated with fossil fuels. The statute creates several measures by which Congress anticipated achieving these goals. For example, to avoid the climate and environmental harms associated with the conversion of uncultivated land – including the release of tremendous volumes of GHG and degradation of biodiversity and habitat – the statute provides that land used to grow qualifying crops must have been in cultivation at the time of the statute's passage.[27] This in turn is intended to reduce GHG emissions from the initial turning of the soil for cultivation as cropland and avoid the negative environmental impacts associated with land conversion.

In addition, the statute requires that every three years, EPA must look at "[e]nvironmental issues, including air quality, effects on hypoxia, pesticides, sediment, nutrient and pathogen levels in waters, acreage and function of waters, and soil environmental quality," as well as "[r]esource conservation issues, including soil conservation, water availability, and ecosystem health and biodiversity, including impacts on forests, grasslands, and wetlands."[28] EPA must both report to Congress about these environmental impacts and take them fully into account

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[22] *See Growth Energy et al. v. EPA*, 5 F.4th 1(D.C. Cir. 2021),
[23] 87 Fed. Reg. at 80587.
[24] DRIA at 252.
[25] Third Triennial Report at IS-4.
[26] *Id.*
[27] *See* 42 U.S.C. § 7545(o)(1)(I).
[28] 42 U.S.C. § 7545(Editorial Notes) (quoting Pub. L. 110–140, title II, §204, Dec. 19, 2007, 121 Stat. 1529).

when setting volumes,[29] including reducing volumes standards below statutory targets if implementation of those volumes will lead to severe environmental harm.[30]

Also reflected in EISA is Congress's goal to conserve resources – including (as discussed further below) land. The law amended Section 977 of the Energy Policy Act of 2005 to establish program goals to develop feedstocks "that are less resource and land intensive and that promote sustainable use of resources, including soil, water, energy, forests, and land, and ensure protection of air, water, and soil quality."[31] And it amended Section 307(d) of the Biomass Research and Development Act of 2000[32] to establish "the systematic evaluation of the impact of expanded biofuel production on the environment, including forest lands, and on the food supply for humans and animals."[33]

Despite these clear statutory goals, EPA's own analyses establish that the RFS program as implemented has not advanced the climate and environmental benefits Congress intended. As discussed above, EPA itself asserts the climate impacts of the RFS program are uncertain, and at a minimum additional studies are needed to better understand the program's effect on overall GHG emissions (and we demonstrate below that best science today indicates a significant negative impact). With more certainty, EPA acknowledges that the program has led to the conversion of millions of acres of land that was not in cultivation at the time of EISA's passage to produce corn for ethanol and soy for biodiesel, in direct contravention of Congress's intention.[34] In fact, the RFS program has "resulted in up to approximately 1.9 million acres of additional cropland between 2005 and 2016, and up to approximately 3.5 million acres of additional corn."[35] Based on EPA's recent attribution analysis, the program accounts for roughly "20% of the estimated cropland *expansion* between 2008 and 2016," and "up to 35% of the *increase* in corn acreage between 2008 and 2016."[36] And as EPA recognizes, "[c]ropland expansion often leads to increases in soil erosion, pesticide and fertilizer applications, and losses of seminatural habitat,"[37] and releases tremendous amounts of GHGs.

In addition, and partially related to the land conversion associated with growing crop-based biomass, the RFS program has led to worsening air, water, and soil quality.[38] In particular, EPA notes that "emissions for nitrogen oxides (NO_x), sulfur oxides (SO_x), carbon monoxide (CO), volatile organic compounds (VOCs), ammonia (HN_3), and particulate matter ($PM_{2.5}$) can

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[29] *Id*. § 7545(o)(2)(B)(ii).
[30] *Id*. § 7545(o)(7)(A).
[31] EISA, Pub. L. No. 110-140, § 232(a)(2)(D)(4), 121 Stat. 1492.
[32] *See* 7 U.S.C. § 8606(d).
[33] *Id.* § 232(b)(3). [1] This provision has now been moved to 7 U.S.C. § 8108.
[34] EISA defines crop-based biomass as "[p]lanted crops and crop residue harvested from agricultural land cleared or cultivated at any time prior to December 19, 2007, that is either actively managed or fallow, and nonforested," 42 U.S.C. § 7545(o)(1)(I)(i).
[35] Third Triennial Report ES-2.
[36] *Id.* ES-2–ES-3 (emphasis in original).
[37] *Id.* at ES-3.
[38] *Id.* at ES-2–ES-3, IS-4, IS-11.

be impacted at each stage of biofuel production, distribution, and usage."[39] Furthermore, EPA explains that "[r]ecent dispersion modeling has shown elevated pollutant concentrations near corn, soybean, and wood biorefineries, which were associated with adverse respiratory outcomes."[40] EPA also found that planting corn and soybeans – particularly on converted grassland – harms soil and water quality, as there is "increased chemical usage, some of which moves as runoff or leaching to surface waterways or groundwater."[41]

In sum, the RFS program has had significant negative impacts on climate and the environment. These deleterious climate and environmental impacts are directly contrary to Congress's goals in EISA and do not justify a longer-term continuation of current RVOs. EPA should therefore not set volumes beyond 2023 so it can allow itself additional time to determine how best to address these harms.

III. EPA'S PROPOSAL IS INCONSISTENT WITH THE ADMINISTRATION'S PLANS FOR TRANSPORTATION DECARBONIZATION PRIMARILY THROUGH ELECTRIFICATION, WHICH WILL REDUCE THE DEMAND FOR BIOFUEL.

EPA's proposed rule is inconsistent with the Administration's own plans and forecasts for decarbonizing the transportation sector. For this reason too, EPA should revisit the proposed RVOs and significantly reduce them.

The Administration published the *Long-Term Strategy of the United States: Pathways to Net-Zero Greenhouse Gas Emissions by 2050* in November 2021[42] and the *U.S. National Blueprint for Transportation Decarbonization* in January 2023.[43] These strategy documents, which are meant to guide the Administration's climate-related policies, point to a future in which "light-duty vehicles are almost all electric by 2050 in most scenarios."[44] This will require a

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[39] *Id.* at IS-3; DRIA at iv, Tbl. ES-1 (explaining that the volumes in the Proposed Rule will lead to "[i]ncreases in CO, NH_3, NO_x, PM_{10}, $PM_{2.5}$, SO_2, and VOC emissions associated with biorefinery production and product transport", "[h]igher ambient concentrations of NO_x, HCHO and SO_2 downwind of production facilities," and "[d]ecrease for THC, CO, and $PM_{2.5}$, but increase slightly for NO_x emissions from pre-2007 diesels running on biodiesel").

