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

September 26, 2022

OFFICE OF
AIR AND RADIATION

Mr. Chris Cavote
President, Manufacturing Chevron U.S.A. Inc.
6001 Bollinger Canyon Road
San Ramon, CA 94583

Dear Mr. Cavote:

You petitioned the Agency on behalf of Chevron U.S.A. Inc. (Chevron) to approve a facility-specific pathway for the generation of advanced biofuel (D-code 5) renewable identification numbers (RINs) for renewable gasoline, renewable gasoline blendstock, renewable jet fuel and non-ester renewable diesel fuel ("renewable diesel") produced from soybean oil through co-processing with petroleum feedstocks in the fluid catalytic cracking (FCC) unit at Chevron's refinery in El Segundo, California (the "Chevron El Segundo Soy FCC Pathways").

Through the petition process described under 40 CFR 80.1416, Chevron submitted data to EPA to perform a lifecycle greenhouse gas analysis of the renewable gasoline, renewable gasoline blendstock, renewable jet fuel and renewable diesel produced through the Chevron El Segundo Soy FCC Pathways. This analysis involved a straightforward application of the same methodology and much of the same modeling used for the March 2010 RFS2 rule (75 FR 14670). Given that EPA has not previously evaluated soybean oil co-processing in an FCC unit, the primary difference between this analysis and the modeling completed for the March 2010 RFS2 rule is the consideration of the facility-specific mass and energy balance data for the Chevron El Segundo FCC process.

Based on our assessment, renewable gasoline, renewable gasoline blendstock, renewable jet fuel, and renewable diesel produced through the Chevron El Segundo Soy FCC Pathways qualify under the Clean Air Act (CAA) for D-code 6 RINs, provided Chevron adheres to all of the conditions specified in the attached determination document and the fuels meet the other definitional and RIN generation requirements for renewable fuel specified in the CAA and its implementing regulations.

Based on the results of our lifecycle analysis, Chevron's fuel satisfies the 20% GHG reduction requirement for D-code 6 RIN eligibility. Chevron's petition requests D-code 5 eligibility, which requires a 50% GHG reduction. However, additional review is needed to determine appropriate conditions for D-code 5 RIN eligibility; such conditions are necessary to ensure that any fuel that generates D-code 5 RINs in fact meets the 50% GHG reduction threshold. In the interest of time, Chevron has asked EPA to move ahead with a D-code 6 determination while review of D-code 5 eligibility continues.

This approval applies specifically to the Chevron refinery facility in El Segundo, California and to the processes, materials used, fuels produced, and process energy types and amounts outlined and described in the September 2020 petition request, and subsequent updates, submitted by Chevron.

EPA's electronic registration and transaction systems will be modified to allow Chevron to register and generate conventional biofuel RINs for renewable gasoline, renewable gasoline blendstock, renewable jet fuel, and renewable diesel produced through the Chevron El Segundo Soy FCC Pathways.

Sincerely,

SARAH DUNHAM
Digitally signed by SARAH DUNHAM
Date: 2022.09.26 17:43:35 -04'00'

Sarah Dunham, Director
Office of Transportation and Air Quality

Enclosure

<u>Chevron El Segundo Soy FCC Fuel Pathway Determination under the RFS Program</u>
Office of Transportation and Air Quality

Summary: Chevron U.S.A Inc. (Chevron) petitioned the agency under the Renewable Fuel Standard (RFS) program to approve a pathway that would allow Chevron to generate advanced biofuel (D-code 5) renewable identification numbers (RINs) for renewable gasoline, renewable gasoline blendstock, renewable jet fuel, and non-ester renewable diesel fuel ("renewable diesel") produced from co-processing soybean oil at approximately 10% by volume with petroleum feedstocks in the fluid catalytic cracking (FCC) unit of Chevron's refinery in El Segundo, California (the "Chevron El Segundo Soy FCC Pathways").

Based on the data submitted by Chevron and our previous modeling of the greenhouse gas (GHG) emissions associated with producing and transporting soybean oil, we conducted a lifecycle assessment and estimated lifecycle GHG reductions compared to the petroleum baseline of 52% for renewable gasoline and renewable gasoline blendstock, 52% for renewable jet fuel and 45% for renewable diesel produced through the Chevron El Segundo Soy FCC Pathways. Based on the results of our lifecycle GHG assessment, renewable gasoline, renewable gasoline blendstock, renewable jet fuel and renewable diesel produced from soybean oil through the Chevron El Segundo Soy FCC Pathways qualifies for renewable fuel (D-code 6) RINs, provided all associated regulatory requirements are satisfied, including the conditions specified in this pathway determination document.

The fuel pathways for which Chevron requested our evaluation are the type of new pathways that EPA described in the preamble to the March 2010 RFS2 rule (75 FR 14670) as capable of being evaluated by comparing the applicant's fuel pathways to pathways that have already been analyzed. Our analysis of the Chevron El Segundo Soy FCC Pathways involved a straightforward application of the same methodology and much of the same modeling used for the March 2010 RFS2 rule. We have not previously estimated the lifecycle GHG emissions of co-processing soybean oil in a refinery FCC unit. Thus, the main difference between this analysis and the analyses completed for these previous assessments was the evaluation of process data from Chevron's El Segundo facility. Our lifecycle analysis is described below in Section III of this 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 Chevron's El Segundo refinery, 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-codes for renewable gasoline, renewable gasoline blendstock, jet fuel and diesel fuel produced through the Chevron El Segundo Soy FCC Pathways.
- *Section IV. Conditions and Associated Regulatory Provisions:* Registration, reporting, and recordkeeping requirements for renewable fuel produced through the Chevron El Segundo Soy FCC 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 Chevron petition.

