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

June 30, 2022

OFFICE OF
AIR AND RADIATION

Mr. Ezra Finkin
Senior Manager
Corporate Affairs & Development
Renewable Energy Group.
416 South Bell Avenue
Ames, Iowa 50010

Dear Mr. Finkin:

Renewable Energy Group (REG) 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 and advanced biofuel (D-code 5) RINs for renewable naphtha and liquefied petroleum gas (LPG) produced from carinata oil through a hydrotreating process using natural gas and grid electricity for process energy at your facility in Geismar, LA (the "REG Geismar Carinata Pathways").

Through the petition process described under 40 CFR 80.1416, REG submitted data to EPA to perform a lifecycle greenhouse gas analysis of fuels produced through the REG Geismar Carinata Pathways. Relevant to our evaluation of these pathways, in April 2015 we published a Federal Register Notice inviting comment on our analysis of the greenhouse gas (GHG) emissions attributable to the production and transport of *Brassica carinata* seed oil ("carinata oil") feedstock for use in making biofuels such as renewable diesel and jet fuel (the "Carinata FRN") (80 FR 22996). Compared to the Carinata FRN, our evaluation of the REG Geismar Carinata Pathways considers more recent information on the emissions associated with carinata production based on the comments received in response to the FRN, and data provided by the REG petition.

Based on our assessment, renewable diesel and jet fuel produced through the REG Geismar Carinata Pathways qualify under the Clean Air Act (CAA) for D-code 4 RINs, and renewable naphtha and LPG produced through the REG Geismar Carinata Pathways qualify under the CAA for D-code 5 RINs, assuming the fuel meets the definitional and other 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 the REG Geismar production facility and to the processes, materials used, fuels produced, and process energy types and amounts described in the March 2017 petition request submitted by REG for their Geismar facility.

The EPA fuels program electronic registration and transaction system applications will be modified to allow REG to register and generate D-code 4 RINs for renewable diesel and renewable jet fuel, and D-code 5 RINs for renewable naphtha and renewable LPG produced from carinata oil through the REG Geismar Process.

Sincerely,

SARAH DUNHAM

Digitally signed by SARAH DUNHAM
Date: 2022.06.30 08:07:06 -04'00'

Sarah Dunham, Director
Office of Transportation and Air Quality

Enclosure

REG Geismar Carinata Oil Renewable Fuel Pathway Determination
under the RFS Program
Office of Transportation and Air Quality

Summary: Renewable Energy Group, Inc. (REG) petitioned the Agency to approve a pathway for the generation of D-code 4 renewable identification numbers (RINs) for renewable diesel and jet fuel, and D-code 5 RINs for renewable naphtha and LPG produced from carinata oil through a hydrotreating process. The fuel production process occurs at REG's facility in Geismar, LA (the "REG Geismar Process"). We refer to the entire set of steps, feedstocks, processes, and related conditions that as the "REG Geismar Carinata Pathways".

In April 2015, EPA published a Federal Register Notice inviting comment on our analysis of the greenhouse gas (GHG) emissions attributable to the production and transport of *Brassica carinata* seed oil ("carinata oil") feedstock for use in making biofuels such as biodiesel, renewable diesel, and jet fuel (the "Carinata FRN") (80 FR 41033). In the Carinata FRN, we invited comment on our intention to apply the estimated upstream GHG emissions associated with soybean oil feedstock production and transport, including indirect agricultural and forestry sector impacts,[1] to future evaluations of facility-specific petitions proposing to use carinata oil as a feedstock for biofuel production. In doing so, we explained that we believed new agricultural sector modeling was not needed to evaluate the lifecycle GHG impacts of using carinata oil as biofuel feedstock because of the similarities between carinata oil and soybean oil, the fact that carinata was not expected to have significant land use change impacts, and because we believed every component of the agricultural sector GHG emissions from carinata oil production were less than or equivalent to the corresponding emissions from soybean oil production.[2]

Through the petition process described under 40 CFR 80.1416, REG submitted data to EPA to perform a lifecycle GHG analysis of renewable fuel produced through the REG Geismar Carinata Pathways. Based on comments received on the Carinata FRN, information submitted in the REG petition, and more recent information on carinata production practices, we are using a more specific approach in analyzing the lifecycle GHG impacts of carinata oil than the soybean oil-based approach reflected in the Carinata FRN. Specifically, our analysis of REG's pathways features energy use and fuel yield data from the REG Geismar renewable fuel production facility; carinata specific feedstock production and transport emissions estimates from recently published studies and the Greenhouse Gases, Regulated Emissions, and Energy use in Technologies (GREET) model; and a revised assessment of the land use change (LUC) impacts associated with producing carinata oil. We also

[1] EPA's soybean oil analysis was contained in the 2010 RFS rule (75 FR 14670).

[2] 80 FR 22996, 22997 (Apr. 24, 2015).

consider three different allocation approaches to account for the meal co-product from carinata oil extraction.

We estimate that fuel produced at the REG Geismar facility from carinata oil feedstock reduces lifecycle GHG emissions compared to the statutory petroleum baseline by approximately 57-64% for renewable diesel, 58-65% for renewable jet fuel, 57-65% for renewable naphtha and 57-65% for renewable LPG. Based on our lifecycle assessment, renewable diesel and jet fuel produced from carinata oil through the REG Geismar Process are eligible for biomass-based (D-code 4) RINs, and renewable naphtha and LPG produced from carinata oil through the REG Geismar Process are eligible for advanced biofuel (D-code 5) RINs, provided all associated regulatory requirements are satisfied, including the conditions specified in Section IV of this determination document. We are also addressing all comments received on the Carinata FRN that are relevant to REG's petition in a separate memorandum, attached.

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 REG, 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 produced through the REG Geismar Carinata Pathways.
- *Section IV. Conditions and Associated Regulatory Provisions:* Registration, reporting, and recordkeeping requirements for renewable fuel produced through the REG Geismar Carinata 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 REG Geismar petition.

I. Required Information and Criteria for Petition Requests

A. Background and Purpose of Petition Process

In 2010, as a result of changes to the RFS program in Clean Air Act section 211(o), as amended by the Energy Independence and Security Act of 2007 (EISA), EPA adopted new regulations, published at 40 CFR Part 80, Subpart M. The RFS regulations specify the types of fuels eligible to participate in the RFS program and the procedures by which renewable fuel producers and importers may generate RINs for the qualifying fuels they produce through approved fuel pathways.[3]

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

> *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 a fuel pathway: (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 also independently approve additional generally applicable fuel pathways into Table 1 for participation in the RFS program, or a party may petition for EPA to evaluate a new, facility-specific fuel pathway in accordance with 40 CFR 80.1416. In addition to producing renewable fuel under a generally applicable pathway or a facility-specific pathway, 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 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 80.76 (Registration of refiners, importers or oxygenate blenders).
- A technical justification that includes a description of the renewable fuel, feedstock(s), and production process. The justification must include process modeling flow charts.
- A mass balance for the pathway, including feedstocks, fuels produced, co-products, and waste materials production.

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[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.

- 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 intend to use a feedstock not previously evaluated by EPA must also include additional information pursuant to 40 CFR 80.1416(b)(2). Although the REG Geismar petition requested an evaluation of pathways that use a feedstock, carinata oil, that EPA previously evaluated in the Carinata FRN, REG submitted new information and data related to the production of carinata oil, as explained below.

II. Available Information

A. Background on REG

REG petitioned the Agency to approve pathways that would allow it to generate D-code 4 RINs for renewable diesel and renewable jet fuel, and D-code 5 RINs for renewable naphtha and renewable LPG, produced through a hydrotreating process from carinata oil feedstock. Specifically, these pathway requests are for REG's production facility in Geismar, LA. A petition was required because these are not approved pathways in Table 1 to 40 CFR 80.1426.