[40] DRIA at 93.

[41] DRIA at 255.

[42] *See* White House, *Long-Term Strategy of the United States: Pathways to Net-Zero Greenhouse Gas Emissions by 2050* (2021)("Long-Term Strategy"), https://www.whitehouse.gov/wp-content/uploads/2021/10/US-Long-Term-Strategy.pdf.

[43] *See* Dep't of Energy et al., *The U.S. National Blueprint for Transportation Decarbonization: A Joint Strategy to Transform Transportation* (2023)("Blueprint"), https://www.energy.gov/sites/default/files/2023-01/the-us-national-blueprint-for-transportation-decarbonization.pdf.

[44] Long-Term Strategy at 30.

continuous reduction in liquid fuel demand by passenger vehicles to zero or near zero over the next 30 years.

The *Blueprint* goes into more detail on the role of electricity versus sustainable liquid fuels for different transportation modes, noting that electrification is the best option for all light-duty passenger vehicles and most other on-road vehicles, in part to make sustainable biomass feedstocks available for the hardest to abate emissions, particularly aviation:

> [Electric Vehicles] are rapidly becoming a practical alternative for most on-road vehicle applications, with potential opportunities in other modes as well. Hydrogen fuel cell vehicles can complement battery EVs for applications requiring longer ranges and faster refueling times, like long-haul trucking. To achieve net-zero targets, sustainable fuels produced from biomass and waste feedstocks can be used to decarbonize hard-to-electrify forms of transportation such as air transport and long-haul shipping that require more energy-dense fuels. Widespread electrification of on-road vehicles will ensure that sufficient amounts of sustainable fuels are available for these harder-to-electrify applications.[45]

Electric vehicles (EVs) powered by a 100% clean electricity system can achieve a truly zero carbon road transport system without the unacceptable land-use tradeoffs inherent in relying on biofuels produced from agricultural crops. For example, the efficiency of converting sunlight into electricity through photovoltaics (PVs) (> 15% net) is about 100 times that of converting sunlight into ethanol through fermentation of corn (~0.15%). In addition, EVs convert electricity stored in their batteries into mobility about three times more efficiently than internal combustion engine vehicles (ICEVs) convert energy stored in liquid fuel into mobility, meaning that an acre of land used for photovoltaics to power electric vehicles will deliver about 300 times as much mobility as an acre of land used to grow corn for ethanol. Wind and nuclear power are even more land-efficient sources of emissions-free electricity.

The National Renewable Energy Laboratory's (NREL's) study *Examining Supply-Side Options to Achieving 100% Clean Electricity by 2035* illustrates this clearly.[46] In NREL's "All Options" scenario, electricity generation increases by about 95% from 2020 to 2035 as transportation, space heating, and other energy end uses are increasingly electrified.[47] Wind and solar supply 80% of this electricity, with wind contributing about twice as much generation as solar.[48] NREL compares the land requirements for this scenario to the land area currently devoted to corn ethanol production in their Figure 30, reproduced below, which shows that the direct land used by wind and solar to supply 80% of all electricity needed in 2035 is less than one-quarter of the land currently used to provide only 10% of the fuel used by passenger cars.[49] (The different boxes for wind reflect either the footprint of the turbines alone or the turbines and

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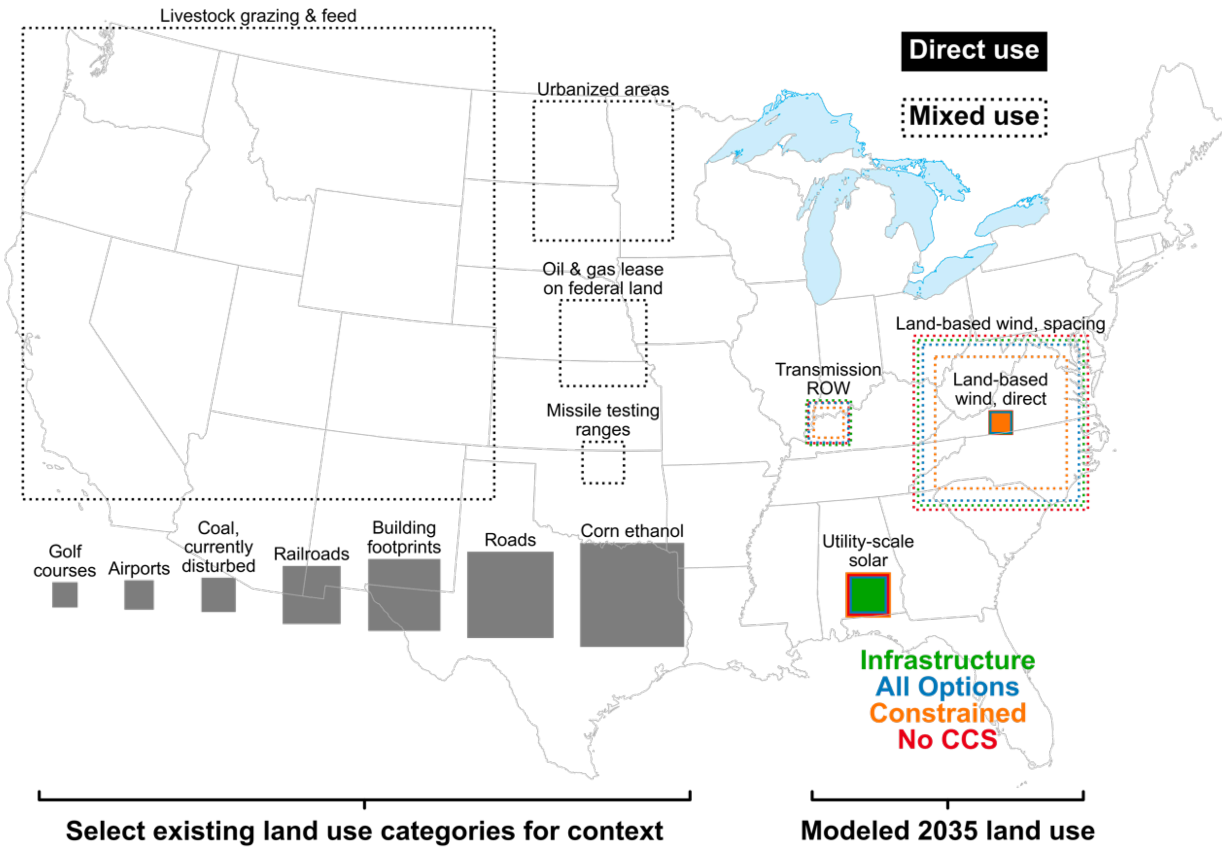
[45] Blueprint at 49.
[46] *See* Paul Denholm et al., *Examining Supply-Side Options to Achieve 100% Clean Electricity by 2035,* NREL (2022), https://www.nrel.gov/docs/fy22osti/81644.pdf.
[47] *Id*. at xi and Figure ES-1.
[48] *Id*. at 22.
[49] *Id*. at 52, Figure 30.

the land on which they are located, including spacing between turbines; in most cases most of that land between turbines will be used for other agricultural purposes.)



