**Raízen Energia S.A.**
Av. Brig. Faria Lima, 4100 - Itaim Bibi,
São Paulo - SP, 04538-132

May 10, 2024

The Honorable Liane Randolph
Chair
California Ai Resources Board
1001 I Street
Sacramento, CA 95814
(Comments submitted electronically)

Dear Chair Randolph,

We appreciate again the opportunity to comment on the Proposed Low Carbon Fuel Standard Amendments.

In our previous submission dated February 20, 2024, we underscored the pivotal role of the 2024 Rulemaking on Amendments to the LCFS in addressing Sustainability and Certification Requirements for Crop-based feedstocks. Since these were central issues discussed at the April 10, 2024, workshop, we are resubmitting our prior comments for easy reference.

The remaining sections of our February 20, 2024, comments were focused upon carbon intensity (CI), CA-GREET and fuel pathway issues. We would like to express our concern that many of the important carbon intensity reductions that Raizen has integrated into our fuels and facilities in Brazil and that have been recognized in the Carbon Offsetting and Reduction Scheme for International Aviation ("CORSIA") have not yet been recognized within the Low Carbon Fuel Standard ("LCFS") program. We look forward to re-engaging with CARB staff on these critical issues. In particular, we strongly advocate for the incorporation of the second-generation ethanol pathway into Tier 1, along with the following proposed adjustments: 1) revision of the Tier 1 CI Calculator related to $N_2O$ emissions from applied N; 2) making the percentage of unburned mechanized harvesting as a primary data source, supported by evidence; 3) considering the margin of the Brazilian electricity grid when accounting for exported electricity credit; 4) also updating the sugarcane straw yield in the Tier 1 CI Calculator, as made in the CA-GREET 4.0 tool. **Please find the submission from February attached in the Appendix for your reference.**

In addition to the points mentioned above, we would like to express our appreciation for the opportunity to address an additional topic raised during the workshop presented on April 10, 2024. At the workshop, there was a discussion regarding a possible **mechanism to assign higher Land Use Change (LUC) values to high-risk crop-based feedstocks entering the California LCFS Program. Since Brazilian sugar-cane base ethanol had been evaluated by CARB Team in the past, no further analysis is required at this moment.**

Nevertheless, in order to prevent any future misclassification that might consider Brazilian sugarcane as a high-risk crop-based feedstock, this letter aims to underscore why sugarcane is far from being a high-risk crop-based feedstock. The justifications are presented below.

## Scientific Evidence Supporting Low-Risk Land Use Change for Sugarcane Ethanol in Brazil

- A study commissioned by the European Commission and conducted by the European Joint Research Centre (JRC)[1] has concluded that sugarcane ethanol production in Brazil presents a low risk of indirect land use change (ILUC)[2]. The key findings regarding sugarcane expansion from 2017 to 2030 are as follows:

  - **Expansion into other croplands**, including food crops, is also projected to be minimal, **less than 1%**, indicating negligible displacement of farming activities and associated ILUC.
  - Approximately **97% of the expansion** is expected to occur on **pasturelands**. Pasture displacement towards northern regions due to sugarcane expansion is possible but **highly uncertain**.
    - Another study conducted by Canabarro et al. (2023)[3] reveals that utilizing just 3.1% of the existing Brazilian pasture area, of which approximately 63% exhibits some degree of degradation, could suffice to double ethanol production in Brazil. Hence, intensifying livestock activities and repurposing a fraction of pastureland can notably boost biofuel output without encroaching upon areas designated for food production.
  - The JRC study identified an LUC value of 2 gCO2eq/MJ for sugarcane ethanol production.
  - **Expansion into forest** (high carbon stock) and **savannah** native vegetation (Cerrado) is projected to be marginal, **less than 2%.**
  - Given its negligible expansion into high carbon stock lands and minimal displacement of other crops, **sugarcane** feedstock production in **Brazil meets** the stringent criteria set by the **EU's environmental standards**.
  - In conclusion, the JRC study indicated that **even under** conditions of **high EU demand for ethanol**, which represents a small portion of Brazil's total supply, sugarcane feedstock production would have **limited impacts** on GHG emissions through **LUC**.

- A recent scientific publication (Guarenghi et al., 2023)[4] offers a refined estimation of **direct LUC** associated with **sugarcane cultivation in Brazil**, covering both the Center-South and North regions, spanning the past two decades (2000–2020). This study incorporates changes in management practices and refined assessments of

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[1] M. Follador, G. Philippidis, J. Davis, and B. Soares-Filho, *Assessing the impacts of the EU bioeconomy on third countries - Potential environmental impacts in Brazil of UE biofuel demand to 2030*. 2019. doi: 10.2760/304776.