I. Required Information and Criteria for Petition Requests

A. Background and Purpose of 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.[1]

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. Pursuant to 40 CFR 80.1426(f)(6) 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 for that baseline volume, assuming all other regulatory requirements are satisfied.[2]

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

[2] "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,

In addition, 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 or generally-applicable fuel pathway in accordance with 40 CFR 80.1416. 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, 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).
- 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.
- Other additional information as requested by the Administrator to complete the lifecycle greenhouse gas assessment of the new fuel pathway.

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. 40 CFR 80.1416(c)(2).

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 Chevron El Segundo petition because the proposed pathways use a feedstock, soybean oil, that EPA has previously evaluated.

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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.

II. Available Information

A. Background on Chevron El Segundo

Chevron petitioned the agency to approve pathways that would allow them to generate advanced biofuel (D-code 5) RINs for renewable gasoline, renewable gasoline blendstock, jet fuel and diesel produced from soybean oil feedstock through an FCC process at Chevron's refinery in El Segundo, California. A petition is 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 Chevron El Segundo petition would produce fuel from a feedstock, soybean oil, that EPA previously evaluated in the March 2010 RFS2 rule (75 FR 14670) (see Table 1). Therefore, no new feedstock modeling was required. Similarly, no new modeling of the emissions associated with the combustion of renewable gasoline, renewable gasoline blendstock, renewable jet fuel or renewable diesel was required because that was previously evaluated as part of prior rulemakings.[3] Compared to previous rulemakings, this petition only required EPA to evaluate a specific fuel production process whereby soybean oil is co-processed with petroleum in the FCC unit of the El Segundo refinery.

The new component of this analysis was the evaluation of Chevron El Segundo's fuel production process. We have not evaluated the GHG emissions associated with an FCC process that co-processes renewable biomass and petroleum in previous RFS rulemakings. However, our analysis of baseline gasoline and diesel included modeling of the FCC refinery process using only petroleum feedstock. Furthermore, some of the renewable fuel production processes that we have modeled (e.g., gasification and upgrading) have similarities with the Chevron El Segundo Soy FCC Process.[4] Given the similarities with prior modeling, this was a relatively straightforward analysis based on existing modeling done for previous rulemakings for the RFS program, but substituting Chevron's specific fuel production process data into the analysis.

[3] See Section III of this document for details.

[4] In the March 2010 RFS2 rule, EPA analyzed and approved an advanced biofuel (D-code 5) pathway for the production of renewable diesel through a hydrotreating process that co-processes soybean oil and petroleum. In the March 2013 RFS Pathways I rule (78 FR 14190), EPA analyzed and approved a similar pathway for jet fuel co-produced with renewable diesel through a hydrotreating process that co-processes soybean oil and petroleum. In the same rule, EPA evaluated and approved cellulosic biofuel (D-code 3) for renewable gasoline produced from cellulosic feedstocks through a range of production processes, including catalytic pyrolysis and upgrading.

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
H	Biodiesel, renewable diesel, jet fuel and heating oil	Soybean oil; Oil from annual covercrops; Oil from algae grown photosynthetically; Biogenic waste oils/fats/greases; *Camelina sativa oil*; Distillers corn oil; Distillers sorghum oil; Commingled distillers corn oil and sorghum oil	One of the following: Trans-Esterification with or without esterification pre-treatment, or Hydrotreating; includes only processes that co-process renewable biomass and petroleum	5 (advanced)
M	Renewable Gasoline and Renewable Gasoline Blendstock; Co-Processed Cellulosic Diesel, Jet Fuel and Heating Oil	Crop residue, slash, pre-commercial thinnings, tree residue, and separated yard waste; biogenic components of separated MSW; cellulosic components of separated food waste; and cellulosic components of annual cover crops.	Catalytic Pyrolysis and Upgrading, Gasification and Upgrading, Thermo-Catalytic Hydrodeoxygenation and Upgrading, Direct Biological Conversion, Biological Conversion and Upgrading utilizing natural gas, biogas, and/or biomass as the only process energy sources providing that process used converts cellulosic biomass to fuel; any process utilizing biogas and/or biomass as the only process energy sources which converts cellulosic biomass to fuel.	3 (cellulosic biofuel)