B. Information Available Through Existing Modeling

The pathways described in the REG petition would produce fuel from a feedstock, carinata oil, that EPA previously evaluated in the Carinata FRN. The type of production process, hydrotreating, described in the REG petition was previously evaluated in prior rulemakings including but not limited to the March 2010 RFS2 rule, the March 2013 Pathways I rule (78 FR 14190), and the August 2018 sorghum oil rule (83 FR 37735). The renewable diesel, jet fuel, naphtha and LPG fuels produced have also been previously evaluated in these prior rulemakings. Compared to previous rulemakings and Federal Register Notices, REG's petition required EPA to evaluate one specific renewable fuel production facility. As discussed below, EPA also considered more recent information and data on carinata oil production and other parts of the REG Geismar Carinata Pathways.

In the March 2010 RFS2 rule, EPA evaluated the GHG emissions associated with a hydrotreating process to produce renewable diesel from vegetable oil. REG's facility uses the same general hydrotreating process that we analyzed for the March 2010 RFS2 rule, with the difference being that the REG facility uses different amounts of process energy and produces different amounts of fuels and co-products per pound of feedstock used. This was a straightforward analysis based on existing modeling done for previous rulemakings for the RFS program. Table 1 illustrates the relevant vegetable oil-based fuel pathways using hydrotreating that currently qualify under the RFS program and their respective D-Codes.

Table 1: Relevant Excerpts of Existing Fuel Pathways from Table 1 to 40 CFR 80.1426

Row	Fuel Type	Feedstock	Production Process Requirements	D-Code
F	Biodiesel, renewable diesel, jet fuel and heating oil	Soybean oil; Oil from annual cover crops; Oil from algae grown photosynthetically; Biogenic waste oils/fats/greases; Camelina sativa oil; Distiller's corn oil; Distiller's sorghum oil; Commingled distillers corn oil and sorghum oil	One of the following: Trans-Esterification with or without esterification pre-treatment, or Hydrotreating; excludes processes that co-process renewable biomass and petroleum	4 (Biomass-based diesel)
I	Naphtha, LPG	*Camelina sativa oil*; Distillers sorghum oil; Distillers corn oil; Commingled distillers corn oil and distillers sorghum oil	Hydrotreating	5 (advanced)

C. Information Submitted by REG

REG supplied all the information as required in 40 CFR 80.1416 that EPA needed to analyze the lifecycle GHG emissions associated with carinata oil renewable fuel produced through the REG Geismar Carinata Pathways. The information submitted 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. Although the REG Geismar petition requested an evaluation of pathways that use a feedstock, carinata oil, that EPA previously evaluated in the Carinata FRN, at EPA's request

REG submitted new information and data related to the production of carinata oil. Our reasons for requesting and evaluating new information on carinata oil production are discussed below.

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 that it replaces, based on its lifecycle GHG emissions. As mandated by CAA 211(o), 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 of a fuel, 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.
- Fuel production – including process energy requirements, impacts of any raw materials used in the process, and benefits from co-products produced.
- Fuel and feedstock 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 REG Carinata Oil Pathway under this petition request is consistent with the CAA's applicable requirements, including the definition of lifecycle GHG emissions and threshold evaluation requirements.

1. Feedstock Production

We invited comment in the Carinata FRN on our analysis of the GHG emissions attributable to the production and transport of carinata oil feedstock (the "upstream" emissions) for use in making biofuels. In that notice, we stated our intention to use our estimate of the upstream emissions associated with soybean oil feedstock, as estimated for the March 2010 RFS2 rule, as a conservative estimate of the emissions associated with carinata oil feedstock. Based on comments received and additional information released since the Carinata FRN pointing to carinata being grown in southern climates as a winter rotation crop in tandem with summer cash crops, we reevaluated the upstream GHG emissions associated with carinata oil feedstock based on information provided in the REG petition, the GREET model and other sources instead of relying on the soybean oil estimates to evaluate the REG Geismar Carinata Pathways. For the reasons discussed below, our updated analysis of carinata oil includes zero land use change or other indirect emissions.

According to REG's petition, the REG Geismar facility is likely to predominantly source carinata oil grown in the U.S. Southeast, where the Southeast Partnership for Advanced Renewables from Carinata (SPARC) is conducting research and engaging with stakeholders towards a goal of planting 800,000 acres of carinata as a winter crop.[5] Carinata is well-suited for winter rotation in Southeast cropping systems due to its high performance compared to other oil crops and ability to provide soil benefits during winter months when vegetative cover is needed.[6]

In the Southeast, carinata is grown during the winter in between planting and harvesting of other crops. A typical farming schedule would include planting in November and harvesting in early May before planting starts for the subsequent crop. Carinata farming involves the use of fertilizer, pesticides and diesel use to operate farm equipment. We estimated the GHG emissions associated with carinata farming based primarily on data from field research by the University of Florida and SPARC. Our assumptions for carinata yield, carinata oil content, and nitrogen, potassium, phosphorous and sulphur fertilizer, and pesticide application rates are based on the lifecycle analysis by Alam et al. (2021), [7] which in turn based its carinata farming assumptions on peer-reviewed studies published by researchers associated with SPARC. The carinata oil cultivation assumptions used in our evaluation are summarized in Table 2.

Table 2: Carinata Oil Cultivation Assumptions for the U.S. Southeast from Alam et al. (2021)

Input	Units	Value
Diesel	Btu/kg dry seed	527
N Fertilizer	g/kg dry seed	35
P Fertilizer	g/kg dry seed	17
K Fertilizer	g/kg dry seed	35
S Fertilizer	g/kg dry seed	4
Pesticide	g/kg dry seed	3
Seed Moisture	% of seed	8%
Oil Content	% of dry seed	44%
Yield	kg dry seed/ha	2576

[5] SPARC. (2021). "About SPARC." Website accessed in December, 2021. https://sparc-cap.org/about/

[6] Alam, A. and P. Dwivedi (2019). "Modeling site suitability and production potential of carinata-based sustainable jet fuel in the southeastern United States." Journal of Cleaner Production 239: 117817. This study estimated that approximately 2 million acres of land are suitable for carinata production in three Southeastern states (Georgia, Alabama, Florida).

[7] Alam, A., et al. (2021). "Break-Even Price and Carbon Emissions of Carinata-based Sustainable Aviation Fuel Production in the Southeastern United States." Global Change Biology Bioenergy. 13(11): 1800-1813.

Table 3 reports our estimates for the GHG emissions associated with carinata oil farming in the U.S. Southeast. We used data and methods from multiple sources to estimate carinata oil cultivation emissions based on the data in Table 2. We estimated GHG emissions associated with fertilizer and pesticide production based on data from GREET-2020.[8] We also estimated GHG emissions associated with diesel production and use with GREET-2020. Consistent with prior lifecycle analyses for the RFS program, we estimated N_2O emissions associated with nitrogen fertilizer and crop residue using IPCC equations.[9] Based on data from Alam et al. (2021) we assume carinata aboveground biomass is 7 metric tonnes per hectare, belowground biomass is 0.7 metric tonnes per hectare, and nitrogen content is 0.8% for aboveground biomass and 0.4% for belowground biomass.[10] We estimated CO_2, CH_4 and N_2O emissions from these activities and converted them to carbon dioxide equivalent emissions with 100-year global warming potentials from the IPCC's Fifth Assessment Report (i.e., CH_4 GWP = 30, N_2O GWP = 265).[11] Based on these assumptions and emissions factors, we estimate farming emissions of 507 grams of carbon dioxide-equivalent per kilogram of dry carinata seed (gCO_2e / kg dry seed).

Table 3: GHG Emissions Associated with Carinata Farming in the Southeastern United States (gCO_2e / dry kg carinata seed)

Farming Emissions Category	GHG Emissions
Diesel	51
N Fertilizer Prod.	131
N Fert. Urea CO2	31
N Fert. Direct N2O	132
N Fert. Indirect N2O	55
Crop Residue (Direct)	54
P Fertilizer	34
K Fertilizer	19
S Fertilizer	0
Pesticide	0.03
Total	507

[8] Argonne National Laboratory. (2020). Greenhouse gases, Regulated Emissions, and Energy use in Transportation (GREET) Model. https://greet.es.anl.gov/

[9] IPCC (2006). 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Vol. 4: Agriculture, Forestry; and Other Land Use. Annex 2.1 Equations for N2O and other CO2 Emissions from Managed Soils. https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/4_Volume4/V4_14_An2_SumEqua.pdf

[10] Alam, A., et al. (2021) and email correspondence with Dr. Sheeja George (University of Florida) on August 30, 2021.