[2] The goal of the study was to assess the potential impacts on land use changes in Brazil resulting from increased EU demand for ethanol.

[3] Canabarro, N. I., Silva-Ortiz, P., Nogueira, L. A. H., Cantarella, H., Maciel-Filho, R., & Souza, G. M. (2023). *Sustainability assessment of ethanol and biodiesel production in Argentina, Brazil, Colombia, and Guatemala.* Ren and Sust Energy Reviews, 171, 113019.doi: 10.1016/j.rser.2022.113019.

[4] Guarenghi,M.M.; Garofalo, D.F.T.; Seabra, J.E.A.;Moreira,M.M.R.; Novaes, R.M.L.; Ramos, N.P.; Nogueira, S.F.; de Andrade, C.A. *Land Use Change Net Removals Associated with Sugarcane in Brazil*. Land 2023, 12, 584. https://doi.org/10.3390/land12030584

land-use carbon stocks. Key highlights include:

- Four different carbon stocks parametrization (A-D) were considered (see Chart below), with variations among them lying in the carbon stock values attributed to planted pasture, sugarcane, and annual crops classes.
- The study revealed that sugarcane expansion predominantly occurred in severely and moderately degraded pastureland.
- 98.4% of expansion was over existent agricultural areas (predominantly pasturelands).
- Sugarcane is primarily produced in the Center-South and Northeast regions, which are geographically distant from deforestation areas.
- By refining the management practices and carbon stocks of pasture, sugarcane, and temporary crop classes, the emissions associated with land use change (LUC) for sugarcane during the last 20 years shifted from 2.2 TgCO2.yr-1 (Parametrization A, worst-case scenario) to a pattern of LUC emission removal at -9.82 TgCO2.yr-1 (Parametrization D, scenario with various management practice improvements).
- The study also showed that the mechanization of sugarcane harvesting, which changed from 28% in 2007 to 97% in 2020, have been long shown as promising solution to reduce the carbon footprint of Brazilian agriculture.

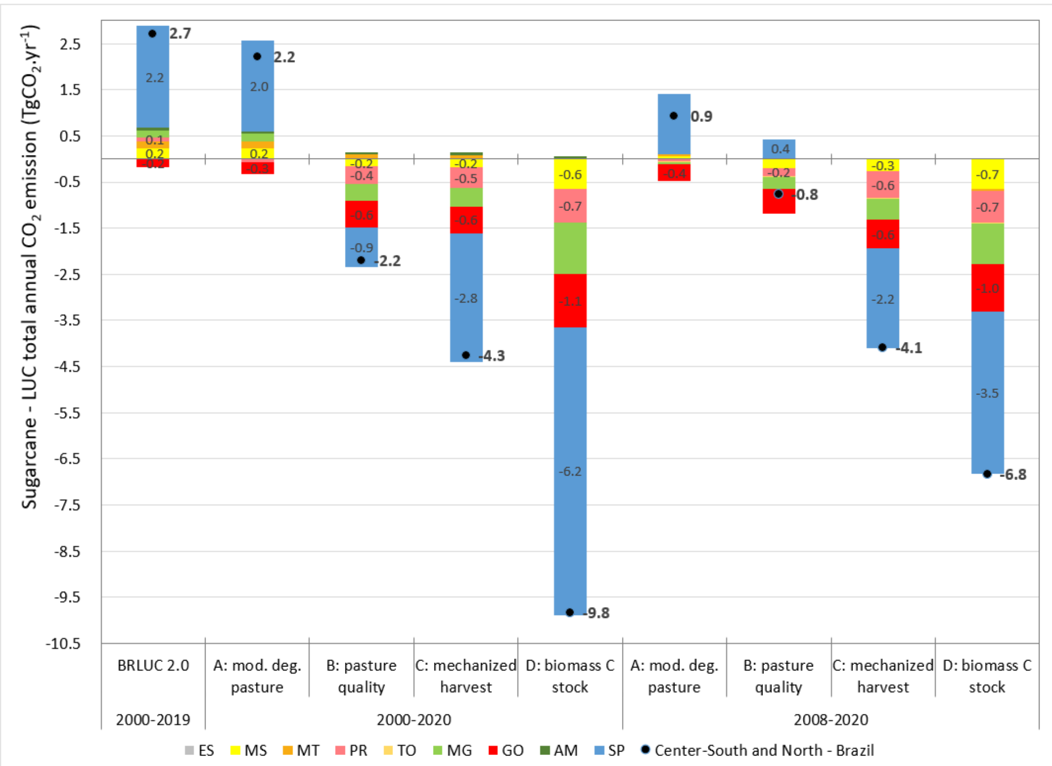


**Figure 1. Estimated absolute annual CO2 emissions from LUCs associated with sugarcane for different parametrizations; from Guarenghi et al., 2023[5].** *Parametrization **A** adopts the carbon stock values from BRLUC 2.0[6] and assumptions include*

