UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

January 12, 2023

OFFICE OF
AIR AND RADIATION

Mr. Alex Menotti
LanzaJet, Inc.
Vice President, Corporate and Government Affairs
520 Lake Cook Road, Suite 600
Deerfield, Illinois 60015

Dear Mr. Menotti:

LanzaJet, Inc. (LanzaJet) petitioned the Agency to approve a pathway for the generation of biomass-based diesel (D-code 4) renewable identification numbers (RINs) for renewable diesel and jet fuel produced at a facility near Soperton, Georgia. The renewable jet fuel and renewable diesel is produced from undenatured ethanol through a process of dehydration, oligomerization, and hydrotreating using grid electricity, natural gas, and hydrogen as process inputs (the "LanzaJet Soperton Process"). The undenatured ethanol is produced from sugarcane.[1] As described in the 2020-2022 RFS Standards final rule (87 FR 39600), undenatured ethanol is a biointermediate. We refer to this entire collection of steps, the feedstock, the biointermediate, the facility, the process, and the fuels produced as the "LanzaJet Soperton Pathways." LanzaJet also included an equivalence value application under 40 CFR 80.1415(c) for the renewable jet fuel produced under the LanzaJet Soperton Pathways.

Through the petition process described under 40 CFR 80.1416, LanzaJet submitted data to EPA to perform a lifecycle greenhouse gas (GHG) analysis of fuels produced through the LanzaJet Soperton Process from undenatured ethanol. For renewable jet fuel and renewable diesel produced through the LanzaJet Soperton Process from sugarcane ethanol, we estimate the associated feedstock and fuel production emissions based on the sugarcane ethanol analysis in the March 2010 RFS2 rule (75 FR 14670) with several data updates as described in the enclosed determination document, and data provided by the LanzaJet petition.

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[1] In addition to the use of undenatured sugarcane ethanol, LanzaJet requested that EPA approve pathways using undenatured ethanol produced from other feedstocks. We need to further consider alternative or comingled sources of undenatured ethanol and how they relate to the finalized biointermediate provisions before making a determination on pathways utilizing undenatured ethanol produced from feedstocks other than sugarcane.

Based on our assessment of LanzaJet's pathway petition under 40 CFR 80.1416, renewable diesel and jet fuel produced through the LanzaJet Soperton Process from undenatured sugarcane ethanol qualify under the Clean Air Act (CAA) for D-code 4 RINs, provided all applicable statutory and regulatory conditions are satisfied including those specified in the CAA and EPA implementing regulations. EPA is additionally specifying conditions unique to the LanzaJet Soperton Process in Section IV of the enclosed determination document that must be satisfied in order for LanzaJet to generate RINs. LanzaJet and the undenatured ethanol producer must also comply with all applicable requirements for the production, transfer, and use of undenatured ethanol as a biointermediate under 40 CFR part 80, subpart M. This pathway petition approval is not intended to address any issue related to the production, transfer, and use of undenatured ethanol as a biointermediate.

Based on our assessment of LanzaJet's equivalence value application, we are temporarily approving an equivalence value of 1.6 for renewable jet fuel produced under the LanzaJet Soperton Process. Given that LanzaJet's current equivalence value application is based on pilot-scale fuel production, EPA is conditioning this pathway approval on LanzaJet submitting a new equivalence value application for their renewable jet fuel within 60 days of operation of the LanzaJet Soperton Facility.

This approval applies specifically to the LanzaJet facility near Soperton Georgia, and to the process, materials used, fuels produced, and energy types and amounts described in the June 2021 petition request submitted for that facility.

The EPA fuels program electronic registration and EPA moderated transaction system applications will be modified to allow LanzaJet to register and generate D-code 4 RINs for renewable diesel and jet fuel produced through the LanzaJet Soperton Process from undenatured sugarcane ethanol acquired from registered biointermediate producers.

Sincerely,

SARAH DUNHAM
Digitally signed by SARAH DUNHAM
Date: 2023.01.12 10:47:00 -05'00'

Sarah Dunham, Director
Office of Transportation and Air Quality

Enclosure

LanzaJet Sugarcane Ethanol to Renewable Jet Fuel and Renewable Diesel Pathway Determination under the RFS Program

Office of Transportation and Air Quality

Summary: LanzaJet, Inc. (LanzaJet) petitioned the Agency to approve a pathway for the generation of biomass-based diesel (D-code 4) renewable identification numbers (RINs) for renewable diesel and jet fuel produced at a facility near Soperton, Georgia (the "LanzaJet Soperton Facility"). The renewable jet fuel and renewable diesel is produced from undenatured ethanol through a process of dehydration, oligomerization, and hydrotreating using grid electricity, natural gas, and hydrogen as process inputs (the "LanzaJet Soperton Process"). The undenatured ethanol is produced from sugarcane. As described in the 2020-2022 RFS Standards final rule (87 FR 39600), undenatured ethanol is a biointermediate.[2] We refer to this entire collection of steps, the feedstock, the biointermediate, the facility, the process, and the fuels produced as the "LanzaJet Soperton Pathways."

Through the petition process described under 40 CFR 80.1416, LanzaJet submitted data to EPA to perform a lifecycle GHG analysis of renewable fuel produced through the LanzaJet Soperton Pathways. In order to assess the lifecycle GHG emissions associated with fuels produced through the LanzaJet Soperton Pathways, we first estimate the emissions associated with biointermediate undenatured sugarcane ethanol. Pathway lifecycle GHG emissions are then estimated by combining ethanol production emissions with the estimated emissions associated with the production of renewable diesel and jet fuel using the LanzaJet Soperton Process, and with emissions from distribution and use of those fuels.

For evaluating undenatured ethanol produced from sugarcane, we rely upon the analysis published in the March 2010 RFS2 rule (75 FR 14670), which included an estimation of the GHG emissions attributable to the production of sugarcane ethanol in Brazil – the primary global producer of ethanol from sugarcane. We made several revisions to the RFS2 sugarcane ethanol analysis, including using more recent data on sugarcane cultivation and estimates of the global warming potentials of greenhouse gasses, and updates to emissions factors used for process energy. We also consider three different methods of accounting for electricity which is coproduced at sugarcane ethanol production facilities in Brazil. This evaluation and a list of revisions to the 2010 analysis of sugarcane ethanol are discussed in further detail in Section III of this determination document.

Our assessment of renewable jet fuel and renewable diesel produced through the LanzaJet Soperton Process from undenatured sugarcane ethanol combines the RFS2 analysis of sugarcane ethanol, as described above, with process data modeled for the LanzaJet Soperton Facility, which were submitted with LanzaJet's petition. We estimate that renewable jet fuel and renewable diesel produced through the LanzaJet Soperton Process from undenatured sugarcane ethanol

[2] LanzaJet and the undenatured ethanol producer must comply with all applicable requirements for the production, transfer, and use of undenatured ethanol as a biointermediate under 40 CFR part 80, subpart M. This pathway petition approval does not alter or modify any requirement related to the production, transfer, and use of undenatured ethanol as a biointermediate.

reduces lifecycle GHG emissions by approximately 54-66% when compared to the statutory petroleum baseline. Based on our evaluation, renewable jet fuel and renewable diesel produced from undenatured sugarcane ethanol through the LanzaJet Soperton Process are eligible for biomass-based diesel (D-code 4) RINs, provided all associated regulatory requirements are satisfied, including the requirements related to biointermediates and the conditions specified in Section IV of this determination document.