[11] IPCC, 2014: Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 151 pp.

Unless where otherwise noted below, we used the default data and assumptions from GREET-2020 to estimate emissions from carinata seed transport, oil extraction and oil transport. GREET-2020 evaluates average carinata production in the United States and for most parts of our evaluation we believe its assumptions are valid for our evaluation of the REG Geismar Carinata Pathways. Following harvest, carinata seeds are trucked to a collection point and then onward to a crushing facility where oil is extracted producing carinata oil and meal. We estimated the GHG emissions associated with transporting carinata seeds 10 miles from the field to a collection point via medium-duty truck and then another 40 miles to an oil extraction facility via heavy-duty truck. We also included back-haul emissions, assuming the trucks make a return trip without cargo. We assume that dry carinata seed has 44% oil content, as reported by Alam et al. (2021), and 4% oil loss during extraction. We assume the oil extraction process uses grid electricity and natural gas as energy sources and N-hexane as a solvent. For grid electricity, we applied the emissions factor for the average United States grid. For natural gas we used the emissions factor for average North American natural gas.

Based on the modeling described above, we estimate total upstream GHG emissions of 1,408 gCO_2e per kg carinata oil with no accounting or allocation for the co-product carinata meal. Three common allocation methods for attributing the GHG emissions among co-products are mass, energy and market-based allocation. For example, Chen et al. (2018) uses mass-based allocation for their lifecycle analyses of biodiesel pathways,[12] the United Nations International Civil Aviation Organization (ICAO) uses energy allocation,[13] and a report prepared for the European Commission recommends market-based allocation.[14] We report results using all three of these allocation methods. We estimate outputs from carinata oil crushing, after accounting for losses, are 42% oil and 58% meal by dry mass. Based on energy contents from GREET-2020 of 35,439 Btu per dry kilogram for the oil and 16,776 Btu per dry kilogram for the meal, the outputs are 65% oil and 35% meal by energy content. Based on market prices from GREET of $0.77 per kilogram for oil and $0.35 per kilogram of meal, the market allocation shares are 66% oil and 34% meal. Table 4 reports the estimated GHG emissions per kilogram of carinata oil unallocated, using mass allocation, energy allocation and market allocation. Emissions per kilogram of carinata oil are higher for the energy and market-based allocation approaches that attribute a greater share of the output to the carinata oil.

Table 4: GHG Emissions Associated with Carinata Oil Production (gCO2e per kg carinata oil)

[12] Chen, R., et al. (2018). "Life cycle energy and greenhouse gas emission effects of biodiesel in the United States with induced land use change impacts." Bioresource Technology 251: 249-258.

[13] ICAO (2021). CORSIA Eligible Fuels -- Lifecycle Assessment Methodology. CORSIA Supporting Document. March 2021. Version 3. Page 18.

[14] European Commission, Joint Research Centre and Institute for Environment and Sustainability. (2010). International Reference Life Cycle Data System (ILCD) handbook – General guide for life cycle assessment – Detailed guidance. 1st ed. Luxembourg: European Commission—Joint Research Centre.

	Unallocated	Mass-Based Allocation	Energy-Based Allocation	Market-Based Allocation
Farming	1201	507	729	741
Seed Transport	34	14	20	21
Oil Extraction	173	73	105	107
Total	1408	595	855	868

Another approach that is commonly used in lifecycle analysis for co-product accounting is called the displacement approach. Using the displacement approach in this case would involve determining a reference product that is "displaced" by the production of carinata meal. For example, we could assume that carinata meal replaces soybeans, soybean meal, or another type of livestock feed. In this case, it is not clear what reference product to assume for displacement. Nor have we previously estimated the GHG emissions associated with products, such as soybean meal, that would likely be displaced by carinata meal. Modeling with the FASOM and FAPRI models would be a potential way to estimate carinata meal displacement GHG emissions impacts in a manner consistent with the methodology developed for the March 2010 RFS2 rule. However, the FASOM and FAPRI models do not currently include carinata and we are unable to add it at this time. For these reasons, we have not used a displacement approach or conducted additional modeling for this analysis of the lifecycle GHG emissions associated with the REG Geismar Carinata Pathways. Should additional data and modeling resources become available, we may revisit the possibility of new agricultural sector modeling for purposes of evaluating future carinata oil biofuel pathways.

Although we are unable to estimate GHG emissions using a displacement approach for carinata meal at this time, we used information from other sources to produce an illustrative estimate of GHG emissions using a displacement approach. Our illustrative example suggests that using a displacement approach for carinata meal may produce estimates within the range or lower than the estimates in Table 4 for the three allocation approaches.

For this illustrative example we start with the displacement approach used in GREET for carinata meal. The default approach in GREET is mass-based allocation for carinata crushing. However, users can select to use displacement in which case GREET assumes that carinata meal displaces soybean production. For example, if we use the default assumptions in GREET-2020, the displacement of soybeans with carinata meal results in -235 gCO2e per kg carinata oil. Note that this example calculation using GREET accounts for the emissions associated with farming and transporting soybeans, but does not account for any land use change emissions associated with soybean production. To address this gap, ICAO (2021) used the GTAP-BIO and GLOBIOM models to estimate the land use change GHG benefits associated with carinata meal as part of their evaluation of the lifecycle GHG emissions associated with carinata oil-based jet fuel.[15] The models were used to simulate a scenario with roughly 200 million gallons of renewable diesel and jet fuel production from carinata oil via a hydrotreating process. The analysis included an estimate of the "indirect land use change" (ILUC) emissions associated with producing carinata oil as a winter cover crop, including the co-product meal displacing soybeans and other types of animal feed. The GTAP-BIO modeling estimated ILUC emissions of -409 gCO2e per kg carinata oil and the GLOBIOM model estimated -822 gCO2e per kg carinata oil.[16]

We now have two elements in our illustrative example displacement calculation. First, we have an example estimate from GREET of -235 gCO2e per kg representing the GHG impacts of carinata meal displacing soybean farming and transport. Second, we have an example estimate from ICAO (2021) of -409 to -822 g CO2e per kg carinata oil representing the GHG impacts of carinata meal displacing the indirect land use change emissions associated with producing soybean meal and other animal feeds. Combining these two elements gives us an example calculation of the GHG impacts of carinata meal displacing soybean meal and other animal feeds that includes the GHG impacts of both reduced soybean farming and transport and indirect land use change. Note that this approach does not include other sources of potential indirect GHG emissions, such as indirect emissions associated with changes in livestock production. Nonetheless, if we combine these two elements we get an overall example estimate of the displacement benefit of -644 to -1056 gCO2e per kg carinata oil. As shown in Table 4, our estimate of the unallocated upstream emissions are 1408 gCO2e per kg carinata oil. Subtracting the example displacement estimates from the unallocated emissions suggests that using a displacement approach might result in upstream GHG emissions of 352 to 764 gCO2e per kg carinata oil, which is lower or within the range of estimates in Table 4 for the allocation approaches of 595 to 868 gCO2e per kg carinata oil. Thus, available information suggests that using a displacement approach may result in GHG estimates that are within the range of our estimates using the mass, energy or market allocation approaches. Given that these displacement estimates are only provided as an illustrative example, the rest of this determination focuses on the results using the three allocation approaches.

Following oil extraction, carinata oil is transported from the extraction facility to REG-Geismar. We assume this transport is 80 miles by heavy-duty truck and 700 miles by train. Following the approach in GREET-2020, we include back-haul for the trucking but not the train portion of the transport. Estimated emissions from carinata oil transport are 32 grams CO_2e per kg oil.

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[15] ICAO (2021). CORSIA Eligible Fuels -- Lifecycle Assessment Methodology. CORSIA Supporting Document. March 2021. Version 3. Page 115-116.