As noted in the *Blueprint for Transportation Decarbonization*, direct electrification is not expected to be a viable approach for eliminating emissions from aviation. While there is a great deal of uncertainty about how to decarbonize aviation, Sustainable Aviation Fuel (SAF) produced from biomass could play a role in this hard-to-abate subsector. For example, woody biomass waste and agricultural residues could be converted to aviation fuel via gasification and the Fischer-Tropsch process.[50] As we show below, however, such fuel is only likely to have a lower overall carbon footprint than petroleum-based fuel if it is derived from waste biomass that does not involve dedicated use of land. *See infra*, Section IV.

Of most importance for EPA's Proposed Rule here, EPA's proposal is predicated on *increased* use of biofuel for road transport, while the nation's *Blueprint* plans to *decrease* the use

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[50] *See* M. Shahabuddin et al., *A Review on the Production of Renewable Aviation Fuels from the Gasification of Biomass and Residual Wastes*, 312 Bioresource Tech. 123596 (2020).

of biofuel for road transport. EPA must resolve this inconsistency in the final rule by reducing the volume requirements to reflect the move to electrification.

IV. EPA MUST INCLUDE THE CARBON OPPORTUNTITY COST OF USING LAND TO PRODUCE BIOFUEL FEEDSTOCK IN ITS LIFECYCLE CALCULATIONS.

Biofuels from food or energy crops are a way of using land to grow plants to replace fossil fuels, and this replacement provides a climate benefit. But this use of land is not "free" from a climate perspective. The cost of using land for biofuels includes the cost of not using that land to meet other needs. These costs must be included in any analysis of biofuels' climate impact.

For existing agricultural land, the highest cost is likely to be the lost production of food, which should be measured by the potential to save forests and other natural lands from conversion to agriculture while meeting global food needs. If agricultural land were not needed for food, the cost of using it for biofuel crops would alternatively be lost opportunities to restore forests or other habitats and sequester carbon. The full "carbon opportunity cost" of land is whichever of these costs is higher.

So long as there are other uses for land (and land area is fixed), using land for one purpose always has an opportunity cost. EPA's analytical approach underlying its Proposed Rule does not fully factor in these opportunity costs. If it did, it would become clear that the proposed RVOs for biofuels that make dedicated uses of land are not justified.

A. The cost of using land to produce feedstock for biofuel must include opportunity costs, which are the climate costs of not using land for food or to store carbon.

The intense global competition for land underlies the high "carbon opportunity cost" of land. Already roughly one quarter of the carbon humans have added to the atmosphere results from the conversion of nearly half of all vegetated land to agricultural use, and the harvest or manipulation of 60–85 percent of forests.[51]

The demand for both food and wood are rising dramatically, with population growth and increased incomes. Nearly all studies project – even after factoring in large yield increases – that global cropland area is likely to expand by one hundred to hundreds of millions of hectares

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[51] *See* Karl-Heinz Erb et al., *A Comprehensive Global 5 Min Resolution Land-Use Data Set for the Year 2000 Consistent with National Census Data*, 2 J. Land Use Sci. 191 (2007); *see also* Karl-Heinz Erb et al., *Unexpectedly Large Impact of Forest Management and Grazing on Global Vegetation Biomass*, 533 Nature 73 (2018); Priyadarshi R. Shukla et al., IPPC, Technical Report, *Climate Change and Land: An IPCC Special Report on Climate Change, Desertification, Land Degradation, Sustainable Land Management, Food Security, and Greenhouse Gas Fluxes in Terrestrial Ecosystems* (2019); Corinne Le Quéré et al., *Global Carbon Budget 2016*, 8 Earth System Sci. Data 605 (2016).

(Mha) by 2050, resulting in yet more emissions.[52] The best satellite evidence is that cropland is now expanding at a rate, if continued, that will clear an additional area the size of India by 2050.[53] Yet nearly every climate strategy consistent with the goals of the Paris climate agreement requires that the world stop expanding agricultural land more or less immediately to avoid emissions from land use change.[54]

Because global land area is fixed, every acre capable of producing plants for biofuels has a high alternative carbon value either in meeting demands for food without more land clearing or in storing carbon. As economists emphasize, any good's cost includes its "opportunity cost" – which is the loss of this alternative use. That is as true in estimating carbon costs as it is in estimating any other cost.

B. Measuring the Opportunity Cost.

The simplest way of assessing the carbon opportunity cost of using existing agricultural land for biofuels is to assess how much carbon this land could sequester if reestablished to native vegetation.[55] If land were available to divert to biofuels, it could also be used to sequester carbon

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[52] *See* David Tilman et al., *Global Food Demand and the Sustainable Intensification of Agriculture*, 108 Proceedings of the Nat'l Acad. of Scis. 202,60 (2011); *see also* David Tilman & Michael Clark, *Global Diets Link Environmental Sustainability and Human Health*, 515 Nature 518 (2014); Bojana Bajželj et al., *Importance of Food-Demand Management for Climate Mitigation*, 4 Nature Climate Change 924 (2014); Marco Springmann et al., *Options for Keeping the Food System within Environmental Limits*, 562 Nature 519 (2018); Timothy Searchinger et al., *Creating a Sustainable Food Future: A Menu of Solutions to Feed Nearly 10 Billion People by 2050*, World Res. Inst. (2019), https://www.wri.org/research/creating-sustainable-food-future; Christoph Schmitz et al., *Land-Use Change Trajectories up to 2050: Insights from a Global Agro-economic Model Comparison*, 45 Argric. Econs 69 (2014); IPPC, *Climate Change and Land: An IPCC Special Report on Climate Change, Desertification, Land Degradation, Sustainable Land Management, Food Security, and Greenhouse Gas Fluxes in Terrestrial Ecosystems* (2019).