This document is organized as follows:

- *Section I. Required Information and Criteria for Petition Requests*: Information on the background and purpose of the petition process, the criteria EPA uses to evaluate petitions and the information that is required to be provided under the petition process as outlined in 40 CFR 80.1416. This section applies to all petitions submitted pursuant to 40 CFR 80.1416.

- *Section II. Available Information*: Background information on LanzaJet, the information that they provided and how it complies with the petition requirements outlined in Section I.

- *Section III. Analysis and Discussion*: Description of the lifecycle analysis done for this determination and how it differs from the analyses done for previous assessments. This section also describes how we have applied the lifecycle results to determine the appropriate D-code for fuels produced through the LanzaJet Soperton Pathways.

- *Section IV. Conditions and Associated Regulatory Provisions:* Registration, reporting, and recordkeeping requirements for renewable fuel produced through the LanzaJet Soperton Pathways.

- *Section V. Public Participation*: Description of how this petition is an extension of the analyses done as part of prior notice and public comment rulemakings.

- *Section VI. Conclusion*: Summary of our conclusions regarding the LanzaJet petition.

I. Required Information and Criteria for Petition Requests

A. Background and Purpose of the Petition Process

The RFS program is contained in CAA 211(o). EPA's regulations implementing this program are published at 40 CFR part 80, subpart M. The RFS regulations implement the statutory requirements regarding the types of renewable fuels eligible to participate in the RFS program and specify the procedures by which renewable fuel producers and importers may generate RINs for the qualifying renewable fuels they produce through approved fuel pathways.[3]

Pursuant to 40 CFR 80.1426(f)(1)(i):

> *Applicable pathways*. D-codes shall be used in RINs generated by producers or importers of renewable fuel according to the pathways listed in Table 1 to this section, subparagraph 6 of this section, or as approved by the Administrator.

Table 1 to 40 CFR 80.1426 lists the three critical components of fuel pathways: (1) fuel type; (2) feedstock; and (3) production process. Each specific combination of the three components comprises a fuel pathway and is assigned a D-code. EPA may independently approve additional generally applicable fuel pathways into Table 1 for participation in the RFS program, or a third party may petition for EPA to evaluate a new, facility-specific fuel pathway in accordance with 40 CFR 80.1416. In addition, renewable fuel producers qualified in accordance with 40 CFR 80.1403(c) and (d) for an exemption from the 20 percent GHG emissions reduction requirement of the Act for a baseline volume of fuel ("grandfathered fuel") may generate RINs with a D-code of 6 pursuant to 40 CFR 80.1426(f)(6) for that baseline volume, assuming all other regulatory requirements are satisfied.[4]

The petition process under 40 CFR 80.1416 allows parties to request that EPA evaluate a potential new fuel pathway's lifecycle GHG emissions and provide a determination of the D-code for which the new pathway may be eligible.

B. Required Information in Petitions

As specified in 40 CFR 80.1416(b)(1), petitions must include all of the following information, as well as appropriate supporting documents such as independent studies, engineering estimates, industry survey data, and reports or other documents supporting any claims:

- The information specified under 40 CFR 1090.805 (Registration of refiners, importers or oxygenate blenders).

[3] See EPA's website for information about the RFS regulations and associated rulemakings: https://www.epa.gov/renewable-fuel-standard-program

[4] "Grandfathered fuel" refers to a baseline volume of renewable fuel produced from a facility that commenced construction before December 19, 2007, and which completed construction within 36 months without an 18-month hiatus in construction and is exempt from the minimum 20 percent GHG reduction requirement that applies to general renewable fuel. A baseline volume of ethanol from a facility that commenced construction after December 19, 2007, but prior to December 31, 2009, qualifies for the same exemption if construction is completed within 36 months without an 18-month hiatus in construction and the facility is fired with natural gas, biomass, or any combination thereof. "Baseline volume" is defined in 40 CFR 80.1401.

- A technical justification that includes a description of the renewable fuel, feedstock(s), biointermediate(s), and production process. The justification must include process modeling flow charts.

- A mass balance for the pathway, including feedstocks and biointermediates, fuels produced, co-products, and waste materials production.

- Information on co-products, including their expected use and market value.

- An energy balance for the pathway, including a list of any energy and process heat inputs and outputs used in the pathway, including such sources produced off site or by another entity.

- Any other relevant information, including information pertaining to energy saving technologies or other process improvements.

- The petition must be signed and certified as meeting all the applicable requirements of 40 CFR 80.1416 by the responsible corporate officer of the applicant company.

- Other additional information as requested by the Administrator to complete the lifecycle greenhouse gas assessment of the new fuel pathway.

In addition to the requirements stated above, parties who use a feedstock not previously evaluated by EPA must also include additional information pursuant to 40 CFR 80.1416(b)(2). This information was not required for the LanzaJet petition because LanzaJet requested evaluation of a pathway that uses a feedstock and a biointermediate input – sugarcane and undenatured ethanol produced from sugarcane – that EPA previously evaluated in the March 2010 RFS2 rule.

II. Available Information

A. Information Available Through Existing Modeling

The pathway described in the LanzaJet petition would produce fuels from undenatured ethanol which has, in turn, been produced from feedstocks and processes that EPA has previously evaluated under the RFS program. In the March 2010 RFS2 rule (75 FR 14670), EPA evaluated the GHG emissions associated with the production of ethanol from sugarcane. That evaluation determined that sugarcane ethanol meets the requirements of advanced biofuel (D-code 5 RINs) by achieving at least a 50% reduction in lifecycle GHG emissions when compared to the statutory petroleum baseline.

Table 1: Relevant Existing Fuel Pathways from Table 1, 40 CFR 80.1426

Row	Fuel Type	Feedstock	Production Process Requirements	D-Code
J	Ethanol	Sugarcane	Fermentation	5 (advanced)

The LanzaJet petition proposes to use undenatured ethanol produced through this previously evaluated process as an input to the LanzaJet Soperton Process. Our evaluation of the lifecycle emissions associated with the LanzaJet Soperton Pathways uses an application of the modeling previously done in support of the RFS2 rule to estimate emissions upstream of the LanzaJet Soperton Facility.

B. Information Submitted by LanzaJet

LanzaJet supplied all the information as required in 40 CFR 80.1416 that EPA needed to analyze the lifecycle GHG emissions associated with renewable jet fuel and renewable diesel produced from sugarcane-derived undenatured ethanol through the LanzaJet Soperton Pathways. The information submitted by LanzaJet included a technical justification describing the requested pathways, modeling flow charts, a detailed mass and energy balance of the processes involved with information on co-products as applicable, and other additional information as needed to complete the lifecycle GHG assessment. The process modeling flow charts, mass and energy balance data and other details about the production process were submitted under claims of confidential business information.

III. Analysis and Discussion

A. Lifecycle Analysis

Determining a fuel pathway's compliance with the lifecycle GHG reduction thresholds specified in CAA 211(o) for different types of renewable fuel requires a comprehensive evaluation of the renewable fuel, as compared to the gasoline or diesel fuel that it replaces, on the basis of its lifecycle GHG emissions. As mandated by CAA 211(o), the lifecycle GHG emissions assessments must evaluate the aggregate quantity of GHG emissions (including direct emissions and significant indirect emissions such as significant emissions from land use changes) related to the full lifecycle, including all stages of fuel and feedstock production, distribution, and use by the ultimate consumer.