[16] ICAO (2021) reports GTAP-BIO and GLOBIOM results of -12.9 and 25.9 gCO2e per MJ carinata-based jet fuel, respectively. We converted these estimates to per kg carinata oil based on the following assumptions in GREET-2020: conversion yield of 1.39 kg carinata oil per kg jet fuel, jet fuel lower heating value of 119,777 Btu/gal and jet fuel density of 2,866 g/gal.

Another component of upstream emissions is emissions associated with any LUC resulting from production of the carinata seed feedstock. In the Carinata FRN, EPA said that carinata is not expected to have significant LUC impacts for two reasons. First, EPA said that carinata will be grown primarily on fallow cropland, so it will not impact other commodities through land competition. Second, EPA said that carinata is not expected to have a significant impact on other agricultural commodity markets because of the lack of large-scale production of carinata or use in non-biofuel applications. However, as explained above, to provide a conservative estimate of emissions, EPA applied soybean oil based upstream emissions, including LUC emissions, in the Carinata FRN.

At the time of the Carinata FRN we expected carinata production to be concentrated in the Great Plains as a fallow-rotation crop with wheat in the Great Plains, whereby carinata would be grown in the summer on land that would otherwise be fallow.[17] Carinata and other brassica oilseeds have been explored as cropping options in place of fallow fields in the Great Plains to address issues of soil moisture loss. Fallow fields in wheat rotations are inefficient at preserving soil moisture and have been found to have a water retention efficiency of around 25% (75% loss of precipitation).[18] However, brassicas have failed to effectively preserve soil moisture when planted in rotation with wheat. Wheat rotated with camelina has produced lower yields than wheat rotated with fallow in the Great Plains,[19] and carinata is expected to perform similarly.[20] There is an inherent challenge to growing oilseeds to produce commercially viable oil yields and allowing enough soil moisture to remain for a following wheat crop in rotation. The oilseed demands more water to grow longer and produce the higher oil content, and this comes at the expense of the landscape's soil moisture. Given these challenges, interest in carinata has largely changed to being grown as a winter rotation crop in southern climates – the U.S. Southeast and South America – where it can survive through winter seasons and farmland does not face the same soil moisture constraints.

With this evolution in carinata growing patterns, and based on additional information provided by the petitioner, we believe carinata will most likely be grown as a rotational winter crop in the U.S. Southeast or South America.[21,22] Based on the data currently available, we believe it is reasonable to

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[17] There are also winter fallow rotations, but carinata is not cold-tolerant to the degree that it could survive the winter season in this region of the country.

[18] Farahani, et al., 1998, *Soil Water Storage in Dryland Cropping Systems: The Significance of Cropping Intensification*. SoilScience Society of America Journal, 62, 984-991. https://doi.org/10.2136/sssaj1998.03615995006200040020x

[19] Obour et al., 2018, *Camelina sativa as a fallow replacement crop in wheat-based crop production systems in the US Great Plains*. Industrial Crops & Products, 111. http://dx.doi.org/10.1016/j.indcrop.2017.10.001

[20] Communication with Russ Gesch, PhD.

[21] https://rsb.org/2021/04/22/nuseed-carinata-restoring-the-earth-through-regenerative-agriculture/

[22] https://www.icao.int/environmental-protection/CORSIA/Documents/ICAO%20document%2006%20-%20Default%20Life%20Cycle%20Emissions%20-%20March%202021.pdf

assume that carinata will likely have de minimis upstream LUC emissions when grown as a winter crop rotation in both the U.S. Southeast and South America, and we detail the rational for this assumption based on four considerations described below.

First, as stated in the Carinata FRN, carinata oil does not currently have established markets outside of its potential as a biofuel feedstock. For established food-based biofuel feedstocks such as soybean oil, there is a risk that diverting the feedstock for biofuel production will result in additional production elsewhere to backfill the initial use. For carinata oil, there is currently no such risk. Second, it is unlikely that carinata will be grown as a primary crop and displace established cash crops such as corn or soybeans. Carinata oil is not a viable oilseed for food use due to high concentrations of erucic acid, which poses risks to human health.[23] Since there are currently no established markets there are no market prices for carinata in the US, which introduces considerable uncertainty around the economic return from carinata plantings. Furthermore, carinata has been unviable when grown through the summer in the Southeast since carinata experiences heat stress-induced flower abortion,[24] limiting its potential to become an economically viable primary spring crop in the Southeast.

Third, carinata grown in the patterns outlined by REG is unlikely to compete for land with other marketable winter rotation crops and therefore there is little risk for indirect impacts from land displacement. In the U.S. Southeast and South America, carinata is being developed as a winter cropping option in rotation with summer crops such as soybeans, sorghum, peanuts, and cotton. There is an increasing trend of winter plantings in the Southeast due to the relatively mild winters, though risk of frost is a concern. Current winter crops are mostly cover crops for the purpose of providing landscape benefits such as weed control, reducing soil erosion, nutrient retention, nematode mitigation, providing habitat for native insect and animal species, and forage. While adoption of winter and cover crops is growing in response to state programs and outreach, many fields still go without winter or cover crops. The 2017 Agricultural Census reported that 15.4 million acres were planted with cover crops throughout the US, a 50% increase from the reported amount in 2012, but only 4% of the total amount of reported cropland acres in 2017 (396 million).[25] A 2021 USDA report found that of fields that had planted a cover crop at least once in the last four years, only 32% of soybean acres planted cover crops in at least three of four years, while that number was 69% for cotton indicating that that there is opportunity for additional winter plantings.[26] Additionally, carinata is only rotated every three years further moderating any potential market impacts.[27] If winter wheat, which is sometimes harvested for markets in the Southeast, is also planted on a given farm, it could still be rotated with the

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[23] *Erucic acid in feed and food*, 2016, EFSA Journal Vol 14, Issue 11 **https://doi.org/10.2903/j.efsa.2016.4593**

[24] Communication with Dr. Sheeja George, University of Florida

[25] 2017 Census of Agriculture (2019). United States Summary and State Data. Volume 1, Part 51. https://www.nass.usda.gov/Publications/AgCensus/2017/Full_Report/Volume_1,_Chapter_1_US/usv1.pdf *Table 47. Land Use Practices by Size of Farm: 2017 and 2012*

[26] *Cover Crop Trends, Programs, and Practices in the United States* USDA Economic Research Service, Economic Information Bulletin Number 222, February 2021

[27] Communication with Dr. Sheeja George, University of Florida

introduction of carinata. An average of 1.57 million acres of winter wheat were planted between 2015 to 2020 in the Southeast,[28] of which an average of 428 thousand acres went unharvested (27%).[29] This indicates that there are opportunities for expanding winter crops in the Southeast without risk of displacing current plantings.

Fourth, carinata is unlikely to significantly reduce the yields of the primary crops it will be grown in rotation with. These crops are mainly cotton, peanuts, soybeans, and sorghum in the U.S. Southeast. If carinata were to reduce yields of the primary crop, this could trigger a market-mediated response, which could have indirect emissions impacts. Early evidence in the Southeast shows that winter carinata plantings have positive yield effects on the summer crops by reducing soil erosion, reducing nutrient losses through leaching, and increasing soil organic matter accumulation.[30] However, research is still ongoing on how to fit carinata into agricultural systems efficiently and without adversely affecting the primary crop. Timing of planting and harvesting of carinata is critical to this end. Carinata needs to be planted early enough (e.g., mid-November in the U.S. Southeast) to allow for robust growth for harvest by mid-May. If carinata is not planted early enough or encounters suboptimal winter weather conditions, farmers will be in a position of facing a carinata crop that is not ready to be harvested by the time of the spring planting. In this event the farmer could 1) terminate the carinata; 2) harvest the carinata early to ensure the full summer crop rotation; or 3) delay the carinata harvest and planting of the summer crop. In this last scenario, the yield of the summer crop could be negatively affected as the planting date is a key determinant in cotton and soybean yields.[31,32] Delayed summer crop planting is a greater risk for cotton (planted late-April to early- May) and peanuts (planted early- to late-May) in the Southeast. In contrast, soybeans and sorghum can be planted later in June and even into July, and achieve a full growth cycle due to the high number of growing degree days in that part of the country.[33] However, as mentioned earlier, given the 3-year rotational schedule that is recommended for crops in these systems, we expect that interannual planting will be sequenced so that the timing of a carinata harvest would not pose a challenge for those rotated summer crops that need to be planted earlier in the Spring.[34]

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[28] Alabama, Arkansas, Florida, Georgia, Louisiana, Mississippi, North Carolina, South Carolina, and Tennessee

[29] USDA's National Agricultural Statistical Survey (NASS). https://quickstats.nass.usda.gov/#F052B91F-B834-3EDF-B405-BED7458DD024

[30] *Carinata fit into SE Cropping Systems,* David Wright. Conference Presentation: *Brassica carinata* Summit. March 30, 2017. Quincy, FL https://sparc-cap.org/wp-content/uploads/2018/03/Carinata-fit-in-SE-crop-rotations.pdf

[31] Liu, Jingran et. al. 2015. *Effect of late planting and shading on cotton yield and fiber quality formation,* Field Crops Research, Volume 183, https://doi.org/10.1016/j.fcr.2015.07.008.