[53] *See* Peter Potapov et al., Global Maps of Cropland Extent and Change Show Accelerated Cropland Expansion in the Twenty-First Century, 3 Nature Food 19 (2022); *see also* Timothy Searchinger et al., *EU Climate Plan Sacrifices Carbon Storage and Biodiversity for Bioenergy*, 612 Nature 27 (2022).

[54] *See* Gert-Jan Nabuurs et al., IPCC, Chapter 7: Agriculture, Forestry and Other Land Uses (AFOLU), *2022: Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* (2022); *see also* Priyadarshi R. Shukla et al., IPPC, Technical Report, *Climate Change and Land: An IPCC Special Report on Climate Change, Desertification, Land Degradation, Sustainable Land Management, Food Security, and Greenhouse Gas Fluxes in Terrestrial Ecosystems* (2019); Hans-Otto Pörtner et al., *Scientific Outcome of the IPBES-IPCC Co-Sponsored Workshop on Biodiversity and Climate Change*, IPCC & IPBES (2021).

[55] This potential should most appropriately be calculated by estimating the quantity of carbon that could be reforested in the most efficient parts of the world to do so if less food production were required. For example, if the world no longer needs 5 tons of of corn, the most efficient place to reforest might not be an acre of Iowa farm land. Instead, the most efficient use might be to continue to use that acre for food and to reforest some land elsewhere with lower crop yields and even higher reforestation potential. This potential is calculated using the "carbon gain" method in Searchinger et al. *See* Timothy D. Searchinger et

in this way. The Biden Administration has recognized such "natural climate solutions" as critical for addressing climate change.[56] Particularly because numerous governments and companies are looking to reforest land to mitigate climate change, the availability of land is the key limiting constraint.[57]

This foregone carbon sequestration potential would be the appropriate measure if the need for agricultural land were declining. It is therefore a minimum carbon opportunity cost. Nothing in the EPA methodology factors in this cost.

So long as the world continues to expand agricultural land, the highest value of crops and cropland will typically be not its reforestation value but continuing to produce food because of the potential that creates to avoid land conversion elsewhere. The cost of this foregone food production is the carbon cost of using other land to replace that food. Use of economic models to estimate the costs of "indirect land use change" (ILUC) is one method of assigning *some* cost to this foregone food production, but this method does not measure the true, full cost. It is also inconsistent with how EPA measures the climate costs of virtually every other product, including gasoline.

The way to estimate the climate cost of devoting crops or cropland to biofuels, is the same way lifecycle calculations estimate the climate costs of everything else, and is usually based on the average costs of producing it. They include the initial investment or cost of the production infrastructure (including cropland) and second, the continued costs of producing the goods (growing the crops).

For example, making manufactured goods requires first making a factory. When the emissions of making a factory are significant, these emissions must be allocated proportionately to the climate costs of producing each good.[58] Similarly, making crops requires first "making" cropland, which causes carbon emissions from clearing vegetation and by disturbing soils. Because these costs of "making cropland" are a large portion of the emissions of making crops to

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al., *Assessing the Efficiency of Changes in Land Use for Mitigating Climate Change*, 564 Nature 249 (2018).

[56] *See* White House Council on Env't Quality et al., *Accelerate Nature-Based Solutions: A Roadmap for Climate Progress, Thriving Nature, Equity, & Prospecty: A Report to the National Climate Task Force* (2022), https://www.whitehouse.gov/wp-content/uploads/2022/11/Nature-Based-Solutions-Roadmap.pdf.

[57] *See* Keith K. Dooley et al., *The Land Gap Report* (2022), https://www.landgap.org/wp-content/uploads/2022/11/Land-Gap-Report_FINAL.pdf.

[58] *See* Greenhouse Gas Protocol, *Product Life Cycle Accounting and Reporting Standard*, https://ghgprotocol.org/sites/default/files/standards/Product-Life-Cycle-Accounting-Reporting-Standard_041613.pdf.

be used for biofuels, [59] these costs must be included in a calculation of the total climate impact of biofuel production.

Whether for agricultural land or for a factory, the costs of making them have already occurred, but the reason to assign these costs to crops or to any good is because they are also part of the cost of making an additional unit of them. The guiding assumption in lifecycle analyses is that the consumption of one additional unit of product, whether an additional car or an additional ton of a crop, will require additional production of one unit. In the absence of strong information that the marginal costs of new production will be different, this is usually estimated by the average cost of existing production. (For example, if a baseball is consumed, lifecycle calculations do not use a global, economy-wide economic model to ask how many baseballs will be replaced or how the whole economy will be influenced, but rather they estimate the average costs of making the baseball.) For cropland used to produce ethanol, in a world with increasing cropland, ethanol emissions should factor in the average carbon cost of producing that cropland.[60]

It is no more appropriate to use an economic model to estimate the climate costs of biofuels, and of the cropland used to produce them, than it is to estimate the climate costs of making and driving a car, or the emissions of mercury from electricity production. (This statement would remain true even if the models could overcome the enormous challenges, some discussed by EPA, to doing this type of economic modeling accurately.) These ILUC methods do not examine the full cost because they do not examine what alternatively *could* be done with land (nearly always with the same or less financial cost) and because they confuse the costs of producing biofuels with the climate effects of a variety of other social welfare effects.

One example is the role that reduced food consumption plays in reducing ILUC estimates in some models. For example, both the FAPRI model EPA used to evaluate corn ethanol in its first rulemaking, and the GTAP model used by California, estimated low ILUC in part because they claimed higher food prices caused by biofuels would cause people around the world to consume less food. [61] As a result, one quarter of the food in the EPA model, and one half in the California model, would not be replaced (independent of by-product effects). If food is not replaced, of course, you don't need to convert other land, so this estimated reduced consumption was a major source of the low ILUC. But this calculation does not estimate the actual climate costs of producing crops (and devoting land) to biofuels. Instead, this method just subtracts from this cost, the claimed climate "benefit" of reduced food production by others, who are primarily the world's poor.