In examining the full lifecycle GHG impacts of fuels for the RFS program, EPA considers the following:

- Feedstock production – based on agricultural sector and other models that include direct and indirect impacts of feedstock production.

- Biointermediate production (when applicable).[5]

- Fuel production – based on evaluation of all processes to convert the feedstock to fuel (including biointermediates when applicable), including process energy requirements, impacts of any raw materials used in the process, and benefits from co-products produced.

- Feedstock, biointermediate (when applicable), and fuel distribution – including impacts of transporting feedstock from production to use, and transport of the final fuel to the consumer.

- Use of the fuel – including combustion emissions from use of the fuel in a vehicle.

EPA's evaluation of the lifecycle GHG emissions related to renewable fuel produced through the LanzaJet Soperton Pathways under this petition request is consistent with the CAA's applicable requirements, including the definition of lifecycle GHG emissions and threshold evaluation requirements.

1. Summary of Lifecycle GHG Analysis

For renewable jet fuel and renewable diesel produced through the LanzaJet Soperton Pathways from undenatured sugarcane ethanol, we estimate the associated lifecycle GHG emissions based on a combination of the sugarcane ethanol analysis in the March 2010 RFS2 rule (75 FR 14670), data provided by the LanzaJet petition, and more recent data on agricultural emissions, emissions associated with fossil energy use, and other data described in the sections below. The analyses used and data updates are summarized in Table 2.

Table 2: Summary of Data and Analyses used for Lifecycle GHG Analysis of the LanzaJet Soperton Pathways

Lifecycle Stage	Methodology	Notes
Biointermediate sugarcane ethanol: sugarcane cultivation, sugarcane transport, ethanol production (Brazil), coproduct electricity generation, ethanol transport to USA, international agriculture, land use change	RSF2 analysis of sugarcane ethanol	Updated land use change emissions data Updated nitrogen content of sugarcane trash based on recent literature Updated emissions factors from GREET-2021*

[5] Provisions covering biointermediates were finalized in the 2020-2022 RFS Standards final rule (87 FR 39600). Revisions to the facility specific petition process defined under 40 CFR 80.1416, finalized under this rule, now require parties to submit for EPA's consideration information related to any biointermediates used in the requested pathways.

		Updated on-farm energy use data Updated data on sources of electricity generation in Brazil (used in grid average electricity displacement accounting)
Fuel production at LanzaJet Soperton Facility	Input and output accounting based on data submitted with the petition	Uses emissions factors from GREET-2021*
Fuel distribution and use	Estimates from GREET-2021	Estimates for renewable jet fuel and renewable diesel from GREET-2021*

*Argonne National Lab's Greenhouse Gases, Regulated Emissions, and Energy use in Technologies (GREET) model.[6]

In addition to the updates noted in Table 2 above, the following assumptions have been applied consistently throughout the analysis.

Emissions Factors

In estimating emissions associated with fuel production at the LanzaJet facility, we rely on emissions factors from GREET-2021 for key process inputs – U.S. grid average electricity, small industrial boilers fired by natural gas, and liquid hydrogen. Emissions factors used for these three key process inputs are presented in Table 3 below.[7]

Table 3: Emissions Factors Used for Key Process Inputs at LanzaJet Soperton Facility

Process Input	gCO_2e / mmBtu
Grid Electricity – U.S. Average	128,879
Natural Gas – Small Industrial Boiler	72,571
Hydrogen – Natural Gas to Liquid Hydrogen	130,302

[6] GREET1-2021 Fuel Cycle Model available for download at https://greet.es.anl.gov/greet.models

[7] We also account for emissions from caustic soda (NaOH) used in the LanzaJet Soperton Process with an emissions factor from GREET-2021 of 1.68 kgCO2e/kg. These emissions have an extremely small contribution to the overall lifecycle GHG emissions.

The lifecycle GHG analyses published in the March 2010 RFS2 rule also relied on numerous emissions factors and assumptions from an older version of GREET – version 1.8c. As detailed in the RFS2 Regulatory Impact Analysis, assumptions from GREET included emissions factors for fuel and fertilizer production, fossil fuel combustion, electricity generation, and transport of agricultural inputs and fuels.[8] In order to use consistent and up-to-date assumptions across stages in our lifecycle GHG analysis of the LanzaJet Soperton Pathways, we have updated, wherever possible, the emissions factors in the 2010 RFS2 analysis of sugarcane ethanol using values in GREET-2021.[9]

Global Warming Potentials

In order to present lifecycle GHG emissions including different gasses in the common unit of carbon dioxide equivalence (CO_2e), we use estimates of the 100-year global warming potentials (GWPs) for carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) which are published in the Intergovernmental Panel on Climate Change (IPCC)'s periodic Assessment Reports. The lifecycle GHG analyses published in the March 2010 RFS2 rule used GWPs from IPCC's Second Assessment Report (SAR) which was published in 1995. More recent IPCC reports have revised the estimated GWPs of CH_4 and N_2O based on advancements in climate science. GREET-2021, on which we rely for a number of emissions factors, defaults to using GWPs from IPCC's Fifth Assessment Report (AR5) which was completed in 2014. For our lifecycle GHG analysis of the LanzaJet Soperton Pathways considered in this petition, we also adopt AR5 GWP factors, as has been done in several other lifecycle GHG analyses for RFS pathways.[10]

In our lifecycle GHG analysis of the LanzaJet Soperton Pathways, estimates of the emissions associated with distribution and use of renewable jet fuel and renewable diesel are derived from GREET-2021, which uses AR5 GWP factors by default. Estimates of emissions associated with fuel production at the LanzaJet Soperton Facility involved a straightforward application of the AR5 GWPs. For the two lifecycle analyses relied upon from the March 2010 RFS2 rule – sugarcane ethanol and baseline diesel – we have updated from SAR GWPs to AR5 GWPs throughout. The effect of using AR5 GWPs, rather than SAR GWPs, is to increase the

[8] The RFS2 final rule Regulatory Impact Analysis and other supporting documents are available on EPA's website ate https://www.epa.gov/renewable-fuel-standard-program/renewable-fuel-standard-rfs2-final-rule-additional-resources
[9] Other pathway lifecycle analyses have taken a similar approach; relying on previous feedstock production modeling while updating emissions factors with values from more recent versions of GREET. See, for example, the REG Geismar Carinata Oil Renewable Fuel Pathway Determination available on EPA's website at https://www.epa.gov/system/files/documents/2022-07/reg-geismar-carinata-deter-ltr-2022-06-30.pdf and the Canola OIL NPRM (87 FR 22827).
[10] See, for example, the REG Geismar Carinata Oil Renewable Fuel Pathway Determination available on EPA's website at https://www.epa.gov/system/files/documents/2022-07/reg-geismar-carinata-deter-ltr-2022-06-30.pdf, and the Canola Oil NPRM (87 FR 22823).

impact of changes in methane (GWP increases from 21 to 30), and to decrease the impact of changes in nitrous oxide emissions (GWP decreases from 310 to 265), in CO_2e terms.[11]

2. Biointermediate Undenatured Ethanol Produced from Sugarcane

EPA estimated GHG emissions attributable to the production of biointermediate undenatured ethanol from sugarcane using the analysis developed for the March 2010 RFS2 rule (75 FR 14670). As noted above, this analysis was updated to use AR5 GWPs and emissions factors from GREET-2021 wherever possible. Several other revisions are detailed below.

