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

MAR 29 2016

OFFICE OF
AIR AND RADIATION

Mr. Chang B. Hong, Esq.
Vice President, IP Counsel
Joule Unlimited Technologies, Inc.
18 Crosby Drive
Bedford, Massachusetts 01730

Dear Mr. Hong:

You petitioned the Agency on behalf of Joule Unlimited Technologies, Inc. (Joule) to approve a pathway for the generation of advanced biofuel RINs under the renewable fuel standard (RFS) program for ethanol produced by photosynthetic cyanobacteria using a proprietary production process called the Helioculture Sunflow-E ethanol process (the "Joule Helioculture Process"). In the Joule Helioculture Process, cyanobacteria act as a catalyst to produce and secrete ethanol, which is then collected and purified for use as a transportation fuel. Additionally, the algal biomass created is processed to produce an algal oil coproduct.

Through the petition process described under 40 CFR 80.1416, Joule submitted data to EPA to perform a lifecycle GHG analysis of ethanol produced through the Joule Helioculture Process. This analysis involved a straightforward application of the same methodology and much of the same modeling used for previous RFS rulemakings.

The attached document "Joule Unlimited Technologies, Inc. Request for Fuel Pathway Determination under the RFS Program" describes the data submitted by Joule, the analysis conducted by the EPA, and our determination of the lifecycle greenhouse gas emissions associated with the fuel production pathway described in Joule's petition. It also includes a full definition of the Joule Pathway and the Joule Helioculture Process evaluated by the EPA.

Based on our assessment, ethanol produced through the Joule Pathway qualifies under the Clean Air Act (CAA) for advanced biofuel (D-code 5) RINs, assuming that the fuel meets the other definitional criteria for renewable fuel (e.g., used to reduce or replace petroleum-based transportation fuel, heating oil or jet fuel) specified in the CAA and EPA's implementing regulations.

This approval applies specifically to Joule Unlimited Technologies, Inc., and to the process, materials used, fuel produced, co-products produced, and process energy sources as outlined and described in the petition request submitted by Joule. This approval is effective as of signature date. EPA will consider extending a similar approval to other petitioners utilizing similar fuel pathways as Joule, but will do so on a case-by-case basis upon verification that the pathway described in the petition meets the applicable CAA requirements.

The OTAQ Reg: Fuels Programs Registration and OTAQEMTS: OTAQ EMTS Application will be modified to allow Joule to register and then generate RINs for advanced ethanol produced from cyanobacteria through the Joule Pathway using a production process of "Joule Helioculture Process."

Sincerely,

Christopher Grundler, Director
Office of Transportation and Air Quality

Enclosure

Summary: Joule Unlimited Technologies, Inc. ("Joule") petitioned the Agency under the Renewable Fuel Standard (RFS) program for approval to generate advanced biofuel (D-Code 5) RINs for ethanol produced by photosynthetic cyanobacteria, using as energy sources solar photovoltaic (PV) electricity, natural gas, and concentrated solar power (CSP) for steam, and using non-potable water, waste carbon dioxide (CO_2), and fertilizer as process inputs. Joule's cyanobacteria, which are grown and circulated in low density polyethlene (LDPE) photobioreactors, act as a catalyst to produce and secrete ethanol. The ethanol is then collected and purified using adsorption and dehydration processes described in the Joule petition and claimed as confidential business information (CBI). The algal biomass created is processed to produce an algal oil coproduct. Joule's fuel production process uses no more than 10,780 Btu of natural gas per gallon of ethanol produced, and no more than 9,660 Btu of net grid electricity per gallon of ethanol produced, calculated on a 365-day rolling average basis.[1] The entire pathway as described in this paragraph is referred to in this document as the "Joule Ethanol Pathway" and the fuel production component of the pathway is referred to as the "Joule Helioculture Process".