[59] *See* Kurt Schmidinger & Elke Stehfest, *Including CO2 Implications of Land Occupation in LCAs—Method and Example for Livestock Products*, 17 Int'l J. Life Cycle Assessment 962 (2012); *see also* Matthew N. Hayek et al., *The Carbon Opportunity Cost of Animal-Sourced Food Production on Land* , 4 Natures Sustainability 21 (2021); *See* Timothy D. Searchinger et al., *Assessing the Efficiency of Changes in Land Use for Mitigating Climate Change*, 564 Nature 249 (2018).
[60] *See* Timothy D. Searchinger et al., *Assessing the Efficiency of Changes in Land Use for Mitigating Climate Change*, 564 Nature 249 (2018).
[61] *See* Timothy Searchinger et al., *Do Biofuel Policies Seek to Cut Emissions by Cutting Food?*, 347 Sci. 1420 (2015).

These kinds of effects are also not morally defensible ways of reducing emissions because they come with high social costs. They would ultimately also harm the climate because governments tend to build roads or otherwise support clearing of land to grow more food when prices are high enough to effect consumption, which are effects that are not and cannot realistically be modeled.

Moreover, the use of economic modeling by EPA and others has also been inconsistent, leading to biased estimates. If the EPA relies on economic "rebound" effects to claim that 1 gallon of ethanol will not lead to 1 gallon's worth of additional crops, it also needs to factor in rebound effects that suggest the ethanol will not reduce gasoline consumption by 1 gallon either. Absent other policies, common estimates are that for each gallon of gasoline displaced, other consumers will increase gasoline use by one quarter to half a gallon.[62] If one gallon of ethanol only requires the emissions of replacing one half to three quarters of the crops, it also saves only half to three quarters of the emissions from gasoline use.

Use of economic models, if reliable, can be appropriate for a full analysis of social welfare effects but not to claim that a gallon of gasoline (or ethanol) does not generate a gallon's worth of emissions. Unlike an ILUC analysis, a full social-welfare analysis would not treat reduced food consumption due to higher food prices as a benefit because it would also factor in the social welfare cost. When just analyzing the emissions of ethanol or gasoline or any other products, the emissions should be based on those involved in producing them (including the carbon lost by turning land into cropland and by keeping it in that use).

In a perfect global carbon pricing system, the cost of biofuels would reflect the carbon opportunity costs as described, and the purpose of lifecycle calculations is to achieve the same result.[63] Like the costs of making a factory, these costs are a direct, not indirect, cost of biofuel production. Because any rational government policy to address climate change must deploy its resources, including land, where they do the most good, excluding these opportunity costs undermines rational efforts to address climate change.

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[62] *See* Jason Hill et al., *Climate Consequences of Low-carbon Fuels: The United States Renewable Fuel Standard*, 97 Energy Pol'y 351 (2016).

[63] The need to factor the opportunity cost of land final into lifecycle calculations can be seen by comparison to a perfect global carbon pricing system widely recognized as the theoretical, if not yet achievable, way of ensuring that all human activities reflect their carbon costs. In such a system, the same carbon price charged for all energy emissions would also be charged to the loss of carbon from land and would be rewarded to uses of land to sequester carbon. In such a system, land would only be diverted to biofuel production if and to the extent its climate benefits exceeded the value of using this land to maintain or sequester carbon, or to produce food, so other land could maintain carbon. Those are the opportunity costs discussed here. Because the world lacks such a perfect global carbon pricing system system, lifecycle analyses are the necessary tools EPA must use to evaluate the greenhouse gas costs of biofuels. But this analogy explains why to get the accounting right, lifecycle calculations must also factor in the carbon opportunity cost of land.

V. BECAUSE THE CARBON OPPORTUNITY COSTS OF DEDICATING LAND TO MAKING BIOFUELS IS HIGH, EPA SHOULD NOT ENCOURAGE ANY BIOFUELS THAT DIVERT THE PRODUCTIVE CAPACITY OF LAND FROM OTHER USES.

The carbon opportunity costs of devoting land to produce biofuels from crops or that otherwise divert the productive capacity of land are likely to exceed the displaced fossil fuel emissions. That is true even if there were no low-carbon alternative to fossil energy. Because there are now much more efficient alternatives, the opportunity cost of devoting land to biofuels is actually hundreds of times the benefits. For these reasons, these types of biofuels should not be encouraged.

Carbon opportunity costs if there are no low-carbon non-fossil fuel alternatives: As Table 1 shows, for corn ethanol, the average carbon cost of land is roughly double the emissions saved from fossil fuels, and for vegetable oil-based biodiesel, the cost is 3-4 times higher. (Using a global cost is appropriate because the close integration of the U.S. into international markets means that crop price changes in the U.S. caused by biofuels are reflected internationally.[64]) Factoring in production emissions for both gasoline and ethanol increases makes the comparison even more disadvantageous.[65]

Even if the world had surplus land, the carbon opportunity cost of not reforesting land is far higher than the benefit of displacing fossil fuels with biofuels from food or energy crops.[66] In fact, even assuming cellulosic ethanol could be produced on surplus "non-cropland," biofuels would be adverse relative to reforesting land even at several times the average yields achieved from energy crop grasses today.[67] And even if cellulosic ethanol were to achieve extraordinary yields in the future, the percentage savings of the resulting biofuels relative to fossil fuels would

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[64] *See* Michael J. Roberts & Wolfram Schlenker, *Identifying Supply and Demand Elasticities of Agricultural Commodities: Implications for the US Ethanol Mandate*, 103 Am. Econ. Rev. 2265 (2013).
[65] Moreover, even if the carbon opportunity costs were calculated half based on the U.S. only and half at the global level, the authors of the above numbers have calculated that the land use costs of corn ethanol are reduced only to 120 gCO2/MJ and soybean-based vegetable oil only to 235 gCO2/MJ (personal communication Stefan Wirsenius).
[66] *See* Renton Righelato & Dominik V. Spracklen, *Environment. Carbon mitigation by* ***b****iofuels or by Saving and Restoring Forests?*, 317 Sci. 1066 (2007); *see also* Samuel G. Evans et al,. *Greenhouse Gas Mitigation on Marginal Land: A Quantitative Review of the Relative Benefits of Forest Recovery versus Biofuel Production,* 49 Env't Sci & Tech. 2503 (2015); Timothy Searchinger et al., *Does the World Have Low-carbon Bioenergy Potential from the Dedicated Use of Land?,* 110 Energy Pol'y 434 (2017).
[67] *See* Samuel G. Evans et al,. *Greenhouse Gas Mitigation on Marginal Land: A Quantitative Review of the Relative Benefits of Forest Recovery versus Biofuel Production*, 49 Env't Sci & Tech. 2503 (2015); *see also* Timothy Searchinger et al., *Does the World Have Low-carbon Bioenergy Potential from the Dedicated Use of Land?,* 110 Energy Pol'y 434 (2017).