The RFS2 analysis of sugarcane ethanol included multiple scenarios using differing assumptions about sourcing of sugarcane ethanol. For this analysis of the LanzaJet Soperton Pathways we use the conservative "no trash collection" scenario in which no sugarcane trash is collected for additional biomass electricity generation.[12] We use the "No CBI" scenario assumptions from the RFS2 analysis, which assumes ethanol is sourced directly from Brazil, rather than through the Caribbean Basin Initiative (CBI).[13]

Finally, the analysis of sugarcane ethanol accompanying the RFS2 final rule included lifecycle emissions calculations under two different assumptions about which sources of electricity in Brazil are displaced by the electricity cogenerated at ethanol production facilities through the burning of sugarcane bagasse – either marginal or grid average electricity. For this determination, we consider several different methods of accounting for cogenerated electricity and the resulting range in lifecycle emissions reductions. Our treatment of this aspect of the analysis is discussed in detail below.

GHG Impacts of Land Use Change

Land use change GHG emissions were estimated following the methodology developed for the March 2010 RFS2 rule, with the following updates to use the most recent data applied in EPA rulemaking analyses after opportunity for notice and public comment. Assumed forest carbon stocks were updated in the regions of Latin America, sub-Saharan Africa, and South and Southeast Asia based on data from Saatchi et al. (2011).[14] Assumed forest carbon stocks were updated in the European Union based on data from Gallaun et al. (2010).[15] Data on carbon

[11] The IPCC's Fifth Assessment Report included a range of 100-year GWP values for CH_4, which depend on whether methane oxidation and climate feedback effects are considered. For this analysis, we use a 100-year GWP value of 30 for methane emissions, which is the default GWP in GREET-2021.
[12] This assumption is "conservative" because when we evaluated ethanol production with trash collection the estimated GHG emissions were lower due additional electricity export from ethanol production facilities.
[13] Data from the United States International Trade Commission indicate that ethanol imports through the CBI have declined since 2010, while imports of ethanol from Brazil have been increasing. Furthermore, according to EMTS data, 99% of the sugarcane ethanol which generated RINs under the RFS program since 2015 was produced in Brazil.
[14] Saatchi, S. S., et al. (2011). "Benchmark map of forest carbon stocks in tropical regions across three continents." Proceedings of the National Academy of Sciences 108(24): 9899-9904.
[15] Gallaun, H., et al. (2010). "EU-wide maps of growing stock and above-ground biomass in forests based on remote sensing and field measurements." Forest Ecology and Management 260(3): 252-261.

sequestered in harvested hardwood products (HWP) were also updated relative to the March 2010 RFS2 rule analysis, based on the approved Verified Carbon Standard methodology for estimation of carbon stocks in the long-term wood products pool.[16] Updates to assumptions on both forest carbon stock and harvested wood products were detailed in the January 2012 Palm Oil NODA (77 FR 4309)[17] and have been used in several subsequent EPA analyses after opportunity for notice and public comment.[18]

The analysis for the March 2010 RFS2 rule produced a mean estimate for land use change GHG emissions of 5.35 $kgCO_2e$ per mmBtu ($kgCO_2e$/mmBtu) of sugarcane ethanol, where methane and nitrous oxide emissions were weighted using SAR GWPs. Based on the forest carbon stock and HWP data updates described above, the updated mean estimate is 2.84 $kgCO_2e$/mmBtu. This lower estimate is a result of the data updates described above and a calculation error that we identified whereby 1.0 $kgCO_2e$/mmBtu of land use change emissions in the United States were double counted in the sugarcane ethanol analysis for the March 2010 RFS2 rule.[19] As discussed above, evaluations of LanzaJet's petition have been completed using AR5 GWPs. Updating from SAR to AR5 GWPs reduces estimated land use change emissions from 2.84 $kgCO_2e$/mmBtu to 2.76 $kgCO_2e$/mmBtu.[20]

Nitrogen Content of Sugarcane Crop Residues

We have revised an assumption in the March 2010 RFS2 rule's analysis of sugarcane ethanol for the nitrogen content of sugarcane crop residues (i.e., "sugarcane trash"). Based on peer review comments on the RFS2 proposal, in the final 2010 analysis EPA accounted for "crop residue N_2O emissions from sugarcane production based on perennial grass as a proxy." This value for the nitrogen content of perennial grasses was taken from a 2006 IPCC report.[21] In our analysis for this determination, we instead use a nitrogen content value specific to sugarcane from GREET-2021.

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[16] Verified Carbon Standard (VCS) methodology module VMD0005: Estimation of carbon stocks in the long-term wood products pool (CP–W), Sectoral Scope 14, http://www.v-c-s.org/methodologies/find.

[17] Harris, N.L. 2011. Revisions to Land Conversion Emission Factors since the RFS2 Final Rule. Report submitted to EPA. EPA-HQ-OAR-2011-0542-0058

[18] December 2012 Grain Sorghum Ethanol rule (77 FR 74596), July 2013 Barley Notice (78 FR 44075), October 2015 Jatropha Oil Notice (80 FR 61406), July 2015 Sugar Beets Notice (82 FR 34656), April 2022 Canola Oil Pathways NPRM (87 FR 22823)

[19] Without this calculation error the land use change GHG estimates for the March 2010 RFS2 rule would have been 4.3 $kgCO_2e$/mmBtu, which would have had no impact on our 2010 determination that sugarcane ethanol satisfies the 50 percent GHG reduction threshold.

[20] The approach developed for the March 2010 RFS2 rule also considered the uncertainty in the international land use change GHG estimates to produce a 95% confidence interval. This uncertainty analysis considered two major components: 1) uncertainty in the classification of land transitions with satellite data to determine the types of land affected by changes in cropland and pasture area in each region, and 2) uncertainty in the emissions factors used to translate the land conversions to GHG emissions. As we have done in past analyses for facility specific petitions, we rely on the mean land use change emission estimate from the 2010 methodology for the purposes of threshold determination. This approach was discussed in further detail in the March 2010 RFS2 final rule.