C. Information Submitted by Chevron

Chevron supplied all the information as required in 40 CFR 80.1416 that EPA needed to analyze the lifecycle GHG emissions associated with the renewable gasoline, renewable gasoline blendstock, renewable jet fuel and renewable diesel produced through the Chevron El Segundo Soy FCC Pathways. Under claims of confidential business information, Chevron provided detailed schematics of their FCC process. They also provided data, submitted under claims of confidential business information, from commercial and pilot scale testing of FCC co-processing with vegetable oil, including three months of commercial-scale operating data from all of the relevant units in the El Segundo refinery. These data included the results of Carbon-14 testing on the inputs and outputs of the co-processing tests to estimate the biogenic carbon in these materials. As part of their petition, Chevron provided a spreadsheet estimating the lifecycle GHG emissions associated with their soybean-oil based fuels based on three months of operational data at the El Segundo refinery. The spreadsheet includes assumptions related to the biogenic content of the products and co-products based on Carbon-14 analyses from other FCC co-processing test runs. The spreadsheet uses process-level energy allocation to attribute emissions to the different product streams moving through the refinery. It also uses emissions factors and other data that align with EPA's previous lifecycle GHG analyses for the RFS program, including emissions factors for natural gas and upstream and indirect GHG emissions associated with producing soybean oil and transporting it to a refinery for biofuel production. EPA conducted a detailed review of the spreadsheet and had multiple technical exchanges with Chevron. Based on our questions, from November 2021 to May 2022, Chevron supplied a significant amount of additional information that we have reviewed and considered as part of the petition record. Based on our review, Chevron made a number of revisions, and we confirmed that the estimates contained in the spreadsheet utilize the same fundamental modeling approach as was used in previous rulemakings for the RFS program.

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 renewable 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).
- Fuel production – 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 the renewable gasoline, renewable gasoline blendstock, renewable jet fuel, and renewable diesel produced through the Chevron El Segundo Soy FCC Pathways under this petition request is consistent with the CAA's applicable requirements, including the definition of lifecycle GHG emissions and threshold evaluation requirements.

Feedstock Production and Transport – The Chevron El Segundo Soy FCC Pathways use a feedstock, soybean oil, that EPA previously evaluated in the March 2010 RFS2 rule. Thus, no new feedstock modeling was necessary to evaluate Chevron's petition. Based on our analysis for the March 2010 RFS2 rule, we estimated that producing and using soybean oil as a biofuel feedstock produces 646.6 grams of carbon dioxide-equivalent emissions (gCO_2e) per pound of soybean oil.[5] This estimate of the "upstream" feedstock emissions includes direct and indirect emissions (including indirect emissions from land use change) associated with growing soybeans, crushing the soybeans to extract the soybean oil and transporting the soybean oil to the Chevron El Segundo refinery.

For our evaluation of Chevron's petition we made straightforward updates to our original estimate of the upstream GHG emissions associated with soybean oil production and transport. As a result of these updates, the estimated upstream emissions associated with soybean oil changed from 646.6 gCO_2e to 647.9 gCO_2e per pound of soybean oil delivered. These updates did not involve any revisions to the agricultural sector (FASOM or FAPRI) modeling conducted for the March 2010 RFS2 rule. First, in places where the original analysis used data from a prior version of the GREET model, we replaced these data with the default estimates, without modification, from the GREET-2021 Fuel Cycle Model.[6] The GREET data updates were applied to the following elements: emissions factors for natural gas production and use, LPG production and use, coal production and use, nitrogen fertilizer production, phosphate fertilizer production, hydrogen production, herbicide and pesticide production and use, energy inputs and efficiency of soybean crushing, and feedstock transport energy use and emissions. Second, we updated the foreign land use change emissions factors based on more recent data on forest carbon stocks in Latin America, Sub-Saharan Africa, parts of Africa and Europe. We have used and explained these data updates in prior rules and Federal Register publications.[7] Third, we

[5] March 2010 RFS2 rule (75 FR 14788-90). See also EPA (2010). Renewable fuel standard program (RFS2) regulatory impact analysis. Washington, DC, Environmental Protection Agency Office of Transportation and Air Quality. (EPA-420-R-10-006). Section 2.6.1.3.

[6] GREET (2021). GREET 2021 Fuel Cycle Model. Argonne National Laboratory. https://greet.es.anl.gov/

[7] These updates are described in the following technical report available in a public docket: 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. They have been applied in the following actions: January 2012 Palm Oil NODA (77 FR 4300), December 2012 grain sorghum rule (77 FR 74592), 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)

updated our estimates of the GHG emissions associated with changes in foreign on-farm energy use.[8] Finally, we updated from using GWP values from the IPPC Second Assessment Report to values from the Fifth Assessment Report.[9]

Fuel Production – Chevron intends to co-process soybean oil at approximately 10% by volume in the FCC unit of the Chevron El Segundo refinery to produce renewable gasoline, renewable gasoline blendstock, renewable jet fuel, and renewable diesel. While some gasoline blend components are produced directly from the FCC unit, much of the output from the FCC is directed to other refinery units for additional conversion and processing (e.g., alkylation unit, jet hydrotreating unit, hydrocracking unit). As part of their petition, Chevron submitted a spreadsheet model that calculates the lifecycle GHG emissions associated with fuels produced through the Chevron El Segundo Soy FCC Pathways. We reviewed the spreadsheet model in detail and, after discussion with Chevron, made several modifications to make the spreadsheet model consistent with our existing approach to lifecycle GHG analysis for the RFS program. The resulting spreadsheet model (the "Chevron GHG Model") estimates the lifecycle GHG emissions associated with renewable gasoline, renewable gasoline blendstock, renewable jet fuel and renewable diesel produced through co-processing soybean oil in the Chevron El Segundo FCC unit and other downstream units. This subsection describes the FCC process, the Chevron GHG Model and our evaluation of the GHG emissions associated with the fuel production stage of the Chevron El Segundo Soy FCC Pathways.