[32] Lee, Chad D. et. al. 2008. *Soybean Response to Plant Population at Early and Late Planting Dates in the Mid-South*, Agronomy Journal, Volume 100, Issue 4, doi:10.2134/agronj2007.0210

[33] Communication with Dr. Sheeja George, University of Florida

[34] Communication with Dr. Sheeja George, University of Florida

For the reasons outlined above, EPA believes that it is more appropriate to assign zero LUC emissions to the oil from carinata grown in the winter-rotation patterns described in the petition than to apply soybean-oil based emissions, which we acknowledged in the Carinata FRN were conservative. It is worth noting that carinata could technically be planted in other agricultural systems outside of what is outlined above, including as a primary, summer crop in Northern States for example. In such cases, if carinata were to be dedicated to new cropland or cropland converted from a different crop, the reasons EPA has outlined for why carinata would have zero LUC emissions would not hold. However, EPA believes it is unlikely that carinata would be grown in this manner due to its nascent status that makes it uncompetitive with established crops. These conditions could change as interest and experience with carinata expands in the future and alternative end uses are established, but this evolution would take time.[35] EPA will revisit the feedstock production emissions of carinata in the future if evidence emerges that it is being grown as a primary crop on dedicated cropland.

2. Renewable Fuel Production

REG provided mass and energy balance data, under claim of confidential business information, for renewable fuel produced at their Geismar facility. This facility uses a hydrotreating process to convert carinata oil to renewable fuel using natural gas, hydrogen, electricity and steam for energy. The outputs from the processes are renewable diesel, jet fuel, naphtha, and LPG. The propane fuel gas produced at this facility is either reused for thermal process energy or flared.

Consistent with our previous analyses of hydrotreating processes, we use an energy allocation approach for attributing GHG emissions among the RIN-generating co-products that qualify as renewable fuel.[36] As the REG petition requests RIN eligibility for all the co-products from the REG Geismar Process, we use energy allocation to evaluate all the co-products. This approach results in higher lifecycle GHG emissions for each of the fuel products than other methods of evaluating co-products, such as a displacement approach. Thus, in this case we view the energy allocation method as a conservative approach. See the March 2013 Pathways I rule, and specifically pages 78 FR 14198-14200 for more explanation of the energy allocation approach and our justification for using it to evaluate hydrotreating co-products.

We used data from GREET-2020 to estimate emissions factors for the energy sources used in the hydrotreating process. For hydrogen, we used GREET's default estimate for gaseous hydrogen produced from North American natural gas at a central plant and transported to a facility via pipeline. Central plants are large hydrogen production facilities that produce greater than 50,000 kilograms of hydrogen per day.[37] This is a conservative choice as GREET has lower GHG estimates for other

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[35] Communication with Dr. Brett Allen, USDA – Agricultural Research Service

[36] See the March 2013 Pathways I rule, specifically 78 FR 14198-14200 (March 5, 2013).

[37] U.S. Department of Energy. Accessed November, 2021." The Hydrogen Analysis (H2A) Project." *https://www.hydrogen.energy.gov/h2a_analysis.html*

sources of hydrogen. We believe this choice is reasonable and appropriate given that these facility-specific pathway approvals are not conditional upon a specific source of hydrogen. For natural gas, we used GREET data for average North American natural gas combusted in a large-scale industrial boiler. For electricity, we used the emissions factor from GREET-2020 representing U.S. average electricity. We assumed steam is produced from natural gas combustion in a boiler with 80% efficiency.

REG's process can also be configured to produce a relatively small amount of jet fuel as a co-product. REG supplied mass and energy balance data for this processing configuration. We used these data and the same methods described above to estimate the GHG emissions associated with producing renewable diesel, jet fuel, naphtha and LPG at the REG Geismar facility. The results are similar to those when the facility does not produce jet fuel. We used the results from this configuration to report the jet fuel lifecycle GHG emissions below in Table 6.

3. Renewable Fuel Distribution

We used data from GREET-2020 to estimate emissions associated with renewable fuel transportation and distribution. We assume fuel is transported by barge, rail, pipeline and truck from REG's facility to a distribution location and then trucked to retail locations via truck. We based these assumptions on the GREET-2020 data for renewable diesel, renewable jet fuel, LPG and renewable gasoline as a proxy for renewable naphtha. GREET includes energy intensity (Btu per ton-mile) for each of the transport modes and back-haul emissions for trucks and barges.

4. Fuel Use

For this analysis we applied non-CO_2 fuel use emissions factors from GREET-2020.[38] 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. For renewable naphtha we used the factors for renewable gasoline consumed in a spark-ignition vehicle and for LPG we used factors for a dedicated LPG vehicle.

5. Lifecycle GHG Results

Based on our analysis, we estimated the lifecycle GHG emissions associated with renewable diesel, jet fuel, naphtha and LPG produced through the REG Geismar Carinata Pathways. Tables 5-8 report our lifecycle GHG estimates for each of the four fuel types. For each fuel type we report

[38] 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 CO_2 emissions from combusting it cancel each other out. Therefore, instead of presenting both the carbon uptake and tailpipe CO_2emissions, 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."

estimates for three different allocation methods to account for the oil and meal co-products from carinata seed crushing: mass-, energy- and market-based allocation. To estimate the lifecycle GHG reductions relative to the statutory petroleum baseline, we compare renewable diesel, renewable jet fuel and renewable LPG to the 2005 average diesel baseline, and renewable naphtha to the 2005 average gasoline baseline. For all the oil and meal co-product allocation approaches considered, renewable diesel, jet fuel, naphtha, and LPG produced from carinata oil through the REG Geismar Process exceed the CAA 50% GHG reduction threshold for the applicable categories of renewable fuel (biomass-based diesel and/or advanced biofuel).

Table 5: Lifecycle GHG Emissions for Renewable Diesel Produced from Carinata Oil through the REG Geismar Process ($kgCO_2e/mmBtu$)[39]

Emissions Category	2005 Diesel Baseline	Oil and Meal Allocation Method		
		Mass-Based	Energy-Based	Market-Based
Farming	19	14	20	20
Feedstock Transport		1	1	1
Oil Extraction		2	3	3
Fuel Production		16	16	16
Fuel Distribution		0.4	0.4	0.4
Tailpipe	79	1	1	1
Net Emissions	98	34	42	42
% GHG Reduction Relative to Baseline		64%	57%	57%

Table 6: Lifecycle GHG Emissions for Renewable Jet Fuel Produced from Carinata Oil through the REG Geismar Process ($kgCO_2e/mmBtu$)

Emissions Category	2005 Diesel Baseline	Oil and Meal Allocation Method		
		Mass-Based	Energy-Based	Market-Based
Farming	19	14	20	20
Feedstock Transport		1	1	1
Oil Extraction		2	3	3
Fuel Production		16	16	16
Fuel Distribution		0.4	0.4	0.4
Tailpipe	79	0.1	0.1	0.1
Net Emissions	98	34	41	41

[39] In Table 5-8, totals may not be the sum of the rows due to rounding.