[21] 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 4, Chapter 11: N_2O Emissions from Managed Soils, and CO2 Emissions from Lime and Urea Application

Table 4 below compares estimates of nitrogen content of sugarcane trash from several studies, GREET-2021, and the proxy value used in the RFS2 2010 assessment. None of the studies reviewed support using the higher value for perennial grasses from the IPCC report as a proxy for sugarcane trash. Given our general reliance on GREET for data and emissions factors in lifecycle GHG assessments for the RFS program, and the fact that the GREET assumption falls well within the range of estimates found in the literature, we adopt the value from GREET-2021 in all regions. As a result of these updates, we estimate N_2O emissions of 10.3 kgCO_2e/mmBtu sugarcane ethanol, whereas the 2010 RFS2 rule estimate was 29.3 kgCO_2e/mmBtu sugarcane ethanol.[22]

Table 4: Estimates of Nitrogen Content of Sugarcane Trash (percent dry mass)

Source	Notes	Sugarcane trash nitrogen content
RFS2 2010	Uses IPCC 2006 value for perennial grass as a proxy	1.5
GREET-2021		0.53
Other estimates from literature		
Macedo 2007[23]	See Table 3	0.371
Trivelin et al. 2013[24]		0.4
Carvalho et al. 2017[25]		0.44 - 0.54
Suma, R & Savitha, CM 2015[26]	Average of 2008-2010 harvest seasons	0.51
Seabra et al. 2011[27]	See Table 3	0.6

Non-USA On-Farm Energy Use

We also updated our estimates of the GHG emissions associated with changes in foreign on-farm energy use, which is explained in the April 2022 Canola Oil Pathways NPRM (87 FR

[22] The estimated 10.3 kgCO_2e of N_2O emissions per mmBtu of sugarcane ethanol are the unallocated emissions which are used in the electricity displacement cases considered below. When we consider the energy allocation approach to accounting for cogenerated electricity, a portion of these N_2O emissions is allocated to the cogenerated electricity.

[23] Macedo, I.C., 2007. Sugar Cane's Energy: Twelve studies on Brazilian sugar cane agribusiness and its sustainability, 2nd ed. UNICA

[24] Trivelin, Paulo & Franco, Henrique & Otto, Rafael & Ferreira, Danilo & Vitti, André & Fortes, Caio & Faroni, Carlos Eduardo & Oliveira, Emídio & Cantarella, Heitor, 2013. Impact of sugarcane trash on fertilizer requirements for São Paulo, Brazil. Scientia Agricola. 70. 345-352. https://doi.org/10.1590/S0103-90162013000500009.

[25] Carvalho, J.L.N., Nogueirol, R.C., Menandro, L.M.S., Bordonal, R.d.O., Borges, C.D., Cantarella, H. and Franco, H.C.J., 2017. Agronomic and environmental implications of sugarcane straw removal: a major review. GCB Bioenergy, 9: 1181-1195. https://doi.org/10.1111/gcbb.12410

[26] Suma R, Savitha CM, 2015. Integrated Sugarcane Trash Management: A Novel Technology for Sustaining Soil Health and Sugarcane Yield. Adv Crop Sci Tech 3: 160. doi:10.4172/2329-8863.1000160

[27] Seabra, J.E.A., Macedo, I.C., Chum, H.L., Faroni, C.E., Sarto, C.A., 2011. Life cycle assessment of Brazilian sugarcane products: GHG emissions and energy use. Biofuels, Bioproducts and Biorefining 5, 519–532.

22834-22835).[28] This update results in estimated emissions from international agriculture of 20.4 kgCO_2e/mmbtu of renewable jet fuel and renewable diesel, whereas without this update those emissions are 19.5 kgCO_2e/mmbtu.

Cogeneration of Electricity from Sugarcane Bagasse

Sugarcane bagasse is a byproduct of the sugarcane ethanol production process and is typically burned to generate electricity. This cogenerated electricity is used to power the ethanol production facility, and any surplus electricity is sold to the Brazilian electrical grid.

There are several methods commonly used to account for coproducts in GHG analyses of renewable fuels. As explained below, in the analyses of sugarcane ethanol accompanying the 2010 RFS2 rule, EPA considered two different accounting methods based on displacement of existing Brazilian electricity generation. In other past determinations, EPA has considered accounting for the emissions associated with coproducts via multiple methods, including displacement and allocation by energy or mass.[29] In general, demonstrating that a renewable fuel would meet the applicable lifecycle GHG emissions reduction threshold using a range of different coproduct accounting methods, including methods that may have more conservative assumptions, increases our confidence in that threshold determination. For our lifecycle GHG analysis of these particular pathways, we consider the following accounting approaches: the two displacement methods considered in the 2010 RFS2 analysis of sugarcane ethanol, and energy allocation.

The analysis of sugarcane ethanol accompanying the 2010 RFS2 final rule included lifecycle emissions calculated under two different methods of accounting for the electricity cogenerated at ethanol facilities through the burning of sugarcane bagasse; displacement of marginal grid electricity, and displacement of Brazilian grid average electricity. For the marginal displacement approach, we maintain the assumption used in the 2010 RFS2 analysis that thermal plants using natural gas are the marginal source of electricity in Brazil, and that electricity produced from sugarcane bagasse displaces an equivalent amount of electricity generated from natural gas. For the grid average displacement approach, we update the average mix of sources of electricity generation assumed to be displaced using recent data on Brazilian electricity generation.[30] For both displacement approaches, we use factors from GREET-2021 and AR5 GWPs to estimate CO_2e emissions displaced by the cogenerated electricity. Emissions factors from the 2010 analysis and updated factors are presented in Table 5 below.

[28] Data and estimates are available on the docket: "Canola RD Intl Ag Energy GHG NPRM v2" (EPA-HQ-OAR-2021-0845-0014).
[29] See, for example, the REG Geismar Carinata Oil Renewable Fuel Pathway Determination available on EPA's website at https://www.epa.gov/system/files/documents/2022-07/reg-geismar-carinata-deter-ltr-2022-06-30.pdf
[30] See Table 2.3 from Empresa de Pesquisa Energética's 2021 Annual Electrical Energy Statistics report, available at https://www.epe.gov.br/pt/publicacoes-dados-abertos/publicacoes/anuario-estatistico-de-energia-eletrica.

Table 5: Estimates of Brazilian Electricity Emissions Factors (kgCO$_2$e/mmbtu)

	2010 RSF2 Estimate	Updated Estimate
Brazilian Grid Average Electricity	1.6	2.2
Marginal Brazilian Electricity (natural gas)	13.3	13.4

In the "no trash collection" scenarios included in the 2010 RFS2 analysis, sugarcane ethanol production facilities are assumed to sell 40 kWh of surplus electricity per metric ton of sugarcane processed. Using this assumption, 7% of the output energy of Brazilian ethanol facilities is sold electricity and 93% is sugarcane ethanol. Thus 7% of the emissions upstream of sugarcane ethanol production, including international agriculture and land use change emissions, are allocated to the electricity output, rather than the sugarcane ethanol used in the LanzaJet Soperton Pathway. The resulting GHG emissions of the energy allocation approach are presented alongside the displacement approaches in Section III.A.5 below.

Transportation

In the analysis of sugarcane ethanol for the March 2010 rule, emissions associated with transportation of feedstock sugarcane and of ethanol from Brazilian ethanol production facilities to U.S. retail filling stations were estimated using emissions factors from GREET and assumed distances and modes of transportation used on different legs. For this LanzaJet evaluation, we rely on the same 2010 analysis, with updates to distance and mode assumptions based on the facility-specific information included in the pathway petition. For the estimated emissions associated with transporting feedstock sugarcane from fields to ethanol producing facilities, and from production facilities to Brazilian ports, we maintain the transportation mode and distance assumptions used in the 2010 analysis, resulting in an emissions estimate of 1.8 kgCO$_2$e/mmBtu sugarcane ethanol produced. In the March 2010 analysis, emissions associated with transporting ethanol from Brazilian ports to U.S. ports was based on an estimate of average travel distance across a range of different ocean tanker routes. For the LanzaJet evaluation, we assume ethanol is transported via ocean tanker from the port of Santos in Brazil to the U.S. port of Savannah, an estimated shipping distance of 5,626 miles.[31] The March 2010 analysis also estimated the emissions associated with transporting sugarcane ethanol from U.S. ports to retail fueling stations. For ethanol transport within the U.S. we assume truck transportation from the port in Savannah, Georgia to the LanzaJet Soperton Facility near Soperton, Georgia – roughly 100 miles. The updated ethanol transportation emissions are 2.2 kgCO$_2$e/mmBtu sugarcane ethanol, whereas the value in the March 2010 rule was 2.6 kgCO$_2$e/mmBtu.