A typical FCC unit produces gasoline blendstocks and other high value products from hydrocarbons by "cracking" the feed (i.e., converting larger hydrocarbon chains into smaller components) at approximately 1000˚F in the reactor. Cracking takes place when the catalyst is fluidized at a high temperature and contacted with the gas oil feed. During the cracking reaction the catalyst surface becomes coated with coke. The coke is a temporary catalyst poison which reduces catalyst activity. The coke-coated "spent" catalyst then goes into a regenerator where the coke is burned off at temperatures above 1100˚F, thus restoring catalyst activity and providing process heat to drive the cracking reaction and excess heat that is recovered to generate steam. Separators inside the regenerator remove the regenerated catalyst from the gas stream. The catalyst is maintained in a fluidized state and is continually cycled back and forth between the reactor and regenerator.

Products from the FCC include gasoline boiling range components that are used directly for gasoline blendstocks as well as products routed to downstream units for further conversion and processing. The lighter components from the FCC reactions are separated and routed to the refinery fuel gas system and burned or routed to the Alkylation unit where gasoline components are produced.

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[8] These updates are explained in the April 2022 Canola Oil Pathways NPRM (87 FR 22834-22835). Data and estimates are available on the docket: "Canola RD Intl Ag Energy GHG NPRM v2" (EPA-HQ-OAR-2021-0845-0014).

[9] 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.

The middle distillate stream from the FCC is routed to the naphtha hydrotreater (NHT) to produce jet fuel. Light cycle oil (LCO) from the FCC is routed to the "Isomax" unit, the refinery's hydrocracker used to produce gasoline and jet fuel. Output from the Isomax unit feeds both the continuous catalytic reformer (CCR) unit to produce gasoline blendstock and the jet hydrofinishing plant (JHP) to produce low aromatic blendstock for jet and diesel blending. Finally, a small amount of renewable material from the CCR is expected to be fed to the Penex isomerization unit, resulting in additional renewable gasoline blendstock. Heavy cycle oil (HCO) from the FCC is sold and is generally used as a fuel-oil blendstock.

The cogeneration facility at El Segundo supplies the electric power and steam used at the facility. The Chevron GHG Model estimates the facility-specific electricity and steam GHG emissions for El Segundo. Both natural gas and refinery fuel gas are used in the Cogen units – natural gas is used to fuel the turbines, while refinery fuel gas is used in the duct burner to extract more steam from the system. The Chevron GHG Model uses operational data to estimate total emissions, steam output and electricity output from the cogeneration unit. GHG emissions from the cogeneration unit are allocated to the steam and electricity assuming 80% efficiency for steam production and 35% for electricity production. The resulting emissions factors used in the model are 491 gCO_2e/kWh of electricity and 143,772 gCO_2e/mmBtu for steam.

Refineries use hydrogen to lower the sulfur content of diesel fuel, as a key input for hydrotreating processes and other purposes. There are three sources of hydrogen at the El Segundo refinery: (1) the steam naphtha reformer (SNR) plant within the refinery; (2) the steam methane reformer (SMR) plant adjacent to the refinery; and (3) the CCR unit within the refinery. The Chevron GHG Model includes operational data to estimate the emissions associated with hydrogen production from the SNR. For purchased SMR hydrogen the Chevron GHG Model uses an average emissions factor for SMR hydrogen from the GREET model. The purpose of the CCR unit is to upgrade low octane gasoline to high octane reformate for gasoline blending, and it produces hydrogen as a co-product. The Chevron GHG Model includes operational data for the CCR unit and an emissions factor for hydrogen produced from this unit is estimated using the unit process level energy allocation approach (this allocation approach is discussed below).

The Chevron El Segundo refinery uses sulfuric acid as a catalyst and purchases isobutane for Alkylation. EPA reviewed the data and assumptions used in the Chevron GHG Model to estimate these emissions factors and confirmed that they are reasonable and based on the best available information.

The FCC is a net producer of fuel gas that is used in other refinery units. It also generates coke (also referred to as catalyst make-up) that is burned for process heat. The final outputs from feeding soybean oil to the FCC unit, including all of the processing in units downstream of the FCC, are renewable gasoline, gasoline blendstock, jet fuel, diesel, light cycle oil (LCO), heavy cycle oil (HCO), FCC light bottoms, propane and n-Butane.[10] Chevron intends to generate RINs for the renewable gasoline, renewable gasoline blendstock, renewable jet fuel and renewable diesel, and these fuels are assigned differing levels of refining GHG emissions (i.e., fuel production GHG emissions) in the Chevron GHG Model based on how they are processed in different refinery units. The Chevron GHG Model assumes that the excess LCO and HCO will be sold as marine cutter stock (i.e., marine fuel), the FCC light bottoms will be sold to another entity for sale as gasoline blendstock, and the propane and n-Butane are used onsite as process fuel. Chevron has not requested RIN eligibility for these co-products (e.g., LCO, HCO, FCC light bottoms, propane, n-Butane) as they do not intend to sell or distribute them for uses that would qualify them as renewable fuels under the RFS program. Should Chevron wish, in the future, to sell or distribute any of these products for qualifying use(s) and generate RINs, it would have to submit a new petition to EPA in order to obtain the relevant pathway(s).