[5] Guarenghi,M.M.; Garofalo, D.F.T.; Seabra, J.E.A.;Moreira,M.M.R.; Novaes, R.M.L.; Ramos, N.P.; Nogueira, S.F.; de Andrade, C.A. *Land Use Change Net Removals Associated with Sugarcane in Brazil*. Land 2023, 12, 584. https://doi.org/10.3390/land12030584.

[6] Garofalo, D.F.T.; Novaes, R.M.L.; Pazianotto, R.A.A.;Maciel, V.G.; Brandão,M.; Shimbo, J.Z.; Folegatti-Matsuura,M.I.S.

*a unique default value for all planted pastures (considering conservatively that all of them are classified as moderately degraded), mechanical harvesting of the entire sugarcane area in the Center-South of Brazil (considering conservatively that nearly 100% of sugarcane harvesting was mechanized in both 2000/2008 and 2020), and default biomass carbon stock values for sugarcane and temporary crops based on European Commission guidelines. Parametrization **B** considers pasture quality levels to calculate a new pasture carbon stock value, using spatially explicit data from MapBiomas Collection 8.0, while maintaining other values from Parametrization A. Parametrization **C** adopts the same assumptions as Parametrization B, with variations in the dynamics of mechanically harvested sugarcane over the analyzed years (2000–2008–2020) and among Brazilian states/regions. Parametrization **D** builds upon Parametrization C by updating sugarcane biomass carbon stock based on fresh yield data from Embrapa Environment studies and assuming carbon stock values for temporary annual crops from IPCC guidelines. This Parametrization includes pasture quality levels, variations in mechanized harvesting, refinement of sugarcane biomass carbon stock, and adoption of carbon stock values for annual crops from the IPCC. The parametrization D results shows that in the period 2000-2020 (-9.8 TgCO2.yr-1), the increases in carbon stocks in areas with sugarcane cultivation were essentially due to the advance of sugarcane over pasture areas, responsible for 54.6% of gross removals, which was followed by the contribution of transition to raw sugarcane (16.4%), temporary crops (15.0%), and mosaic (13.7%). So, land use change pattern associated with sugarcane expansion predominantly over degraded pastures was essential to contribute to removal emissions.*

- A recent publication from the U.S. Department of Energy, pertaining to Section 40B of the Inflation Reduction Act (IRA), has estimated that sugarcane-based Sustainable Aviation Fuel (SAF) production, at a volume of 1 billion gallons per year, results in an indirect emission impact of ca. 5.9 gCO2eq/MJ. While the estimation primarily addresses SAF demand and **indirect effects**, this figure suggests a relatively low impact of Land Use Change for sugarcane ethanol in Brazil. Notably, this value is lower than the projection of Land Use Change under the LCFS Program, which stands at 11.8 gCO2eq/MJ.

## Renovabio: Brazil's Biofuel Policy and Its Deforestation Prevention Requirements

The Brazilian Biofuels Policy, Renovabio, is designed to stimulate the production and distribution of biofuels in Brazil, with the goal of decarbonizing the energy sector and fulfilling the country's climate obligations. Renovabio serves as a **legal mechanism** aimed at **mitigating deforestation** for the cultivation of feedstocks used in biofuel production, **thereby reducing the risk of land use change**. Two crucial prerequisites support the notion that deforestation-related land use change is unlikely to occur:

- Renovabio's environmental requirements **prohibit** the cultivation of biofuel **feedstocks** on **lands converted** from **forest after December 2017**.
  - The Brazilian sugarcane Agroecological Zoning points out 64 million hectares suitable for sugarcane production, most of than composed by abandoned areas or degraded pastures, with no need for deforestation.
- Operators seeking to participate in the Renovabio Program undergo a rigorous certification process.

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Land-use change CO2 emissions associated with agricultural products at municipal level in Brazil. J. Clean. Prod. 2022, 364, 132549

In conclusion, Raízen expresses appreciation for the opportunity to participate in the LCFS rulemaking process and collaborate with CARB staff. We are once again eager to engage in technical discussions with CARB's highly qualified team. We anticipate continuing the ongoing dialogue and collaboration to advance these discussions, which we believe will play a crucial role in reducing emissions in the California transport sector.