3. Renewable Jet Fuel and Renewable Diesel Production

LanzaJet provided mass and energy balance data, based on process-engineering modeling, for renewable jet fuel and renewable diesel produced at LanzaJet Soperton Facility. This facility

[31] 5,626 miles is equivalent to 4,889 nautical miles, which we estimate to be the ocean tanker distance using https://sea-distances.org/.

uses a process of dehydration, oligomerization, and hydrotreating to convert undenatured ethanol into renewable jet fuel and renewable diesel. The facility uses grid electricity, natural gas, and hydrogen as process inputs. Emissions from the use of grid electricity, natural gas, and hydrogen are estimated using the emissions factors from GREET-2021 presented in Table 3 in Section III.A.1 above. The LanzaJet Soperton Process does not produce any coproducts; the only outputs considered in this analysis are renewable jet fuel and renewable diesel. The LanzaJet Soperton Process simultaneously produces both renewable jet fuel and renewable diesel as process outputs. As these two fuels are co-produced from the same inputs and processes, we do not separately assess GHG emissions for the production of each fuel; we estimate the average production emissions for the combined energy content of the output of both fuels using process output data provided by LanzaJet (i.e., we allocate emissions by the energy content of the fuels produced).[32] Based on LanzaJet's reported process parameters and data, the total lifecycle GHG emissions for the fuel production stage, excluding upstream emissions for the production and transport of sugarcane ethanol, are 16.3 kg CO_2e/mmBtu of combined renewable jet fuel and renewable diesel.[33]

4. Fuel Distribution and Use

In the GHG lifecycle analyses of renewable fuels in the 2010 RFS2 rulemaking, emissions associated with the distribution of renewable fuels were estimated based on transportation and distribution data in GREET version 1.8c. As discussed in Section III.A.1, for this analysis we use data and assumptions from GREET-2021 to estimate the GHG emissions associated with transporting the renewable diesel and jet fuel produced at the LanzaJet Soperton Facility. The renewable diesel and jet fuel are assumed to be transported by truck, rail, and barge. To estimate fuel use emissions, we applied non-CO_2 fuel use GHG emissions factors from GREET-2021.[34] For renewable diesel, we used the factors for renewable diesel used in a compression ignition direct injection vehicle. For renewable jet fuel, we used the factors for hydrotreated renewable jet fuel consumed in a single aisle passenger aircraft. The combined distribution emissions and non-CO_2 fuel use emissions are roughly 0.5 kgCO_2e/mmbtu for both renewable jet fuel and renewable diesel.

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[32] See discussion of allocation by energy content of co-produced, RIN-generating fuels in the *Regulation of Fuels and Fuel Additives: Identification of Additional Qualifying Renewable Fuel Pathways Under the Renewable Fuel Standard Program* ("Pathways I") final rule (78 FR 14198-14200).

[33] LanzaJet additionally requested consideration of the use of hydrogen produced via electrolysis from purchased electricity, rather than purchased liquid hydrogen. Based on an assumption of grid average electricity use and data provided by LanzaJet on expected electrolysis efficiency, use of hydrogen produced on-site via electrolysis would not impact our GHG lifecycle analysis significantly enough to affect our determination that the LanzaJet Soperton Pathways would meet the 50% reduction threshold for biomass-based diesel.

[34] Following the methodology developed for the March 2010 RFS2 rule after notice, public comment, and peer review, the carbon in the finished fuel derived from renewable biomass is treated as biologically derived carbon originating from the atmosphere. In the context of a full lifecycle analysis, the uptake of this carbon from the atmosphere by the renewable biomass and the CO2 emissions from combusting it cancel each other out. Therefore, instead of presenting both the carbon uptake and tailpipe CO2 emissions, we leave both out of the results. Note that our analysis also accounts for all significant indirect emissions, such as from land use changes, meaning we do not simply assume that biofuels are "carbon neutral."

5. Lifecycle GHG Results

Based on our analysis of the full fuel lifecycle for the LanzaJet Soperton Pathways, described above, we estimate the lifecycle GHG emissions associated with jet fuel and renewable diesel produced through the LanzaJet Soperton Pathways. Table 6 shows the lifecycle GHG emissions of renewable jet fuel and renewable diesel produced from undenatured sugarcane ethanol, along with the corresponding net emissions and percent reductions. We report estimates for three different methods of accounting for surplus electricity generated at ethanol production facilities: displacement of marginal grid electricity, displacement of average grid electricity, and energy allocation.

To determine if these fuels satisfy the GHG reduction requirements, we compared the lifecycle GHG emissions for jet fuel and renewable diesel produced through the LanzaJet Soperton Pathways to the statutory 2005 average diesel baseline. For the 2005 diesel baseline we use the lifecycle GHG emissions estimated in the 2010 RFS2 rule. We updated this estimate to use AR5 GWPs for consistency with the analysis of the LanzaJet Soperton Pathways, but otherwise make no alterations. Emissions for the 2005 diesel baseline and percent reductions relative to this baseline are also presented in Table 6.

Table 6: Lifecycle GHG Emissions of Renewable Jet Fuel and Renewable Diesel Produced from Sugarcane Ethanol through the LanzaJet Soperton Process ($kgCO_2e/mmBtu$)[35]

Emissions Category	2005 Diesel Baseline	Cogenerated Electricity Accounting Method: Energy Allocation	Grid Average Displacement	Marginal Displacement
Domestic agriculture	18.0	0.0	0.0	0.0
International agriculture		19.0	20.4	20.4
Land use change		2.6	2.8	2.8
Sugarcane transport		1.7	1.8	1.8
Ethanol production		2.2	0.2	-11.0
Ethanol transport to LanzaJet facility		2.2	2.2	2.2
Fuel production at LanzaJet facility		16.3	16.3	16.3
Downstream & use	79.7	0.5	0.5	0.5
Net emissions	97.7	44.5	44.2	33.0
% GHG reduction relative to baseline	-	54%	55%	66%

B. Application of the Criteria for Petition Approval

LanzaJet provided all the necessary information that was required for this type of petition request. Based on the data submitted and information already available through analyses

[35] Note that lifecycle GHG emissions estimates for renewable jet fuel and renewable diesel are identical for all emissions categories except for fuel distribution and use. When presented in kgCO2e/mmbtu and rounded to one decimal place, as is presented in Table 6, estimates are identical in all categories.

conducted for previous RFS rulemakings, EPA conducted a lifecycle assessment of jet fuel and renewable diesel produced through the LanzaJet Soperton Pathways. The purpose of this analysis was to determine whether these fuel pathways satisfy the statutory 50 percent GHG reduction threshold under the RFS program for biomass-based diesel. For all of the cogenerated electricity accounting methods considered, renewable diesel and jet fuel produced from sugarcane ethanol through the LanzaJet Soperton Process exceed the CAA 50% GHG reduction threshold of the biomass-based diesel category of renewable fuel.