% GHG Reduction Relative to Baseline		65%	58%	58%

Table 7: Lifecycle GHG Emissions for Renewable Naphtha Produced from Carinata Oil through the REG Geismar Process (kgCO_2e/mmBtu)

Emissions Category	2005 Gasoline Baseline	Oil and Meal Allocation Method		
		Mass-Based	Energy-Based	Market-Based
Farming	20	14	20	20
Feedstock Transport		1	1	1
Oil Extraction		2	3	3
Fuel Production		16	16	16
Fuel Distribution		1	1	1
Tailpipe	79	1	1	1
Net Emissions	99	34	42	42
% GHG Reduction Relative to Baseline		65%	58%	57%

Table 8: Lifecycle GHG Emissions for Renewable LPG Produced from Carinata Oil through the REG Geismar Process (kgCO_2e/mmBtu)

Emissions Category	2005 Diesel Baseline	Oil and Meal Allocation Method		
		Mass-Based	Energy-Based	Market-Based
Farming	19	13	19	19
Feedstock Transport		1	1	1
Oil Extraction		2	3	3
Fuel Production		15	15	15
Fuel Distribution		1	1	1
Tailpipe	79	1	1	1
Net Emissions	98	32	39	40
% GHG Reduction Relative to Baseline		65%	57%	57%

B. Application of the Criteria for Petition Approval

The REG Geismar carinata oil petition included a production process, feedstock and fuel products that, separately, were already considered as part of the March 2010 RFS2 rule and the Carinata FRN. REG provided all the necessary information that was required for its pathway petition under 40 CFR 80.1416. Based on the data submitted and information already available through analyses conducted for previous RFS rulemakings, EPA conducted a lifecycle assessment and determined that renewable fuels produced through the RFS Carinata Oil Renewable Fuel pathways meet the 50 percent lifecycle GHG threshold requirement specified in the CAA for biomass-based diesel and/or advanced biofuel. The lifecycle GHG results presented above justify authorizing the generation of D-code 4 RINs for renewable diesel and jet fuel, and the generation of D-code 5 RINs for renewable naphtha and LPG produced through the REG Carinata Oil Pathways, assuming that the fuel satisfies the definitional and other 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.

IV. Conditions and Associated Regulatory Provisions

The authority for REG to generate RINs for renewable fuel produced through the REG Geismar Carinata Pathways is expressly conditioned on REG satisfying all the following conditions as detailed in this section, in addition to all 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 REG has failed to comply with any of the conditions specified herein. EPA has authority to bring enforcement action of 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.

REG must adhere to the applicable RIN generation, registration, recordkeeping, and reporting requirements in 40 CFR Part 80, Subpart M that apply to renewable fuel producers. EPA may modify the conditions contained in this pathway approval document as it deems necessary and appropriate to ensure that fuel produced pursuant to the REG Geismar Carinata Pathways achieves the required lifecycle GHG reductions, including 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 REG Geismar Carinata Pathways, the Agency will explain such changes in a public determination letter, like this one, and specify in that letter the effective date for any such changes.

A. Invasiveness Concerns and Provisions

EPA sought comment on appropriate provisions to address potential concerns with invasiveness of carinata in the Carinata FRN. EPA stated that the monitoring and reporting requirements like those required for *Arundo donax* and *Pennisetum purpureum* could potentially be appropriate and solicited input on which of these specific requirements would be appropriate for carinata. The National Wildlife Federation expressed concern about the uncertain nature of carinata's spread potential as indicated by the USDA completed Weed Risk Assessment (WRA)[40] and urged EPA to include robust risk management practices in consultation with relevant agencies. In response to the comments, EPA engaged with the Animal and Plant Health Inspection Service (APHIS) of USDA and Nuseed, the research and development company that provides guidance to farmers on growing carinata and supplies the carinata oil to REG Geismar, to evaluate best management practices and to produce a risk mitigation plan (RMP). The attached document, *Nuseed Carinata Letter_APHIS* expresses APHIS's support for the REG Geismar Carinata Pathways based on the RMP presented by Nuseed for a period of six years. In recognition of the nascent nature of carinata cultivation, APHIS believes it is appropriate to reevaluate carinata and Nuseed's RMP after a period of six years. The third registration renewal following the initial two (three-year) registrations will require a new letter of support from APHIS. The Nuseed RMP is also attached with this letter, as is our detailed response to invasiveness related comments from the Carinata FRN.

V. **Public Participation**

The definition of advanced biofuel in CAA 211(o)(1) 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 2013 RFS2 rule (78 FR 14190) we took public comment on our lifecycle assessment of renewable diesel, jet fuel, naphtha and LPG produced from camelina oil feedstock through a hydrotreating process, including all models used and all modeling inputs and evaluative approaches. In the Carinata FRN (80 FR 22996) we invited comment on our assessment of the GHG emissions associated with producing and transporting carinata oil for use as a renewable fuel feedstock.

In the March 2010 RFS2 rule we acknowledged that it was unlikely that our final regulations would address all possible qualifying fuel production pathways. We therefore promulgated the petition process at 40 CFR 80.1416, under which 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 the Carinata FRN we invited comment on our analysis of the GHG emissions attributable to the production and transport of carinata oil feedstock for use in making biofuels such as renewable diesel, jet fuel, naphtha, and LPG. We proposed to apply our estimate, from the March 2010 RFS2 rule, of the upstream GHG emissions associated with soybean oil feedstock production and transport,

[40] https://www.aphis.usda.gov/plant_health/plant_pest_info/weeds/downloads/wra/Brassica-carinata.pdf

including indirect agricultural and forestry sector impacts, to future evaluations of petitions proposing to use carinata oil as a feedstock for biofuel production. We are addressing the comments received on the Carinata FRN that are relevant to our action on REG's petitions in a separate memorandum, attached.

In responding to this petition, we have relied to a large extent on the modeling and analysis approach developed for the March 2010 RFS2 rule and adjusted the analysis in response to the comments we received on the Carinata FRN and the REG Geismar petition, including by adjusting the analysis of the upstream GHG emissions associated with carinata oil production. We revised our evaluation of upstream emissions based on information contained in the REG petition and other scientific information as described above, as well as in response to comments received on the Carinata FRN, which questioned the assumption that carinata will be grown in rotation with wheat in the Great Plains and suggested that carinata will mostly likely be grown as a winter rotation crop in the Southeast instead. The adjustments to the upstream emissions rely on methods and models that are consistent with the lifecycle analysis methodology developed for the March 2010 RFS2 rule. Thus, the fundamental approaches and analyses relied on for this decision have been made available for public comment as part of previous actions. Our approach to evaluating the lifecycle emissions associated with REG's proposed pathways 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 assessment, renewable diesel and jet fuel produced from carinata oil through the REG Geismar Process qualifies for biomass-based diesel (D-code 4) RINs, and renewable naphtha and LPG produced from carinata oil through the REG Geismar Process qualifies for advanced biofuel (D-code 5) RINs, provided all the conditions and associated regulatory provisions specified in Section IV of this document are satisfied, and the fuel meets the definitional and other 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 REG Geismar and to the process, materials used, fuels produced, and process energy types and amounts outlined and described in the petition requests submitted by REG.[41] This approval is effective as of signature date. RINs may only be generated for

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

renewable fuel produced through the REG Geismar Carinata Pathways that is produced after the date of activation of the registration for this new pathway.[42]

The OTAQ Reg: Fuels Programs Registration and OTAQ EMTS Application will be modified to allow REG to register and generate D-code 4 RINs for renewable diesel and renewable jet fuel produced from carinata oil using a production process of “REG Geismar Process,” and to register and generate D-code 5 RINs for renewable naphtha and renewable LPG produced from carinata oil using a production process of “REG Geismar Process.”

[42] 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.”

Response to Comments

Introduction

This document contains EPA responses to all comments received on EPA's 2015 Federal Register Notice, *Notice of Opportunity To Comment on an Analysis of the Greenhouse Gas Emissions Attributable to Production and Transport of Brassica Carinata Oil for Use in Biofuel Production* ("2015 FRN")(80 CFR 22996).