Sincerely,

Raízen

## APPENDIX – Letter submitted in February 2024

**Raízen Energia S.A.**
Av. Brig. Faria Lima, 4100 - Itaim Bibi,
São Paulo - SP, 04538-132

February 20, 2024

The Honorable Liane Randolph
Chair
California Air Resources Board
1001 I Street
Sacramento, CA 95814
(Comments submitted electronically)

Dear Chair Randolph,

We appreciate the opportunity to comment on the Proposed Low Carbon Fuel Standard (LCFS) Amendments.

Raízen is a company created from an independent Joint Venture with shared control between Shell and Cosan, which operates in theproduction and sale of sugar, bioenergy and bioeletricity. We have a fully integrated process that involves everything from the cultivation of the sugarcane to the production of sugar and ethanol and thelogistics of distribution and marketing of these products. We are currently the largest sugarcane-ethanol producer globally, and a unique holder of second-generation ethanol technology operating in a commercial scale.

We would like to start our comments by recognizing CARB's technical staff's diligent work and willingness to engage with stakeholders in the process of updating the LCFS regulations through this rulemaking.

We continuously seek to manage and improve the carbon footprint of our products by diversifyingour renewable energy portfolio, with the objective of delivering decarbonization solutions to themarket. We increasingly invest to support the mitigation of climate change and the global energytransition. Markets that aim to decarbonize the transportation sector and have a premium policyrelated to biofuels, such as LCFS / CARB (Low Carbon Fuel Standard / California Air Resources Board), are naturally of interest to Raízen for the commercialization of our biofuels. We pride ourselves for being a committed stakeholder to CARB's LCFS program for a long time and for always offering reliable and trustworthy data on the ethanol sector in Brazil. Raízen has also supplied a significant amount of ethanol to California in recent years.

While acknowledging the advancements that the draft proposal brings, we would like to highlight some points we believe may improve the proposed amendments to the LCFS program.

1. **Comments on Sustainability Requirements for Crop-Based Feedstocks (Section 95488.9 (g), Appendix A-1.1)**

   We understand the pivotal role sustainability certifications play in assuring a fair-trade system combined with sustainable development. Raízen, for instance, has its plants certified by certification schemes, such as Bonsucro and ISCC. Recently, we were the first ethanol producer in the world to be certified with the ISCC CORSIA Plus certification.

   In addition to certifications, geographic traceability is maintained for the sugarcane we process, whether sourced from our own operations or from third-party suppliers. This entails the possession of shapefiles delineating the locations of the farms and plots from which we procure or cultivate sugarcane. Our differentiated management of the supply chain enables us to ensure the geographic traceability of our raw materials under the highest sustainability standards in production.

   Based on our experience complying with and promoting sustainable practices, we regard such certifications (RSB, ISCC and Bonsucro) as internationally recognized in this field. Not to mention Renovabio, in Brazil. We would therefore encourage CARB to carefully consider these established certification schemes and taking steps to recognize and align with these respected approaches thus avoiding duplication of efforts and placing additional burdens on companies that intend to have trade flows with the state of California and would need to abide by LCFS' sustainability criteria.

   Finally, for tracking crop-based feedstock in the supply chain, Raízen strongly recommends the mass-balance approach, a system widely recognized by sustainability certification schemes. The mass balance approach is widely utilized due to its simplicity, particularly within value chains that involve multiple suppliers. In the mass balance tracking model, materials, or products with a set of specified characteristics are mixed according to defined criteria with materials or products without that set of characteristics. Acknowledging the relevance of international reliable certification schemes, the mass balance approach would require fewer resources for biofuel producers, CARB staff and certification bodies. It also ensures transparency through clear documentation. This approach provides feedstock buyers with greater certainty about the sustainability criteria.

2. **Comments on Tier 1 for Second-Generation Ethanol (E2G)**

   Raízen is the unique holder of second-generation ethanol technology operating at a commercial scale. We have one E2G plant operating since 2018 (Costa Pinto) producing at full capacity (~7,925.161,6 gallons/year), as well one recently delivered new plant under construction and 8 more to be constructed soon. It is important to highlight that the E2G production is entirely bagasse-based, tackling climate change with a less carbon intense fuel compared to conventional biofuels, and bringing disruptive technology, as well providing good local jobs and economic growth.