In the Chevron GHG Model, a process unit level allocation approach is used to estimate GHG emissions from FCC co-processing. In this approach, total emissions from each refinery unit (e.g., FCC unit) are allocated to individual products (including co-products) based on the energy content of the products from each processing unit. In effect, this approach carries "upstream" energy and emissions inputs along with the intermediate products and process units until a final product is made.

EPA has used the process unit level approach for lifecycle GHG analysis of gasoline and diesel refining for the March 2010 RFS2 rule, including the modeling used to estimate the lifecycle GHG emission associated with the statutory 2005 gasoline and diesel baselines. Furthermore, process unit level allocation has also been applied[11] and recommended[12] in multiple peer reviewed scientific journal articles on the lifecycle GHG emissions associated with petroleum refining. The process unit level allocation approach is also appropriate for analysis of refineries that co-process petroleum and biomass, provided the biomass co-processing does not substantially alter the energy inputs and outputs from the process units being evaluated. The California Air Resources Board (CARB) proposed the

[10] In this instance we call these products "renewable" insofar as they are produced from soybean oil. We are making no statement here about the eligibility of these fuels or products as "renewable fuel" as that term is defined in CAA 211(o) or the RFS implementing regulations.

[11] See for example: Gregory Cooney, Matthew Jamieson, Joe Marriott, Joule Bergerson, Adam Brandt, and Timothy J. Skone Environmental Science & Technology 2017 51 (2), 977-987 DOI: 10.1021/acs.est.6b02819; Pingping Sun, Ben Young, Amgad Elgowainy, Zifeng Lu, Michael Wang, Ben Morelli, and Troy Hawkins. Environmental Science & Technology 2019 53 (11), 6556-6569 DOI: 10.1021/acs.est.8b05870

[12] Wang, M., Lee, H. & Molburg, J. Allocation of energy use in petroleum refineries to petroleum products. Int J LCA 9, 34–44 (2004). https://doi.org/10.1007/BF02978534. The last sentence in this article is, "When possible, process-level allocation should be used in life-cycle analyses."

process unit level approach for purposes of evaluating the carbon intensity of co-processing triglycerides in FCC units.[13]

One possible drawback of process unit level allocation for co-processing is that it may underestimate energy use and emissions when a biogenic feedstock consumes (i.e., requires for processing) disproportionately more energy and inputs, such as hydrogen, in which case an incremental allocation approach may be more appropriate.[14] However, when using the incremental allocation approach it is often difficult to determine the most appropriate baseline. Thus, for practical and technical reasons, in cases where the process unit level allocation approach can be justified it is generally preferred.

When co-processed at approximately 10% in a refinery FCC unit, soybean oil processing may not consume exactly the same energy inputs as the petroleum feed, but the differences are relatively small. The information we reviewed, including data from Chevron and peer reviewed journal articles, indicates that, in the case of approximately 10% soybean oil co-processing, once the oxygen in the soybean oil is removed, what remains is a poly-unsaturated hydrocarbon that is relatively similar to conventional petroleum FCC feed, and produces a generally similar yield of products. The removed oxygen forms a mixture of inerts in the form of H_2O, CO and CO_2. The carbon "removed" with the inert CO and CO_2 results in a lower renewable carbon content by volume percent in the products relative to the feedstock. However, studies indicate that the effect of inert formation on product formation is muted as the oxygen in the vegetable oils is converted primarily to water.[15] Data provided by Chevron, under claims of confidential business information from commercial and pilot scale FCC co-processing tests shows that soybean oil, when co-processed at approximately 10% by volume in the FCC unit, reacts similarly to the petroleum-based vacuum gas oil (hereafter referred to as "petroleum") feedstock. Based on our review of this information, we believe the process unit level allocation approach is appropriate for evaluating the Chevron El Segundo Soy FCC Pathways.

Chevron would only be eligible to generate RINs for fuel produced from soybean oil that meets the definition of renewable fuel. For this reason, our lifecycle analysis estimates the GHG emissions associated with only the fraction of fuel produced from soybean oil (i.e., not an average of all fuel produced from soybean oil and petroleum). Using the process level allocation approach, it is straightforward, with few exceptions, to assign the energy use and GHG emissions to the products produced from the soybean oil. However, emissions associated with refinery fuel gas and coke are less

[13] California Air Resources Board (CARB). 2017. "Co-processing of Low Carbon Feedstocks in Petroleum Refineries." Draft Discussion Paper. May 30, 2017. p. 10-14.

[14] Ibid., p. 15

[15] See Bielansky et al. (2011). "Catalytic conversion of vegetable oils in a continuous FCC pilot plant." Fuel Processing Technology. (92) 2305-2311. doi:10.1016/j.fuproc.2011.07.021. See in particular Figure 3 and the statement in the Conclusion section, "The decrease in conversion was mainly caused by the oxygen content of the vegetable oils."

straightforward given uncertainties about whether soybean oil produces and consumes disproportionate amounts of coke and fuel gas relative to the petroleum feed. Fuel gas and coke are produced in the FCC unit and also combusted for process energy within the refinery. Coke is combusted to heat the FCC process and fuel gas is exported from the FCC to other refinery units. Fuel gas and coke combustion are a source of refinery GHG emissions. However, fuel gas and coke produced from soybean oil feed is composed of biogenic carbon, and our analysis assigns a value of zero to the CO_2 emissions from combusting these biogenic materials.[16] This treatment of the fuel gas and coke CO_2 emissions is consistent with our previous lifecycle GHG analyses for the RFS program.