We received five comment letters on the 2015 FRN. Of these, three express general support for pathways for renewable fuels produced from carinata oil. Each of these comments also encourages EPA add carinata oil under the list of generally applicable pathways in Table 1 of 40 CFR 80.1426. Further, one of these comments also criticized EPA's characterization of invasiveness risk of carinata and potential monitoring and reporting requirements. The other two comments expressed degrees of concern about carinata oil-based pathways, with one focusing on carinata invasiveness risks and the other critiquing EPA's evaluation of the upstream lifecycle GHG emissions associated with producing carinata oil.

For flow and readability, the comments, and responses below are organized by topic.

- EPA's Lifecycle Greenhouse Gas Analysis
- EPA's Pathway Approval Process
- Invasiveness of Carinata

Summary and Analysis of Comments

EPA's Lifecycle Greenhouse Gas Analysis

Comment: One commenter (EPA-HQ-OAR-2015-0093-0028) questions whether "soybean production is an appropriate analogue for carinata production" due to "important differences" between soybean production and carinata production. This commenter further states they did not believe that EPA provided the public with an adequate statement of the "basis and purpose" for the decision to base the LCA of carinata on key comparisons between carinata oil and soybean oil. Specifically, the commenter questioned the assumed differences in fuel consumption requirements between the production of carinata and soybeans, the emissions associated with carinata feedstock collection, and the application of soybean oil-based land use change (LUC) impacts. The commenter questioned EPA's findings based on the reliance on these comparisons.

Response: In response to the comment and based on newer information we have updated our assessment of the emissions associated with the carinata seed production and transport as well as for the carinata oil extraction and transport. We are no longer using the lifecycle GHG emissions associated with soybean oil production as a proxy for carinata oil. We based updated carinata cultivation assumptions on Alam et al. (2021) and emissions from other stages, including oil extraction, on data from GREET-2020. The publication of carinata-specific information, including the inclusion of carinata in

GREET,[1] since the 2015 FRN enabled us to complete this more targeted lifecycle GHG analysis of carinata oil.

Our updated, carinata-specific assumptions are detailed in the *REG Geismar Carinata Pathways Determination letter* (attached). In response to this comment, we have also updated our assessment of the LUC impacts of carinata taking a careful look at current carinata growth patterns and how we expect carinata production may expand. The full discussion of the updated LUC assessment for carinata can be found in the *REG Geismar Carinata Pathways Determination Letter*.

<u>Comment</u>: A commenter (EPA-HQ-OAR-2015-0093-0028) questioned EPA's assumptions about where carinata will be grown. Specifically, the commenter questioned that carinata would be grown in northern U.S. and Canada wheat fields in the winter due to cold weather (i.e., lack of sufficient growing degree-days). The commenter also questioned the claim that carinata would be grown in a fallow rotation with wheat in the Northern Great Plains and Canada, citing the fact that the moisture carinata requirements would compromise the soil moisture levels for the following wheat rotation, and thus reduce the wheat yields. The commenter thought it more likely that carinata would be grown in the U.S. Southeast as a cover crop, or in the Northern Great Plains as a summer crop. The commenter further stated that EPA should provide a "more robust and better-substantiated analysis of *likely* production practices" for any feedstock it considers.

<u>Response</u>: The commenter appears to have misunderstood part of the description of the potential carinata growing practices. EPA did not assume that carinata would grow as a winter crop in the Northern Great Plains and Canada in the 2015 FRN. We are aware that carinata cannot survive at those latitudes during the winter season.

Regarding the commenters' questioning of carinata being grown in the fallow periods in the Northern Great Plains, at the time of completing analysis for the 2015 FRN the Northern plains was an area of focus for carinata development. Agrisoma Biosciences L.L.C. in their 2013 facility-specific pathway petition to EPA was focusing on carinata production in the Northern Plains in rotation with wheat. At that time, universities in that region, such as Montana State University, South Dakota State University, and North Dakota State University, were conducting carinata field trials.

Since the 2015 FRN, research and interest in growing carinata has shifted primarily to the U.S. Southeast and South America, where carinata is being explored as a winter rotation crop. Carinata has not to date met initial targets in terms of yield potential in the Northern Great Plains systems, due in part to the moisture demands of carinata, as the commenter stated. Based on our evaluation of more recent information, we do not expect the Northern Plains to be a significant source of carinata oil for the REG Geismar facility. Based on this more recent information and in response to the comment, we have

[1] Summary of Expansions and Updates in GREET 2018. Argonne National Laboratory, Energy Systems Division. ANL-18/38. https://greet.es.anl.gov/publication-greet-2018-summary

updated and bolstered our assessment of likely carinata production practices including where, and when it will be grown, and what the potential land use implications are.

Our updated assessment focuses on carinata grown as a winter crop in the U.S. Southeast, where carinata research and development has been targeted.[2] We evaluate the potential for carinata to be grown in rotation with primary, summer crops such as soybeans, sorghum, peanuts, and cotton. Based on carinata's ability to be compatibly grown in the winter season with primary crops, and the opportunity for additional winter plantings in the Southeast, we do not believe carinata will either demand dedicated cropland or supplant existing market crops, and thus will not have impacts on LUC (emissions).

The updated assessment for where and how we think carinata is likely will be grown is further detailed in the *REG Geismar Carinata Pathways Determination Letter*.

EPA's Pathway Approval Process

Comment: Three commenters (EPA-HQ-OAR-2015-0093-0027, 0030, 0031) generally supported the 2015 FRN and EPA's efforts to approve pathways for renewable fuel produced from carinata oil, but encouraged EPA to approve generally applicable carinata oil-based pathways by adding carinata oil to Table 1 in 40 CFR 80.1426(f). Two commenters (EPA-HQ-OAR-2015-0093-0027, 0030) suggested that the EPA could provide forward-looking guidance that a facility intending to utilize carinata oil could provide only information on the facility's production process and energy use. The EPA could evaluate these through an expedited review based on its finding that the greenhouse gas emissions reduction requirements should be met for a "typical" biodiesel or renewable diesel facility. One commenter (EPA-HQ-OAR-2015-0093-0027) requested that EPA provide guidance on how to seek approval to use carinata oil (and other feedstocks approved through this process). This commenter believes that individual producers may find the process of submitting petitions "onerous, time consuming or costly." They further express concern that individual producers may not fully understand the actions that may be needed to utilize carinata oil… under this process". The commenter believes EPA should make clear that feedstocks analyzed for upstream impacts (such as carinata) are available for use despite not appearing in Table 1, but that companies must submit a facility-specific petition. The commenter urges EPA to make clear what specific information it needs to complete evaluate a petition. The commenter acknowledges EPA's "Pathway Screening Tool" but believes the information available through it is not specific enough. Further, the commenter states that "EPA has indicated it would reject petitions it finds incomplete, and a facility may feel compelled to obtain data that EPA does not need to reach its assessment for these feedstocks." One commenter (EPA-HQ-OAR-2015-0093-0031) requested that EPA add carinata oil to Table 1 to put carinata on a level playing field with other (approved) feedstocks.

Response: EPA appreciates the desire for carinata oil to be a generally approved feedstock under the RFS. In 2015 we published upstream lifecycle assessment in line with a facility-specific review and

[2] https://sparc-cap.org/resources/research-extension-products/

approval process for carinata in the interest of expediting determinations on carinata oil-based pathway determinations. We believed this to be the best approach given the relatively nascent and uncertain status of carinata as an agricultural crop and biofuel feedstock and the relative time-intensity of doing a formal rulemaking for carinata oil pathways to be added to Table 1. We are now approving a facility-specific pathway using carinata oil as a feedstock because we have the REG Geismar petition before us; depending on the level of continued interest in carinata oil as a biofuel feedstock we may consider a generally applicable (Table 1) pathway in the future.