   Looking at this expansion plan and benefits of the second-generation ethanol, Raízen's E2G production will significantly increase during the coming years. **Therefore, we**

**strongly advocate for CARB staff to incorporate the second-generation ethanol pathway into Tier 1.** Recognizing the hurdles in integrating new pathways, we stand ready to support CARB staff by providing valuable operational data.

**3. Comments on Backhaul Energy Intensity (Section II-C, Appendix B)**

Raízen echoes Shell's assertion that **the addition of backhaul energy intensity to ocean tankers for Brazilian sugarcane is not a universally applicable condition**. This situation does not apply to ethanol transported from Brazil to the US. Raízen can provide evidence of its trading logistics, as it has done in the past, and is pleased to collaborate with CARB staff again to offer further information.

**4. Comments on Tier 1 CI Calculator**

Firstly, we want to acknowledge CARB's technical staff for their continued efforts and willingness to collaborate with us in the ongoing process of updating the calculator for sugarcane ethanol. However, CARB is faced with a significant responsibility, one that will influence transportation policy for years to come, not only in the US but also in other jurisdictions across the United States and internationally. We are eager to continue contributing to this endeavor.

As we discussed last year during the amendment process of the Draft Tier 1 Calculator, we would like to reiterate some of our comments regarding the assumptions incorporated in the Tier 1 CI Calculator. **Recognizing the potential challenges faced by CARB staff in reviewing Tier 2 applications, we respectfully propose the integration of the following requests into the Tier 1 calculator**. This strategic enhancement aims to optimize efficiency and mitigate administrative burdens associated with Tier 2 evaluations, aligning with our commitment to facilitating smoother processes within regulatory frameworks.

**a. $N_2O$ emissions from applied N**

The emission factor for direct $N_2O$ emissions from nitrogen inputs, as previously outlined in CA-GREET 3.0, stood at 0.01 kg-$N_2O$-N/kg N-fert applied to soils, as sourced from the IPCC (2006). In the current version of the CA-GREET 4.0, this figure has been revised to 0.00895 kg-$N_2O$-N/kg N-fert based on Wang et. al (2012). But no updated was included in the Tier 1 CI Calculator. Raízen acknowledges the efforts of CARB staff in updating this value in CA-GREET 4.0. Despite this updated science evidence, it is worth noting that this adjustment may still not accurately reflect the Brazilian reality, and **the IPCC generally recommends prioritizing regional data whenever available.**

Carvalho et al. (2021)[7], in a recent publication, conducted a comprehensive study based on 14 relevant publications reflecting current nitrogen fertilization practices in South-Central Brazil's sugarcane industry. Their research is grounded in data gathered from field studies conducted across 17 experimental sites. Importantly, they meticulously accounted for background emissions of $N_2O$ EF, incorporating

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[7] Carvalho, J. L. N.; Oliveira, B. G.; Cantarella, H.; Chagas, M. F.; Gonzaga, L. C.; Lourenço, K. S.; Bordonal, R. O.; Bonomi, A. *Implications of regional N2O-N emission factors on sugarcane ethanol emissions and granted decarbonization certificates.* Renewable and Sustainable Energy Reviews, 149 (2021), 111423. https://doi.org/10.1016/j.rser.2021.111423

over 86 reported values. Notably, the study encompasses $N_2O$ EFs derived from sugarcane cultivated under green mechanized harvesting, which dominates over 95% of the sugarcane cultivation area in the South-Central region of Brazil.
**Carvalho et al. (2021) found the average $N_2O$–N EF of 0.006 kg N2O-N/kg N applied, considering all N fertilizer sources**, for the sugarcane ratoon, which receives most of the N application of the sugarcane areas, and represents 80% of the sugarcane cycle and 89% of the total amount of N fertilizer consumed considering the entire sugarcane mill. **The EF value recommended by Carvalho is 33% lower than the value proposed by Wang et at. (2012).** The value identified by Carvalho is justified by good drainage properties of the deep Oxisols soils, where sugarcane is commonly cultivated in Brazil.

Hence, the review of in situ $N_2O$–N EF measurements from sugarcane in Brazil indicates values below the default currently proposed in the CA-GREET 4.0, and notably lower than those observed in many sugarcane areas in other regions worldwide. IPCC (2019) values, used in the current Tier 1 CI Calculator, were primarily derived from studies in Europe (34%), North America (28%), and Asia (19%), with Central-South America contributing with only 6−7% to the dataset. Therefore, does not represent the sugarcane reality in the region.

**Raízen strongly recommends that CARB staff consider using the value of 0.006 kg-$N_2O$-N/kg N-fert for both CA-GREET 4.0 and Tier 1 CI Calculator, reflecting the specific conditions in South-Central Brazil's sugarcane production areas**.