be modest and far from the near 100% reductions needed from the mitigation of fossil fuels to address climate change.[68]

Table 1: Global Carbon Opportunity Costs of Various Crop-Based Biofuels gCO_2/MJ[69]

Corn ethanol	160	Soy biodiesel	330
Wheat ethanol	123	Palm biodiesel	260
Sugarcane ethanol	93	Rapeseed biodiesel	270
Comparison tailpipe emissions:			
Gasoline	74	Diesel	81

For the same reasons, EPA should not provide RFS credits for biofuels based on wood harvested for this purpose or used to make electricity that in turn is used for biofuels. The opportunity cost of not harvesting wood is allowing this wood to stay in a forest. Numerous

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[68] For example, Evans et al. (2015) estimated that with high conversion efficiencies and grass yields of 25.5 tons per hectare, cellulosic ethanol over 30 years would achieve a 10% higher mitigation advantage over reforestation. And that yield is four times the average yield for switchgrass in the United States found in a 2017 study of 6.3 tons per hectare per year. *See* John H. Fike et al., *Switchgrass Nitrogen Response and Estimated Production Costs on Diverse Sites,* 9 GCB Bioenergy 1526 (2017).

[69] *See* Timothy D. Searchinger et al., *Assessing the Efficiency of Changes in Land Use for Mitigating Climate Change*, 564 Nature 249, at Supplementary Tbl. 4 (2018). As explained in this Searchinger et al. (2018) and supporting information, this calculation starts by estimating the carbon lost from terrestrial vegetation and soils used to produce each crop that is the biofuel feedstock. It divides this by the global production of that crop to obtain a carbon loss per ton. It then discounts this carbon loss using an approach that produces a result similar to EPA's policy of amortizing land use emissions over 30 years of biofuel production. This generates the "carbon opportunity cost" per ton of each crop. To estimate the portion that goes into a mega joule of the biofuel, it estimates the quantity of each crop required after generously excluding a portion of the crop, and therefore the carbon opportunity cost, that can be attributed to co-products or by-products.

studies have found that harvesting and using wood for electricity from virtually any forest or using any harvesting regime generates higher emissions for decades than even using coal, and yet even more than using natural gas. *See* papers cited in Appendix A.

Carbon opportunity costs in light of solar/electric vehicle alternatives: Because, as the Biden Administration has acknowledged, the viable and cheaper alternative to gasoline and diesel is electric cars fueled by solar panels or wind, the true land use opportunity costs of biofuels are hundreds of times higher than fossil fuels.

The reason is that even on highly productive land – which is the most efficient land for producing biofuels but does not increase the efficiency of solar cells – biofuels require far more land than solar cells to produce the same quantity of useable energy in the fuel. The useable energy produced on Iowa land for corn ethanol is only 1/100th that of even the solar cells available five-years ago.[70] Even in the U.S. location with the highest estimated potential future switchgrass yields estimated by the U.S. DOE, the land use efficiency of cellulosic ethanol would only reach 2% of the efficiency of even older solar cells. Globally, using optimistic assumptions for future cellulosic ethanol, and comparing it to solar cells available today, an acre of PV would produce at least 100 times more useable energy on 75% of the world's land. When combined with the nearly three times higher efficiency of electric engines than fossil engines, the relative land efficiency rises three-fold more.[71]

As discussed above, a single hectare of reforestation has at least the same GHG mitigation as even high-yielding cellulosic ethanol and mitigates far more than corn ethanol or soybean biodiesel.[72] In effect, therefore, if instead of devoting 300 hectares of land to biofuels, the world devoted one hectare to solar cells and 299 to reforestation, the world would generate the same replacement of fossil fuels and achieve at least 300 times the overall climate mitigation.

Put simply, the world has a vital need to use productive land for food and for forests and other habitats that store carbon. Because it has far better alternatives to devoting land to biofuels, the climate costs of devoting land to biofuels are hundreds of times the savings.

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[70] *See* Timothy Searchinger et al., *Does the World Have Low-carbon Bioenergy Potential from the Dedicated Use of Land?*, 110 Energy Pol'y 434 (2017). This reference provides all figures in this paragraph.

[71] Even if fossil fuels are used to make the car batteries, the net efficiency rises by a factor of 1.5 to 2, but the production of batteries even now has started to utilize solar power. *See* Timothy Searchinger et al., *Does the World Have Low-carbon Bioenergy Potential from the Dedicated Use of Land?*, 110 Energy Pol'y 434 (2017).

[72] *See* Renton Righelato & Dominik V. Spracklen, *Environment. Carbon mitigation by **b**iofuels or by Saving and Restoring Forests?*, 317 Sci. 1066 (2007); *see also* Joseph E. Fargione et al., *Natural Climate Solutions for the United States*, 4 Sci. Advances eaat1869 (2008); Timothy Searchinger et al., *Does the World Have Low-carbon Bioenergy Potential from the Dedicated Use of Land?*, 110 Energy Pol'y 434 (2017).

VI. BIODIVERSITY AND OTHER HIGH ENVIRONMENTAL COSTS ALSO MAKE IT EXCESSIVELY COSTLY TO DEVOTE LAND TO BIOFUEL PRODUCTION.

The evaluation of the RFS2, according to statute, must also consider non-climate effects "on the environment" as well, specifically including "conversion of wetlands, ecosystems, wildlife habitats." Because the effects of biofuels that make dedicated uses of land are, if anything, even more adverse to these environmental values than carbon, EPA should also refuse to authorize credits for these kinds of biofuels on the basis of these harms.

Primarily due to agriculture, the world has lost 35 percent of its forests and for various products, is heavily manipulating two thirds of what remain.[73] It has also converted or heavily transformed more than 90 percent of its native grasslands and more than 80 percent of its shrublands.[74] The rate of loss has also accelerated. Just between 1990 and 2020, global forest area declined by 420 million hectares (Mha), or roughly 10 percent. That 1990–2020 forest loss included 81 Mha of primary forests, which the Food and Agriculture Organization of the United Nations (FAO) defines as forests with little sign of human impact.[75]

There is broad agreement that the main driver of biodiversity loss has been these physical transformations of habitat.[76] There is also scientific agreement that ongoing land-use change accordingly poses grave threats to remaining biodiversity. A major UN report recently found that 1 million species are threatened with extinction,[77] a rate of extinction now being called Earth's sixth mass extinction event.[78] One recent paper found that 80 percent of all threatened terrestrial bird and mammal species are imperiled by agriculture-driven habitat loss.[79]

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[73] *See* James E. M. Watson et al., *The Exceptional Value of Intact Forest Ecosystems*, 2 Nature Ecology & Evolution *599* (2018); *see also* Priyadarshi R. Shukla et al., IPPC, Technical Report, *Climate Change and Land: An IPCC Special Report on Climate Change, Desertification, Land Degradation, Sustainable Land Management, Food Security, and Greenhouse Gas Fluxes in Terrestrial Ecosystems* (2019).