Based on the information we reviewed, including data from pilot and commercial testing provided by Chevron and peer reviewed journal articles, we assume that 100% of the fuel gas produced from FCC processing of soybean oil is produced from the soybean oil. We also assume that 90% of the coke combusted to heat FCC soybean oil processing is produced from the soybean oil. In other words, we assume that biogenic carbon contained in the soybean oil forms fuel gas at the same rate and coke at almost the same (90%) rate as carbon in the conventional petroleum feed. For safety reasons it is infeasible to sample and test the biogenic carbon content of refinery fuel gas and coke from the FCC unit of a commercial refinery. Thus, our assumptions are based on indirect evidence from the FCC co-processing test data provided by Chevron.

The assumption for fuel gas is based on data showing that co-processing approximately 10% soybean oil does not significantly alter the FCC heat balance and outputs.[17] The 90% biogenic assumption for the coke is based on EPA's review of FCC co-processing test data provided by Chevron under claims of confidential business information While there is uncertainty in this assumption, we believe it is reasonable based on the available information. Furthermore, the lifecycle GHG estimates are not very sensitive to this assumption about coke formation.[18]

[16] Following the methodology developed for the March 2010 RFS2 rule, after notice, public comment, and peer review, the carbon in the 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 CO_2 combustion emissions, we leave both out of the results. Note that our analysis also accounts for all significant indirect emissions associated with soybean oil, such as from land use changes, meaning we do not simply assume that biofuels are "carbon neutral."

[17] Furthermore, our lifecycle GHG estimates are not sensitive to this assumption on biogenic carbon in fuel gas produced from the FCC unit. For example, if we assume none of the fuel gas carbon is biogenic (an extreme assumption), the percent GHG reduction estimates change by 1% or less for renewable gasoline, renewable gasoline blendstock, jet fuel and diesel.

[18] For example, assuming soybean oil forms coke at 50% the rate of petroleum feed (instead of our 90% assumption) would increase the lifecycle GHG estimate for renewable gasoline from 47.9 (51.6% reduction) to 49.0 $kgCO_2e/mmBtu$ (50.5% reduction).

Fuel Distribution – We used data from GREET-2021 to estimate emissions associated with renewable fuel transportation and distribution. We assume fuel is transported by barge, rail, pipeline and truck from Chevron El Segundo to a distribution location and then trucked to retail locations via truck. We based these assumptions on the GREET-2021 data for transportation and distribution of renewable gasoline, renewable gasoline blendstock, jet fuel and diesel. GREET includes energy intensity (Btu per ton-mile) for each of the transport modes and back-haul emissions for trucks and barges.

Fuel Use – For this analysis we applied non-CO_2 fuel use emissions factors from GREET-2021.[19] For renewable gasoline and renewable gasoline blendstock we used the factors for renewable gasoline consumed in a spark-ignition vehicle. For renewable jet fuel we used the factors for hydrotreated renewable jet fuel consumed in a single aisle passenger aircraft. For renewable diesel we used the factors for renewable diesel used in a compression ignition direct injection vehicle.

In previous RFS rulemakings we have selected appropriate approaches for estimating fuel use emissions depending on the fuels and pathways being evaluated. For the March 2010 RFS2 rule we estimated the GHG emissions associated with ethanol, biodiesel, baseline gasoline and baseline diesel fuel use based on results from the EPA MOVES model.[20] In the March 2013 Pathways I rule, we used the non-CO_2 tailpipe emissions estimates for baseline gasoline in our analysis of renewable gasoline and renewable gasoline blendstock (78 FR 14208). In the 2018 Sorghum Oil rule we used the non-CO_2 tailpipe emissions estimates for baseline diesel in our analysis of renewable diesel and jet fuel (83 FR 37743). More recently, the April 2022 Canola Oil Pathways proposed rule uses emissions factors from GREET for renewable diesel, renewable jet fuel, naphtha and LPG (74 FR 22823). The tailpipe emissions estimates from these various sources are all similar, within approximately one $kgCO_2e$/mmBtU, and the results of our evaluation of the Chevron El Segundo Soy FCC Pathways are not sensitive to the minor differences between tailpipe emissions estimates across these data sources. Thus, we believe the approach used here of applying emissions factors from GREET is generally consistent with prior RFS rulemakings and appropriate for the purposes of this evaluation.

Co-product Allocation – As discussed above, the final outputs from feeding soybean oil to the FCC unit, including all of the processing in units downstream of the FCC, are renewable gasoline, renewable gasoline blendstock, jet fuel, diesel, light cycle oil (LCO), heavy cycle oil (HCO), FCC light bottoms, propane and n-Butane. As also discussed above, process unit level energy allocation is used to estimate GHG emissions from FCC co-processing of soybean oil. For each refinery process unit (e.g., FCC, Alky, Isomax) we use energy allocation to assign GHG emissions to each of the product's

[19] See footnote above about treatment of CO2 emissions including explanation that we do not simply assume that biofuels are "carbon neutral."