Based on the analyses described above, EPA has determined that the renewable jet fuel and renewable diesel produced through the LanzaJet Soperton Pathways meet the 50% lifecycle GHG threshold requirement specified under the CAA for biomass-based diesel. These lifecycle GHG results justify authorizing the generation of D-code 4 RINs for renewable jet fuel and renewable diesel produced through the LanzaJet Soperton Pathways, provided the fuel satisfies all of the associated regulatory requirements, including requirements related to biointermediates and the conditions specified in Section IV of this determination.

IV. Conditions and Associated Regulatory Provisions

EPA's approval of the LanzaJet Soperton Pathways is predicated on the circumstances and analysis described in this document. In order to ensure that renewable fuel produced through these Pathways is produced in a manner consistent with those circumstances and analysis, we are prescribing certain conditions as described below. The authority for LanzaJet to generate RINs for renewable fuel produced through the LanzaJet Soperton Pathways is expressly conditioned on LanzaJet satisfying all of the following conditions as detailed in this section, in addition to the other applicable requirements for renewable fuel producers set forth in the RFS regulations.

The conditions in this section are enforceable under the CAA. They are established pursuant to the informal adjudication reflected in this decision document, and also pursuant to any regulations cited below and 40 CFR 80.1426(a)(1)(iii), 40 CFR 80.1416(b)(1)(vii), 80.1450(i), and 80.1451(b)(1)(ii)(W). In addition or in the alternative to bringing an enforcement action under the CAA, EPA may revoke this pathway approval if it determines that LanzaJet has failed to comply with any of the conditions specified herein. EPA has authority to bring an action to enforce these conditions under 40 CFR 80.1460(a), which prohibits producing or importing a renewable fuel without complying with the RIN generation and assignment requirements. These conditions are also enforceable under 40 CFR 80.1460(b)(2), which prohibits creating a RIN that is invalid; a RIN is invalid if it was improperly generated. Additionally, pursuant to 40 CFR 80.1460(b)(7) generating a RIN for fuel that fails to meet all of the conditions set forth in this petition determination is a prohibited act. In other words, unless all of the conditions specified in this section are satisfied, fuel cannot be validly produced through the pathway approved in this document.

As described in the 2020-2022 RFS Standards final rule (87 FR 39600) and pursuant to 40 CFR 80.1401, undenatured ethanol is a biointermediate and LanzaJet and the undenatured ethanol producer must comply with all applicable requirements for the production, transfer, and use of undenatured ethanol as a biointermediate under 40 CFR part 80, subpart M. This pathway petition approval does not alter or modify any requirement related to the production, transfer, and use of undenatured ethanol as a biointermediate. LanzaJet must adhere to the general RIN generation, registration, recordkeeping, and reporting requirements in 40 CFR Part 80, Subpart M that apply to renewable fuel producers, including the requirements for renewable fuel producers producing fuel from biointermediates.

EPA may modify these, or place additional, conditions in the future as it deems necessary and appropriate to ensure that fuel produced pursuant to the LanzaJet Soperton Pathways meets all applicable statutory requirements, including the required lifecycle GHG reductions, as well as to make the conditions align with any future changes to the RFS regulations. If EPA makes any changes to the conditions noted in this document for fuel produced pursuant to the LanzaJet Soperton Pathways the Agency will explain such changes in a public determination letter, similar to this one, and specify in that letter the effective date for any such changes.

A. Definitions

For the purposes of this petition approval, we define the following terms, in addition to terms defined under 40 CFR 80.1401:

a. *LanzaJet Soperton Process* means the process of producing renewable diesel and jet fuel from undenatured sugarcane ethanol at the LanzaJet Soperton Facility through dehydration, oligomerization, and hydrotreating using grid electricity, natural gas, and hydrogen as process inputs, as described in the June 2021 petition request submitted for that facility.

b. *Used for fuel operations* means energy or other process inputs used in all buildings or other areas at the LanzaJet Soperton Facility that are used in any part for the storage and/or processing of biointermediate undenatured ethanol, the production and/or storage of fuel intermediates, the production and/or storage of finished fuel, and the handling of undenatured ethanol, fuel, and wastes.

B. RIN Generation, Registration, Reporting, and Recordkeeping Requirements

LanzaJet must adhere to the general RIN generation, registration, recordkeeping, and reporting requirements in 40 CFR Part 80, Subpart M that apply to renewable fuel producers, whether producing under a generally applicable pathway or a pathway approved through the petition process at 40 CFR 80.1416, including the requirements for renewable fuel producers producing fuel from biointermediates. These requirements are found at 40 CFR 80.1426 for RIN generation, 40 CFR 80.1450 for registration, 40 CFR 80.1451 for reporting, and 40 CFR 80.1454 for recordkeeping.[36]

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[36] Included in these requirements are provisions for co-processing and simultaneous conversion, which may apply if ethanol derived from different feedstocks is used. Since this determination letter only evaluates a single pathway involving ethanol from sugarcane, this letter does not cover complying with co-processing or simultaneous conversion provisions in detail. If LanzaJet plans to commingle ethanol from different sources, it will need to show how it will comply with these requirements prior to EPA accepting its registration to produce renewable fuel.

In addition, LanzaJet must produce monthly records of their production process inputs and outputs described in Table 7 below. LanzaJet must maintain these records for at least 5 years from the date they were created, consistent with 40 CFR 80.1454(s)(1). Additionally, at each three-year registration update under 40 CFR 80.1450(d)(3) LanzaJet must submit copies of these records to EPA in the following forms: monthly totals, annual totals, and the totals over the entire time period since LanzaJet's most recent registration or three-year registration update.

Table 7: Processing Inputs and Outputs

Description	Measurement
Undenatured sugarcane ethanol used for fuel operations	Measured by volume, adjusted to 0% water content, adjusted to 60°F as described in 40 CFR 80.1426(f)(8), and converted to energy units using a lower heating value (LHV) of 76,330 Btu/gal and density of 2,988 g/gal.
Natural gas used for fuel operations	Measured in accordance with API MPMS 14.3.1-4 or API MPMS 14.12 and converted to energy units using a LHV of 983 Btu/scf or as measured in accordance with ASTM D7164 (including sections 9.2, 9.3, 9.4, 9.5, 9.7, 9.8, and 9.11 of ASTM D7164).
Hydrogen used for fuel operations	Measured in accordance with API MPMS 14.3.1-4, API MPMS 14.12, or other standard approved at registration. The measurement must be converted to energy units using a LHV of 290 Btu/scf or as measured in accordance with ASTM D7164 (including sections 9.2, 9.3, 9.4, 9.5, 9.7, 9.8, and 9.11 of ASTM D7164).
Grid electricity used for fuel operations	Measured in either kWh or Btu, where 1 kWh is assumed to be equivalent to 3,412 Btu.
Output renewable jet fuel	Measured in volume, temperature corrected to 60°F as described in 40 CFR 80.1426(f)(8), and converted to energy units using a lower heating value (LHV) of 116,000 Btu/gal or as determined through laboratory testing as described in 40 CFR 80.1415(c)(2)(i) and density as determined using a method specified at 40 CFR 1090.1337(d)(1).
Output renewable diesel	Measured in volume, temperature corrected to 60°F as described in 40 CFR 80.1426(f)(8), and converted to energy units using a lower heating value (LHV) of 123,500 Btu/gal or as determined through laboratory testing as described in 40 CFR 80.1415(c)(2)(i) and density as determined using a method specified at 40 CFR 1090.1337(d)(1).