## b. Unburned Mechanized Harvesting

**Mechanized harvesting, which involves unburned methods, dominates the sugarcane harvesting landscape in Brazil's Center-South region, representing more than 95% of the total yield.** This assertion is substantiated by both official governmental data[8] and primary data meticulously collected and audited by Renovabio in 2018 and 2019. Renovabio's findings further affirm the correlation between mechanized harvesting practices and the adoption of unburned methods. However, despite this evidence, the default values in the Tier 1 CI Calculator for sugarcane ethanol indicate a mechanization rate of just 80% in São Paulo state and 65% in other states, including the Center-South region.

As per CARB's request, an analysis utilizing remote sensing data was conducted employing the Mapbiomas-Fire[9] and UNICA's sugarcane area vectors. Data were processed in the Qgis software. For each sugarcane polygon, the percentage of intersection with the polygon of burned area from Mapbiomas-Fire was estimated. After the geospatial statistics calculations, the results were added to the attribute table of the vector, and state-level statistics were computed. Consequently, the total sugarcane area for 2020 was assessed at 10,280,528.7 hectares, of which 82,847.10 hectares were subjected to burning practices, accounting for less than 1% of the

[8] Safra cana-de-açúcar, Center-South region: https://unicadata.com.br/listagem.php?idMn=4
[9] MapBiomas. MapBiomas Project - Mapbiomas-Fire Collection 1. 2022. Available at: https://mapbiomas.org/en/colecoes-mapbiomas-1?cama_set_language=en. *The Mapbiomas-Fire product was elaborated from mosaics of Landsat Satellite images, with 30 meters of spatial resolution, covering the years from 1985 to 2020, providing monthly and annual data of the burned areas in Brazil. The burned area estimation was carried out using artificial intelligence from machine learning algorithms in the Google Earth Engine platform. The algorithm was trained with samples of burned and non-burned areas, in addition with the burned area product of MODIS sensors (MCD64A1) and hot spots data from INPE.*

sugarcane area (**Figure 1**).

Considering the significant influence of this input on the calculator and the industry's substantial efforts to reduce emissions through modern harvesting techniques**, Raízen asks CARB staff to carefully review this information**. The implications of CARB's policies extend beyond California, impacting the wider country and the world. It's crucial that CARB's assumptions regarding mechanized harvesting accurately reflect Brazil's sugarcane production patterns, translating into improved carbon intensity for Brazilian ethanol.

**We respectfully urge CARB to consider implementing an option for individual mechanization percentage, supported by evidence, within the Tier 1 CI calculator.** If, for any reason, this is not feasible, we kindly request that the staff adjust the default mechanization values for Center-South Brazil to a value no lower than 95%. By doing so, CARB will align input more closely with actual practices.

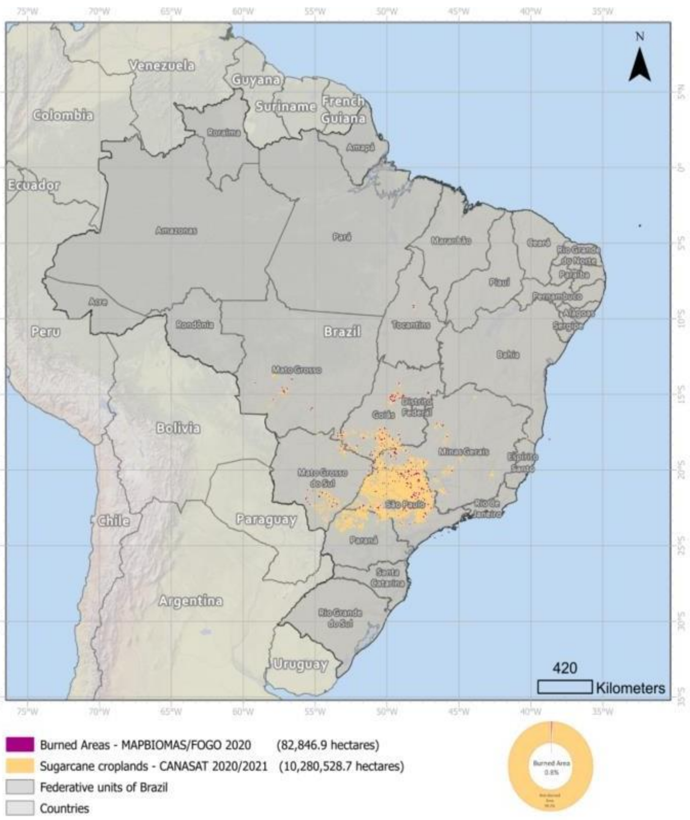



**Figure 1**. Intersection from the sugarcane area with the burned areas polygons from the MapBiomas-Fire for the center-south region of Brazil. Sources: Mapbiomas-Fire, Canasat.