[20] EPA (2010). Renewable fuel standard program (RFS2) regulatory impact analysis. Washington, DC, Environmental Protection Agency Office of Transportation and Air Quality. (EPA-420-R-10-006). See section 2.5.6 for gasoline and diesel. See section 2.4.9 for biodiesel and ethanol.

output from that process unit. We also use energy allocation to assign the upstream GHG emissions associated with soybean oil production and transport (including significant indirect emissions such as land use changes) to the products and co-products from FCC co-processing. That is, the total upstream emissions are allocated to all of the products and co-products on an energy basis.

An alternative approach for co-product accounting that we have used in some cases in previous analyses is the displacement approach. In the displacement approach all of the upstream and refining GHG emissions would be allocated to the products (i.e., renewable gasoline, renewable jet fuel and renewable diesel). The GHG impacts of the co-products displacing other fuels would then be estimated, and these displacement impacts would be allocated to the products. While our determination that fuel produced through the Chevron El Segundo Soy FCC Pathways meets the 20% GHG reduction threshold is not sensitive to the choice of allocation approach, we note that the energy allocation approach has an important advantage in this case relative to the displacement approach – by using energy allocation for co-products the GHG reduction estimates do not depend on which co-products generate RINs (or which products producers request RIN eligibility for), which is subject to change based on market and regulatory conditions.

Lifecycle GHG Results – Based on our analysis described above, including the refinery estimates in the Chevron GHG Model, we estimated the lifecycle GHG emissions associated with renewable gasoline, renewable gasoline blendstock, diesel and jet fuel produced through the Chevron El Segundo Soy FCC Pathways. Table 2 shows the lifecycle GHG emissions associated with the fuels produced through these pathways. To determine if these fuels satisfy the GHG reduction requirements, we compared the lifecycle GHG emissions for renewable gasoline and renewable gasoline blendstock with the statutory 2005 average gasoline baseline.[21] We compared the lifecycle GHG emissions for renewable jet fuel and renewable diesel with the statutory 2005 average diesel baseline.[22] As shown in Table 2, renewable gasoline, renewable jet fuel, and renewable diesel produced through the Chevron El Segundo Soy FCC Pathways exceed the CAA 20% GHG reduction threshold to qualify as renewable fuel.

Table 2: Lifecycle GHG Emissions for Fuels Produced Through the Chevron El Segundo Soy FCC Pathways (kgCO_2e/mmBtu)[23]

[21] For the March 2010 RFS2 rule we estimated baseline lifecycle GHG emissions for 2005 average gasoline equals 98.2 kgCO2e/mmBtu using IPCC SAR GWP values. For our analysis of the Chevron FCC petition we updated the baseline emissions with IPCC AR5 GWP values for an estimate of 99.0 kgCO2e/mmBtu.

[22] For the March 2010 RFS2 rule we estimated baseline lifecycle GHG emissions for 2005 average diesel equals 97.0 kgCO2e/mmBtu using IPCC SAR GWP values. For our analysis of the Chevron FCC petition we updated the baseline emissions with IPCC AR5 GWP values for an estimate of 97.7 kgCO2e/mmBtu.

[23] Totals may not be the sum of the rows due to rounding.

	2005 Gasoline Baseline	2005 Diesel Baseline	Renewable Gasoline[24]	Renewable Jet Fuel	Renewable Diesel
Feedstock Upstream	9.2	18.9	44.4	44.4	44.4
Refining			2.6	1.6	8.6
Fuel Distribution			0.6	0.4	0.4
Fuel Use	78.8	78.8	0.3	0.1	0.0
Total	99.0	97.7	47.9	46.4	53.4
Reduction from Baseline	--	--	52%	52%	45%

B. Application of the Criteria for Petition Approval

The Chevron petition request included a feedstock and fuel products already considered as part of the March 2010 RFS2 rule (75 FR 14670). EPA's evaluation of this petition included evaluation of a new fuel production process. Chevron provided all necessary information that was required for this type of evaluation.

Based on the data submitted and information already available through analyses conducted for previous RFS rulemakings, EPA conducted a lifecycle assessment and determined that the renewable gasoline, renewable gasoline blendstock, diesel and jet fuel produced through the Chevron El Segundo Soy FCC Pathways meet the 20% lifecycle GHG threshold requirement specified in the CAA for renewable fuel.

The lifecycle GHG results presented above justify authorizing the generation of D-code 6 RINs for renewable gasoline, renewable gasoline blendstock, renewable diesel and renewable jet fuel produced through the Chevron El Segundo Soy FCC Pathways, provided the fuel satisfies the other definitional and RIN generation criteria for renewable fuel specified in the CAA and EPA implementing regulations and the conditions specified in this pathway determination document.

Chevron's petition requests D-code 5 eligibility, which requires a 50% GHG reduction. However, additional review is needed to determine appropriate conditions for D-code 5 RIN eligibility; such conditions are necessary to ensure that any fuel that generates D-code 5 RINs in fact meets the 50% GHG reduction threshold. In the interest of time, Chevron has asked EPA to move ahead with a D-code 6 determination while review of D-code 5 eligibility continues.