C. Equivalence Value

Renewable Jet Fuel

EPA is conditioning this pathway approval on LanzaJet submitting a new equivalence value application for renewable jet fuel produced under the LanzaJet Soperton Process within 60 days of operation of the LanzaJet Soperton Facility. The regulations at 40 CFR 80.1415 do not include an equivalence value for renewable jet fuel, and producers of renewable jet fuel must therefore submit an equivalence value application under 40 CFR 80.1415(c) to establish an equivalence value. LanzaJet included an application for an equivalence value for its renewable jet fuel in its pathway petition. In its equivalence value application, LanzaJet requested an equivalence value of 1.6 based on test results for a sample collected at a pilot plant from 2016. Based on the information LanzaJet submitted, the requested equivalence value of 1.6 for the renewable jet fuel sampled and tested is consistent with the regulatory requirements for the establishment of a new equivalence value of 1.6 under 40 CFR 80.1415(c). However, EPA has concerns that the renewable jet fuel produced, sampled, and tested at the pilot plant may not be representative of the renewable jet fuel produced at the LanzaJet Soperton Facility. Therefore, in order to ensure that the requested 1.6 equivalence value is appropriate for the renewable jet fuel produced at the LanzaJet Soperton Facility, EPA is temporarily approving LanzaJet's equivalence value submission under 40 CFR 80.1415(c) and conditioning this pathway approval on LanzaJet resubmitting a new equivalence value submission under 40 CFR 80.1415(c) within 60 days of operation of the LanzaJet Soperton Facility. The temporary approval of LanzaJet's equivalence value application will expire 60 days after the LanzaJet Soperton Facility is operational. Before the expiration date, LanzaJet should submit a new equivalence value application under 40 CFR 80.1415(c) based on test results of a representative sample of renewable jet fuel produced from the LanzaJet Soperton Facility. EPA will then evaluate the new equivalence value application and assign a permanent equivalence value for LanzaJet's renewable jet fuel.

Renewable Diesel

In LanzaJet's pathway petition, LanzaJet supplied test results for a sample of renewable diesel produced at a pilot plant that indicated that the sampled renewable diesel had a lower heating value of at least 123,500 BTUs per gallon; these results are intended to show that renewable diesel produced at the LanzaJet Soperton Facility qualifies for an equivalence value of 1.7 under 40 CFR 80.1415(b)(4). However, EPA has concerns that the renewable diesel produced, sampled, and tested at the pilot plant may not be representative of the renewable diesel produced at the LanzaJet Soperton Facility and thus may not qualify for the 1.7 equivalence value for renewable diesel under 40 CFR 80.1415(b)(4). Therefore, to ensure that the renewable diesel produced at the LanzaJet Soperton Facility qualifies for the 1.7 equivalence value, LanzaJet would be expected to submit in its registration submission to EPA a certificate of analysis for a representative sample of renewable diesel produced from the facility that demonstrates that the renewable diesel has a lower heating value of at least 123,500 BTUs per gallon.

V. Public Participation

The definition of advanced biofuel in CAA 211(o)(1)(B) specifies that the term means "renewable fuel . . . that has lifecycle greenhouse gas emissions, as determined by the Administrator, after notice and opportunity for comment, that are at least 50 percent less than the baseline lifecycle greenhouse gas emissions." As part of the March 2010 RFS2 rule (75 FR 14670), we took public comment on our lifecycle assessment of the production of ethanol from sugarcane, including all models used and all modeling inputs and evaluative approaches. As part of the 2020-2022 RFS Standards proposed rule, we took public comment broadly on the biointermediates provisions (see 86 FR 72467) including on the use of undenatured ethanol as a biointermediate input to new pathways under the RFS program. Our consideration of the implications of the use of biointermediates on lifecycle GHG assessments is discussed in the 2020-2022 RFS Standards final rule at 87 FR 39649-51. As part of the March 2010 RFS2 rule and the March 2013 RFS2 rule (78 FR 14190) we took public comment on our lifecycle assessment of renewable diesel and jet fuel pathways, including the emissions associated with the distribution and use of these fuels. Thus, we have provided notice and opportunity to comment on the lifecycle analysis methodology, feedstock, type of biointermediate and types of fuel included in the LanzaJet Soperton Pathways.

In the March 2010 RFS2 rule we acknowledged that it was unlikely that our final regulations would address all possible qualifying fuel production pathways. After considering comments, we finalized the current petition process at 40 CFR 80.1416, where we allow for EPA approval of certain petitions without going through additional rulemaking if we can do so as a reasonably straightforward extension of previous assessments, whereas rulemaking would typically be conducted to respond to petitions requiring new modeling. See 75 FR 14797 (March 26, 2010).

In responding to this petition, we have relied on the same methodology and much of the same modeling that we conducted for the March 2010 RFS2 rule for evaluating GHG emissions associated with sugarcane ethanol. This prior modeling has been paired with a straightforward analysis of LanzaJet's process data. Adjustments specific to this facility-specific pathway analysis considered information contained in the LanzaJet petition and other scientific information as described above. For example, changes to sugarcane cultivation assumptions described in Section III of this determination document were straightforward revisions to values in post processing of modeling completed for the March 2010 RFS2 rule. Thus, the fundamental analyses relied on for this decision have been made available for public comment as part of previous rulemakings. Our approach today is also consistent with the petition process for new RFS fuel pathways at 40 CFR 80.1416, which was established in the March 2010 RFS2 rule after notice and public comment.

VI. Conclusion

Based on our evaluation, jet fuel and renewable diesel produced from undenatured sugarcane ethanol through the LanzaJet Soperton Process are eligible for biomass-based diesel (D-code 4) RINs, provided all associated regulatory requirements and the conditions specified in Section IV of this determination document are satisfied, and the fuel meets the other definitional criteria for renewable fuel (e.g., produced from renewable biomass, and used to reduce or replace the quantity of fossil fuel present in transportation fuel, heating oil or jet fuel) specified in the CAA and EPA implementing regulations.

This approval applies specifically to LanzaJet, Inc. and to the LanzaJet Soperton Process.[37] This approval is effective as of signature date. RINs may only be generated for renewable fuel produced through the LanzaJet Soperton Pathways that is produced after the date of activation of the registration for this new pathway.[38]

The OTAQ Reg: Fuels Programs Registration and OTAQ EMTS Application will be modified to allow LanzaJet to register and generate D-code 4 RINs for jet fuel and renewable diesel produced using a production process of "LanzaJet Soperton Process" from undenatured sugarcane ethanol.

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[37] As with all pathway determinations, this approval does not convey any property right of any sort, or any exclusive privilege.

[38] A fuel pathway is activated under the RFS program when EPA accepts the registration application for the pathway, allowing it to be used in EMTS for RIN generation. When EPA accepts a registration application, an email is automatically sent from otaqfuels@epa.gov to the responsible corporate officer (RCO) of the company that submitted the registration application. The subject line of such an email includes the name of the company and the company request (CR) number corresponding with the registration application submission, and the body of the email says the company request "has been activated."