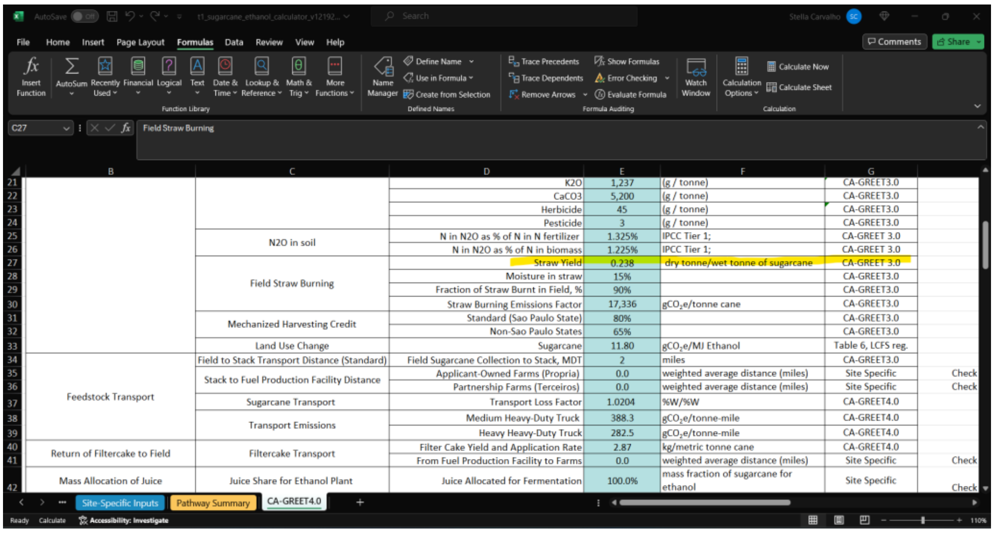
### c. Electricity Exported Credits

Sugarcane-based electricity in Brazil serves as a valuable supplement to hydroelectric generation, particularly during the dry season when water resources may be limited. Its contribution helps mitigate the need for natural gas- and coal-based electricity generation, thus promoting a more sustainable energy mix. **Raízen strongly recommends that CARB staff consider electricity export credits by acknowledging the displacement of the margin of the Brazilian electricity grid.** This should be based on sugarcane electricity's contribution to total thermoelectric generation during the dry season in Brazil. This approach allows for the reallocation of energy dispatching primarily during this period, reducing the risk of deficit without worsening water reservoir conditions. Raízen disagrees with CARB's approach, which excludes energy exported in the off-season and fails to consider energy produced by cogeneration from third-party biomass. This can create a "double standard" where the rainy season is used to calculate the national electricity grid average but ignored when CARB excludes export electricity credits generated in the off-season months. Both approaches significantly impact the carbon intensity (CI) value of ethanol mills in Brazil.

For a more detailed exploration of electricity production and dispatch in Brazil, please refer to **Annex A.**

### d. Straw Yield

Raízen greatly appreciates CARB staff's consideration in updating the sugarcane straw yield in the CA-GREET 4.0, reducing it from 0.24 t/t cane (dry basis) to 0.14 t/t cane (dry basis). However, **Raízen identified the need to CARB staff also implement this change in the Tier 1 CI Calculator.** As previously explained, this revised value is widely accepted by the academic community and is being utilized in numerous studies, including the latest versions of the Argonne GREET Model. **We therefore strongly ask CARB to reconsider this value in the Tier 1 CI Calculator.**