IV. Conditions and Associated Regulatory Provisions

This approval for Chevron to generate D-code 6 RINs for renewable gasoline, renewable gasoline blendstock, renewable jet fuel, and renewable diesel is expressly conditioned on Chevron 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 (40 CFR part 80, Subpart

[24] By proxy we assume the same approximate results for renewable gasoline blendstock.

M). 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 regulations cited below and 40 CFR 80.1416(b)(1)(vii), 80.1426(a)(1)(iii), 80.1450(i), and 80.1451(b)(1)(ii)(W). In addition, or in alternative to bringing an enforcement action under the CAA, EPA may revoke this pathway approval if it determines that Chevron has failed to comply with any of the conditions specified herein.[25] 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.

Fuel produced through the Chevron El Segundo Soy FCC Pathways shall be produced from co-processing approximately 10% soybean oil by volume of the total feed into the FCC unit, not to exceed 20% by volume. In order to determine the renewable content of the co-processed fuels, Chevron must conduct carbon-14 testing as specified in 40 CFR 80.1426(f)(9) and determine the number of RINs based on the equation in 40 CFR 80.1426(f)(4)(i)(B). When registering under 40 CFR 80.1450(b), Chevron must submit a RIN generation protocol that specifies how Chevron will meet the requirements in 40 CFR 80.1426(f)(9) and 40 CFR 80.1426(f)(4)(i)(B). The RIN generation protocol must contain a description of how Chevron will determine the number of RINs that it can generate through the pathway approved in this document, the locations where samples for carbon-14 testing will be taken, a description explaining how Chevron will determine that composite sampling is representative (if applicable), and, if the method for carbon-14 testing is an alternative test method approved by the EPA, the method, the equipment, and the laboratory that will be used for the carbon-14 measurements

V. Public Participation

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 extensive new modeling. See 75 FR 14797 (March 26, 2010).

As part of the March 2010 RFS rule, we took public comment on our lifecycle assessment of the soybean oil biodiesel, renewable diesel and renewable jet fuel pathways listed in Table 1 to 40 CFR

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

80.1426,[26] including all models used and all modeling inputs and evaluative approaches. In responding to the petition submitted by Chevron, we have relied to a large extent on the soybean oil modeling that we conducted for the March 2010 RFS2 rule. We made adjustments based on a straightforward application of updated data and emissions factors or approaches that we took comment on in prior rulemakings (see Section III.A above). Thus, our fundamental modeling of soybean oil, renewable diesel, and renewable jet fuel for this decision has already been made available for public comment as part to the March 2010 RFS2 rule, and other relevant subsequent rulemakings.

As part of the March 2013 Pathways I rule, we took public comment on our lifecycle analysis of the renewable gasoline and renewable gasoline blendstock pathways in row M of Table 1 to 40 CFR 80.1426. Thus, our fundamental modeling of renewable gasoline and renewable gasoline blendstock has already been made available for public comment as part to the March 2013 Pathways I rule.

In responding to this petition, we have relied on the same methodology and much of the same modeling used for the March 2010 RFS2 rule and the March 2013 Pathways I rule, and have adjusted the analysis to account for the Chevon El Segundo process data. This includes use of the same emission factors and types of emission sources that were used in previous rules, with straightforward updates as explained above. As we have not previously estimated the lifecycle GHG emissions of co-processing soybean oil in a refinery FCC unit, the main difference between this analysis and the analyses completed for these previous assessments was the evaluation of process data from Chevron's El Segundo facility. Although this analysis involved evaluation of a new process, the fundamental methodology and much of the 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 our description of the petition process in the preamble to the March 2010 RFS Rule and our promulgation of 40 CFR 80.1416, as our work in responding to the petition was a logical extension of analyses already conducted.

VI. Conclusion

Based on our assessment, renewable gasoline, renewable gasoline blendstock, renewable jet fuel, and renewable diesel produced from soybean oil through the Chevron El Segundo Soy FCC Pathways qualifies for D-code 6 RINs, provided all the conditions and associated regulatory provisions specified in Section IV of this document are satisfied, and the fuel meets all other definitional and RIN generation criteria for renewable fuel specified in the CAA and its implementing regulations.

This conditional approval applies specifically to Chevron El Segundo, and to the process, materials used, fuels produced, and process energy types and amounts outlined and described in the

[26] The March 2013 Pathways I rule clarified that the definition of renewable diesel used in the March 2010 RFS2 rule included jet fuel (78 FR 14201).

petition request submitted by Chevron.[27] This approval is effective as of the signature date. D-code 6 RINs may only be generated for renewable gasoline, renewable gasoline blendstock, renewable jet fuel, and renewable diesel produced through the Chevron El Segundo Soy FCC Pathways that are produced after the date of acceptance and activation of Chevron El Segundo's registration for the new pathways.[28]

The OTAQ Reg: Fuels Programs Registration and OTAQ EMTS Application will be modified to allow Chevron to register and generate D-code 6 RINs for renewable gasoline, renewable gasoline blendstock, renewable jet fuel, and renewable diesel produced from soybean oil produced through the Chevron El Segundo Soy FCC Pathways using a production process of "Chevron El Segundo Soy FCC Process."

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

[28] 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."