Regarding commenters' request for additional guidance from EPA for individual facilities, EPA appreciates the desire for certainty and further information for petitioners and potential petitioners. EPA believes that an initial facility-specific approval for a given feedstock, such as the REG Geismar approval for producing carinata oil-based fuels, will provide a useful template for any additional petitioners of carinata oil-based biofuels and reduce any uncertainty regarding what is required for a complete petition. Additionally, we disagree with the commenter's description of EPA's process for evaluating petitions without additional context, specifically that "EPA has indicated that it would reject petitions it finds incomplete". As described on the *Renewable Fuel Petition Review Process* webpage[3], EPA will communicate with petitioners and request additional information deemed necessary to make it "complete". It is only in instances where the petitioner cannot provide requested information, or is unresponsive, that EPA will reject a petition; we do not do it outright. A company interested in submitting a petition should not hesitate to do so, provided it's appropriate per the *Petition Screening Tool*.

EPA appreciates the comment requesting we provide additional guidance for what specific information petitioners need to provide. We believe the guidance document on our website titled *How to Prepare a Complete Petition,*[4] provides adequate information to help parties prepare new fuel pathway petitions pursuant to 40 CFR 80.1416. Furthermore, as alluded to in the comment we have a Pathway Screening Tool process to provide individual petitioners with tailored input on what information is needed. While we believe these resources are sufficient to help petitioners, we will continue looking for ways to improve the petition process and provide helpful information to petitioners.

Invasiveness of Carinata

Comment: One commenter (EPA-HQ-OAR-2015-0093-0029) was generally supportive of EPA's assessment of the invasiveness concerns of brassica carinata in the 2015 FRN. The commenter recommended that carinata be approved only on a pilot basis with stringent best management practices (BMPs), given the USDA Weed Risk Assessment (WRA) designated it as a crop for "further evaluation". The commenter expressed concern that risk management plans (RMPs) for carinata are not likely to be as robust as plans for *Arundo donax* and *Pennisetum purpureum*. The commenter urged EPA to include a

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[3] https://www.epa.gov/renewable-fuel-standard-program/renewable-fuel-petition-review-process#step3

[4] How to Prepare a Complete Petition Version 1.1 (PDF) (32 pp, 1.13 MB, EPA-420-B-15-083, July 2015), https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P100MUKP.pdf

robust RMP written with guidance from the National Invasive Species Council and relevant federal and/or state agencies.

Another commenter (EPA-HQ-OAR-2015-0093-0031) was critical of EPA's judgement that monitoring and reporting requirements like those applied for *Arundo donax* and *Pennisetum purpureum* are appropriate for carinata. The commenter stated that all real-world evidence indicates that carinata does not present invasiveness concerns. The commenter believed that it was not appropriate to compare carinata to *Arundo donax*, but rather that it should be compared to canola, soybean, and corn as it is a cultivated crop. The commenter states that proposing additional requirements based on uncertainty due to incomplete information based on the USDA Weed Risk Assessment (WRA) findings is arbitrary and does not present reasoned decision-making. The commenter included letters of support for the claim that carinata does not present risks of invasiveness from several researchers. The commenter further makes the case that carinata does not present a risk of invasiveness based on four traits of carinata seeds, 1) minimal seed shattering, 2) a lack of seed dormancy, 3) the relatively large size of the carinata seed which limits the range of dispersal, and 4) carinata is "highly susceptible to a wide range of herbicides".

<u>Response</u>: Following this comment on the 2015 FRN, EPA engaged with the Animal Protection and Plant Health Inspection Service (APHIS) agency of USDA to consider new information on the invasiveness risks of carinata and determine appropriate measures for addressing concerns. As described in the *REG Geismar Carinata Pathways Determination Letter*, for the purposes of the REG Geismar facility-specific pathway approval APHIS engaged with stakeholders in the carinata supply chain including Agrisoma Biosciences, Inc. – the original petitioner for approval of carinata oil-based biofuel pathways, and Nuseed, the research and development company that develops carinata seeds, provides guidance to farmers to grow carinata, and supplies the carinata oil to REG Geismar. APHIS worked with Nuseed to establish a RMP that mitigates risks of carinata spread. The RMP, *Nuseed Carinata - Risk Mitigation Plan,* is attached to this document and the REG Geismar determination letter. APHIS provided a letter communicating support for the use of carinata to produce carinata oil to be used as a renewable fuel feedstock, given adherence to the procedures outlined in the RMP. That information is also attached as a document – *REG Geismar Carinata RMPs Letter APHIS*. APHIS's approval of the REG Geismar RMP is valid for 3 years, after which time REG will have to engage with APHIS to reestablish a RMP to continue to generate RINs for carinata-oil based fuels.

<u>Comment</u>: One commenter (EPA-HQ-OAR-2015-0093-0031) questioned EPA's authority to include emissions related to invasiveness concerns in the lifecycle assessment, thinking that any emissions associated with invasiveness remediation are "highly speculative" and outside of the full "fuel lifecycle", which EPA is bound to in considering emissions.

<u>Response</u>: In the July 2013 Additional Pathways I rule (78 FR 41703), in response to comments on the proposal concerning the potential for certain crops to behave as invasive species, we adopted additional registration, recordkeeping, and reporting requirements to address the potential for GHG emissions

related to these concerns. EPA's lifecycle evaluation of carinata oil for the *REG Geismar Carinata Pathways Determination Letter* assumes no significant indirect greenhouse gas emissions associated with actions to remove or remediate the unintended spread of these feedstocks outside of the intended planting area. The RMP discussed above, developed in consultation with APHIS, are designed to ensure that this assumption is realized.

USDA

United States Department of Agriculture

Animal and Plant Health Inspection Service

Plant Protection and Quarantine

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March 15, 2022

Ezra Finkin
Senior Manager, Corporate Affairs & Development
Renewable Energy Group

Dear Mr. Finkin,

On behalf of the U.S. Department of Agriculture's (USDA) Biofuels Team, the Animal and Plant Health Inspection Service (APHIS) submits this letter in support of the use of carinata (*Brassica carinata*) to produce renewable fuel under the U.S. Environmental Protection Agency's (EPA) Renewable Fuel Standard program. We base our assessment and conclusion on the Carinata Risk Mitigation Plan (RMP) outlined by Nuseed – the carinata seed supplier for the Renewable Energy Group (REG) Geismar.

A 2014 APHIS weed risk assessment showed that *B. carinata* poses a moderate risk of becoming weedy or invasive in the United States. The assessment considered a range of biological factors about the species as well as evidence of spread and impacts where it occurs. While it's not likely to be any weedier than other cultivated *Brassica* oilseed crops, there was a large amount of uncertainty associated with the analysis due to the limited amount of information available for the species.

EPA requested APHIS to assess Nuseed's RMP in conjunction with the proposed REG Geismar Carinata Pathways to produce renewable fuel. During the review of the RMP, the USDA Biofuels Team noted that carinata's resiliency characteristics could potentially pose a risk, and there is limited industry experience growing carinata as a crop. APHIS engaged with Nuseed to understand their practices for carinata seed transport, planting, harvesting, and storage and remediation procedures if carinata is found outside of intended areas.

Based on our review of available scientific information, we concluded that the *Nuseed Carinata – Risk Mitigation Plan* contains practices that adequately reduce the risks of carinata spread. We support the use of carinata to produce renewable fuel under EPA's Renewable Fuel Standard program following the mitigation measures outlined in the RMP. Given the nascent experience of carinata in the United States, we request that the effectiveness of the RMP be reevaluated in six years from the date of this letter. We further request that REG engage with APHIS in advance of the end of this six-year window to reassess and revise the RMP to the extent necessary. This includes addressing any evidence that carinata has spread beyond intended growing fields.

Sincerely,

Mark L. Davidson, DVM, MS
Acting Deputy Administrator
Plant Protection and Quarantine

Cc:
Michael Shell, Environmental Protection Agency
Aaron Levy, Environmental Protection Agency
Sharyn Lie, Environmental Protection Agency
Samantha Simon, Animal and Plant Health Inspection Service

Attached: *Nuseed Carinata Risk Mitigation plan.pdf*

NuSeed Risk Management Practices – Claimed as Confidential Business Information