| | B | C | D | E | F | G | |
|---|---|---|---|---|---|---|---|
| 21 | | | K2O | 1,237 | (g / tonne) | CA-GREET3.0 | |
| 22 | | | CaCO3 | 5,200 | (g / tonne) | CA-GREET3.0 | |
| 23 | | | Herbicide | 45 | (g / tonne) | CA-GREET3.0 | |
| 24 | | | Pesticide | 3 | (g / tonne) | CA-GREET3.0 | |
| 25 | | N2O in soil | N in N2O as % of N in N fertilizer | 1.325% | IPCC Tier 1; | CA-GREET 3.0 | |
| 26 | | | N in N2O as % of N in biomass | 1.225% | IPCC Tier 1; | CA-GREET 3.0 | |
| 27 | | Field Straw Burning | Straw Yield | 0.238 | dry tonne/wet tonne of sugarcane | CA-GREET 3.0 | |
| 28 | | | Moisture in straw | 15% | | CA-GREET3.0 | |
| 29 | | | Fraction of Straw Burnt in Field, % | 90% | | CA-GREET3.0 | |
| 30 | | | Straw Burning Emissions Factor | 17,336 | $gCO_2e$/tonne cane | CA-GREET3.0 | |
| 31 | | Mechanized Harvesting Credit | Standard (Sao Paulo State) | 80% | | CA-GREET3.0 | |
| 32 | | | Non-Sao Paulo States | 65% | | CA-GREET3.0 | |
| 33 | | Land Use Change | Sugarcane | 11.80 | $gCO_2e$/MJ Ethanol | Table 6, LCFS reg. | |
| 34 | Feedstock Transport | Field to Stack Transport Distance (Standard) | Field Sugarcane Collection to Stack, MDT | 2 | miles | CA-GREET3.0 | |
| 35 | | Stack to Fuel Production Facility Distance | Applicant-Owned Farms (Propria) | 0.0 | weighted average distance (miles) | Site Specific | Check |
| 36 | | | Partnership Farms (Terceiros) | 0.0 | weighted average distance (miles) | Site Specific | Check |
| 37 | | Sugarcane Transport | Transport Loss Factor | 1.0204 | %W/%W | CA-GREET4.0 | |
| 38 | | Transport Emissions | Medium Heavy-Duty Truck | 388.3 | $gCO_2e$/tonne-mile | CA-GREET4.0 | |
| 39 | | | Heavy Heavy-Duty Truck | 282.5 | $gCO_2e$/tonne-mile | CA-GREET4.0 | |
| 40 | Return of Filtercake to Field | Filtercake Transport | Filter Cake Yield and Application Rate | 2.87 | kg/metric tonne cane | CA-GREET4.0 | |
| 41 | | | From Fuel Production Facility to Farms | 0.0 | weighted average distance (miles) | Site Specific | Check |
| 42 | Mass Allocation of Juice | Juice Share for Ethanol Plant | Juice Allocated for Fermentation | 100.0% | mass fraction of sugarcane for ethanol | Site Specific | Check |

**Figure 2.** Current assumption for straw yield in the Tier 1 CI Calculator for sugarcane ethanol.

In conclusion, Raízen appreciates the opportunity to contribute with the LCFS rulemaking process and with CARB staff. Once again, we would like to put ourselves available for technical discussions with the high qualified CARB staff. We look forward to continuing the ongoing dialogue and collaboration staff to move forward with these discussions that we are certain will contribute to lowering emissions in the California transport sector.

Sincerely,

Raízen

## Annex A. The Brazilian Electrical System

The Brazilian Electrical System (National Interconnected System - SIN) is 99% interlinked[10], so virtually all the production and transmission of electricity in Brazil happens in one maingrid closely monitored by the National Electric System Operator (ONS), a federal agency responsible for coordinating and controlling operation of the electricity generation and transmission facilities in the SIN under the supervision and regulation of the National Electric Energy Agency (ANEEL). This unique system adopted by the country creates certainty as to what sources contribute to the marginal generation of power. Sugarcane biomass-based electricity in Brazil receives a fixed income to deliver a "package" of energy per year to the grid. Sugarcane biomass receives this fixed income for the energy it produces and declares its Unit Variable Cost (UVC) equal to zero, since cogeneration of sugarcane biomass electricity occurs in order to meet the demand of the sugar and ethanol industry. Wind and solar sources also have a UVC equal to zero. In this way, all the electrical energy these sources produce is made available to the national grid (since the government already paid a fixed income for it).

The procedure varies for thermo-gas sources. In addition to the fixed income they receive for standby readiness, their UVC exceeds zero. This implies that whenever the ONS deploys them, they are compensated for both their fuel expenses and operational costs. In fact, since sugarcane biomass is classified with a unit variable cost equal to zero, the ONS adopts the so-called merit order,where thermal plants from lower to higher operating costs are dispatched in order to meet demand. The ones with lower UVC are the first to be called to meet domestic demand. Since biomass plants have unit variable cost equal to zero, when available (during the sugarcane harvest season), they are the first to be dispatched to the system, without the need for an order from the ONS. Differently from sources like coal, diesel, and natural gas, the generation of energy from sugarcane biomass sources is controlled and dictated by the industrial process itself instead of by order of the national operator.

[10] https://www.ons.org.br/paginas/sobre-o-sin/sistemas-isolados