[74] *See* Priyadarshi R. Shukla et al., IPPC, Technical Report, *Climate Change and Land: An IPCC Special Report on Climate Change, Desertification, Land Degradation, Sustainable Land Management, Food Security, and Greenhouse Gas Fluxes in Terrestrial Ecosystems* (2019); *see also* Erle C. Ellis et al., *Anthropogenic Transformation of the Biomes, 1700 to 2000*, 19 Global Ecology & Biogeography *589* (2010).

[75] *See* Food & Agric. Org. of the U.N,, Rome, *Global Forest Resources Assessment 2020 Main Report* (2020), https://www.fao.org/3/ca9825en/ca9825en.pdf.

[76] *See* IPBES, *Summary for Policymakers of the Global Assessment Report on Biodiversity and Ecosystem Services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Service* (2019); *see also* S.L. Pimm et al., *The Biodiversity of Species and Their Rates of Extinction, Distribution, and Protection*, 344 Sci. 124,6752 (2014).

[77] *See* IPBES, *Summary for Policymakers of the Global Assessment Report on Biodiversity and Ecosystem Services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Service* (2019).

[78] *See* Gerardo Ceballos et al,. *Accelerated Modern Human–Induced Species Losses: Entering the Sixth Mass Extinction*, 1 Sci. Advances e1400253 (2015).

[79] *See* David Tilman et al., *Future Threats to Biodiversity and Pathways to Their Prevention*, 546 Nature 73 (2017).

Another paper found that bird species with impending extinctions due to land-use activities ranged from 74 to 121 in 2011 (depending on the conservativeness of the estimate), which could nearly double the 140 bird species estimated to have been lost since the year 1500.[80] The loss of plant and insect species is even more directly attributable to land conversion.

The biodiversity consequences of ongoing conversion of savannas can rival that of the conversion of forests. The tallgrass prairies of the United States, which once typically harbored 300 more grass and herbaceous species per hectare, have been almost completely eliminated.[81] When replaced with pasture, typically only 1 or 2 grass species are present. The result has been large declines in grassland bird species and vast numbers of insect species, many of which we will never know about. The Brazilian Cerrado is one of the world's most biologically diverse ecosystems with more than 12,000 species of plants, of which 4,400 are found nowhere else.[82] Most of the native Cerrado has been converted to agricultural use,[83] including pasture that uses a single African grass species.

In the United States, agricultural expansion is threatening biodiversity in the Great Plains, which have retained significant areas of mid-grass prairie. But millions of acres per year are being rapidly lost to cropland conversion, with great cost to plant biodiversity, rare birds and others.[84] For example, the six endemic songbirds to the Great Plains have lost from two-thirds to 94% of their populations since the 1960s.[85] A recent study found that from 2006 to 2016—a period which corresponds with rapid increases in U.S. corn ethanol—the rate of cropland expansion in the Western corn belt tripled compared to the period 1980–2005.[86]

Because of climate change and other threats, preserving biodiversity requires not only avoiding agricultural expansion and preserving habitats, but also restoring habitats. A comprehensive UN study found that not only does habitat loss threaten extinctions, but without

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[80] *See* Alexandra Marques et al., *Increasing Impacts of Land Use on Biodiversity and Carbon Sequestration Driven by Population and Economic Growth*, 3 Nature Ecology & Evolution 628 (2019).
[81] *See* David S. Wilcove, *The Condor's Shadow: The Loss and Recovery of Wildlife in America* (2000).
[82] *See* Juan F. Silva et al., *Spatial Heterogeneity, Land Use and Conservation in the Cerrado Region of Brazil*, 33 J. Biogeography 536 (2006).
[83] *See* V. De Sy et al., *Land Use Patterns and Related Carbon Losses Following Deforestation in South America*, 10 Env't Rsch. Letters 124,004 (2015).
[84] *See* World Wildlife Fund, *Plowprint* (2017), https://files.worldwildlife.org/wwfcmsprod/files/Publication/file/75nqs69p1_plowprint_AnnualReport_2017_revWEB_FINAL.pdf?_ga=2.217137939.446957529.1675923727-663665490.1675923727; *see also* Tyler J. Lark et al., *Cropland Expansion Outpaces Agricultural and Biofuel Policies in the United States*, 10 Env't Rsch. Letters 1 (2015).
[85] *See* World Wildlife Fund, *Plowprint* (2017), https://files.worldwildlife.org/wwfcmsprod/files/Publication/file/75nqs69p1_plowprint_AnnualReport_2017_revWEB_FINAL.pdf?_ga=2.217137939.446957529.1675923727-663665490.1675923727.
[86] *See* Chaoqun Lu et al., *Increasing Carbon Footprint of Grain Crop Production in the US Western Corn Belt*, 13 Env't Rsch. Letters 124,007 (2018).

habitat restoration, 500,000 species are likely to go extinct.[87] Key landscapes are at a breaking point. For example, scientists believe that the Amazon rain forest is at a tipping point. Additional clearing of forest is likely to reduce the Amazon's internal generation of clouds and rainwater necessary for it to remain a rain forest.[88] If deforestation continues at present rates for even 10 more years, the Amazon could inexorably transform into a savanna, losing much of its present biodiversity and carbon.

Biofuels that make dedicated uses of land leave less land for habitat. The effects are large. For example, the dominant sources of global vegetable oil are soybeans and palm oil, the growth of biodiesel is responsible for one third of the growth in demand for vegetable oil in the last decades and roughly 60% in the last six years,[89] and both crops are drivers of habitat loss in the U.S. and outside.[90] To avoid severe impacts on biodiversity, EPA should not make biofuels that make dedicated uses of land eligible for meeting RFS targets.

VII. AMERICAN FARMERS HAVE GREAT DEMANDS FOR THEIR CORN AND OTHER CROPS EVEN WITHOUT BIOFUELS.

EPA need not be concerned that phasing out the use of land for biofuels will leave American farmers without markets for their products. Even without biofuels, virtually all analyses estimate that the demand for crops will grow by at least 50% between 2010 and 2050. Corn and other feed crops are particularly in demand because of expected 60-100% increases in

[87] *See* IPBES, *Summary for Policymakers of the Global Assessment Report on Biodiversity and Ecosystem Services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Service* (2019).
[88] *See* Armineh Barkhordarian et al., *A Recent Systematic Increase in Vapor Pressure Deficit over Tropical South America*, 9 Sci. Reps. 153 (2019); *see also* Thomas Lovejoy & Carlos Nobre, *Amazon Tipping Point: Last Chance for Action*, 5 Sci. Advances eaba2949 (2019).
[89] *See* Chris Malins, *Biofuel to the Fire – The Impact of Continued Expansion of Palm and Soy Oil Demand through Biofuel Policy*, Rainforest Found. Nor. (2020), http://www.circulareconomy.lt/wp-content/uploads/2020/03/RF_report_biofuel_0320_eng_SP.pdf; Hannah Ritchie & Max Roser, *Soy*, Our World in Data (2021), https://ourworldindata.org/soy; Additional calculations by Chris Malins.
[90] *See* Mikaela Weisse & Elizabeth Dow Goldman, *Just 7 Commodities Replaced an Area of Forest Twice the Size of Germany Between 2001 and 2015*, World Res. Inst. (2021), https://www.wri.org/insights/just-7-commodities-replaced-area-forest-twice-size-germany-between-2001-and-2015; *see also* Tyler J. Lark et al., *Cropland Expansion in the United States Produces Marginal Yields at High Costs to Wildlife*, 11 Nature Commc'ns 4295 (2020).

this time-frame for meat and milk.[91] All trend lines suggest that corn and soybean demand will continue to increase, providing large markets for U.S. farmers.[92]

For the world to stop clearing land, it is vital that wealthier countries, such as the United States and countries in Europe, stabilize or reduce their own demands for agricultural products so that they can contribute food to meeting rising global demands.[93]

VIII. EPA SHOULD ESTABLISH RENEWABLE VOLUME OBLIGATIONS THAT CAN BE MET USING WASTE BIOMASS.

As discussed above, electrification should be the focus of policies to decarbonize transportation and any use of dedicated land to produce biofuels is likely to exacerbate, rather than ameliorate, climate change, biodiversity loss, and food insecurity. Given EPA's statutory requirement to consider these factors, EPA should not set RVOs that it expects to be met by dedicating millions of acres of arable land to fuel production. EPA's proposal fails this test.

The Draft Regulatory Impact Analysis (DRIA) provides EPA's assessment of the production volumes and feedstocks it expects will be supplied to the U.S. market. For 2023, EPA projects: 0 gallons of liquid cellulosic biofuel (Table 6.1.2-3); 719 million ethanol-equivalent gallons of CNG/LNG derived from biogas, which comes from waste (Table 6.1.3-2); 0 eRINs; 3600 million gallons of biomass based diesel (BBD), of which 1010 million gallons comes from waste fats, oils, and greases (FOG) and 320 million gallons comes from distillers corn oil (DCO), both of which can be considered waste biomass, although some backfilling with crops from dedicated lands would likely be required to replace them in animal feed (Table 6.2.5-2); 110 million gallons of imported sugarcane ethanol, all of which requires dedicated land to produce (p. 368); 146 million gallons of other (non-cellulosic) advanced biofuel, including 26 million gallons of domestic advanced ethanol, and with the amount of other advanced biofuel coming from wastes unspecified in the DRIA (p. 369); 14.5 billion gallons of corn ethanol, all of which requires the dedicated use of land (Table 6.6-1).

Based on the share of these projected volumes from waste biomass, and generously including the 146 million gallons of other advanced biofuels with unspecified feedstocks, we urge EPA to set RVOs for 2023 of no more than 719 million gallons of cellulosic biofuel; 1330

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[91] *See* David Tilman & Michael Clark, *Global Diets Link Environmental Sustainability and Human Health*, 515 Nature 518 (2014); *see also* Bojana Bajželj et al., *Importance of Food-Demand Management for Climate Mitigation*, 4 Nature Climate Change 924 (2014); Timothy Searchinger et al., *Creating a Sustainable Food Future: A Menu of Solutions to Feed Nearly 10 Billion People by 2050*, World Res. Inst. (2019), https://www.wri.org/research/creating-sustainable-food-future; Hugo Valin et al., *The Future of Food Demand: Understanding Differences in Global Economic Models*, 45 Agric. Econ. 51 (2014).

[92] *See* Olaf Erenstein et al., *Global Maize Production, Consumption and Trade: Trends and R&D Implications*, 14 Food Security 1295 (2022); *see also* Hannah Ritchie & Max Roser, *Soy*, Our World in Data (2021), https://ourworldindata.org/soy.

[93] *See* Timothy Searchinger et al., *EU Climate Plan Sacrifices Carbon Storage and Biodiversity for Bioenergy*, 612 Nature 27 (2022).

million gallons of BBD, 2195 million gallons of total advanced biofuels and 2195 million gallons of total biofuel.

While these RVOs are dramatically lower than those proposed by EPA (see Table 2 below), actual biofuel production is likely to be much closer to EPA's proposal as it is expected to continue to be cost-effective to blend 10% ethanol into gasoline. EPA estimates that this 10% blend wall would allow for 13.9 billion gallons of ethanol consumption in 2023. Hence, if EPA promulgated these RVOs we expect total biofuel consumption to be 16.1 billion gallons in 2023. Note that were EPA to finalize RVOs that require more use of conventional biofuel than can be accommodated within the 10% blend wall the primary effect would be to induce more biodiesel production from soybeans or other crops, which are both much more expensive and have a much higher carbon opportunity cost than corn ethanol.

Table 2

RVO Category	**EPA Proposal (million gallons equivalent)**	**WRI & Earthjustice Proposal (million gallons equivalent)**
Cellulosic biofuel	719	719
Bio-Based Diesel	3,600	1,330
Total Advanced Biofuel	5,819	2,195
Total Biofuel	20,819	2,195

CONCLUSION

For the foregoing reasons, we urge EPA to finalize a Set Rule only for 2023 at this time, and to set the RVOs for 2023 at a level that can be supplied from waste biomass and to recognize only such biofuels as qualifying to satisfy these RVOs.

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Appendix A

Studies Estimating Greenhouse Gas Consequences of Harvesting Wood for Electricity

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