The cyanobacteria grown by Joule simultaneously accumulate biomass and produce ethanol. The accumulated biomass can be processed to obtain an algal oil coproduct that may be used to produce biodiesel, renewable diesel, or other algal oil derived products. The algal oil to biodiesel/renewable diesel pathway already exists as a qualifying pathway under the RFS regulations and does not require a new pathway. Therefore, this determination document focuses only on the cyanobacteria to ethanol pathway. Based on data submitted by Joule, available information regarding typical chemical and biochemical unit processes, and EPA's assessment for the March 2010 RFS rule (*75 FR 14670, March 26, 2010*) of the greenhouse gas (GHG) emissions associated with ethanol distribution and use, EPA conducted a lifecycle assessment estimating that the ethanol produced through the Joule Ethanol Pathway reduces lifecycle GHG emissions compared to the statutory petroleum baseline by 85%. Based on these results, we have determined that ethanol produced by the

[1] The petition submitted by Joule says their process will use as energy sources PV, CSP and natural gas. Over the course of a year, Joule anticipates exporting as much PV electricity to the grid as they purchase, resulting in the use of zero net grid electricity. However, if PV and CSP provide less energy than Joule anticipates, they will use more natural gas and grid electricity. EPA conducted an assessment to determine the upper limits for natural gas and net grid electricity use per gallon of ethanol produced. Based on our assessment, and with Joule's agreement, we are including upper limits on the amounts of natural gas and net grid electricity that Joule's process can use, as specified above, while meeting the 50% GHG emission reduction threshold required for advanced renewable fuels. No limits are applied on CSP and PV, as these energy sources are evaluated as zero GHG sources of energy (see Section III for details). For the purposes of this determination document, Btu is expressed on a lower heating value (LHV) basis and gallons of ethanol are expressed on an undenatured (neat) basis.

Joule Ethanol Pathway meets the 50% lifecycle greenhouse gas reduction requirement for advanced biofuel (D-Code 5).

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 the petitions and required information as outlined in 40 CFR 80.1416. (This section is not specific to Joule's request and applies to all petitions submitted pursuant to 40 CFR 80.1416.)
- *Section II. Available Information*: Background information on Joule and the information Joule provided, and how it complies with the petition requirements outlined in Section I.
- *Section III. Analysis and Discussion*: Lifecycle analysis done for today's determination and how it differs from the analyses done for previous rulemakings. This section also describes how we have applied the lifecycle results to determine the appropriate D code for ethanol produced through the Joule Ethanol Pathway.
- *Section IV. Conditions and Associated Regulatory Provisions*: Registration, Reporting, and Recordkeeping requirements for the Joule Ethanol Pathway.
- *Section V. Public Participation*: Describes how this petition is an extension of the analyses done as part of previous RFS rules.
- *Section VI. Conclusion*: Conclusions regarding Joule's petition, including the D code Joule may use in generating RINs for ethanol produced using the Joule Ethanol Pathway.

I. Required Information and Criteria for Petition Requests

A. Background and Purpose of Petition Process

As a result of changes to the RFS program in Clean Air Act ("CAA") Section 211(o) required by the Energy Independence and Security Act of 2007 ("EISA"), EPA adopted new regulations, published at 40 CFR Part 80, Subpart M, that specify the types of renewable fuels eligible to participate in the RFS program and the procedures by which renewable fuel producers and importers may generate Renewable Identification Numbers ("RINs") for the qualifying renewable fuels they produce through approved fuel pathways.[2]

Pursuant to 40 CFR 80.1426(f)(1) of the regulations:

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, paragraph (f)(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, or fuel

[2] See EPA's website for information about the RFS regulations and associated rulemakings: http://www.epa.gov/renewable-fuel-standard-program/regulations-and-volume-standards-under-renewable-fuel-standard

pathway, is assigned a D code. EPA may also independently approve additional fuel pathways not currently listed in Table 1 for participation in the RFS program, or a third party may petition for EPA to evaluate a new fuel pathway in accordance with 40 CFR 80.1416. In addition, producers of facilities identified in 40 CFR 80.1403(c) and (d) that are exempt from the 20% GHG emissions reduction requirement of the Act may generate RINs with a D code of 6 pursuant to 40 CFR 80.1426(f)(6) for a specified baseline volume of fuel.

The petition process under 40 CFR 80.1416 allows parties to request that EPA evaluate a new fuel pathway's lifecycle GHG reduction and provide a determination of the D code for which the new pathway may be eligible. EPA will consider extending a similar approval to other petitioners utilizing similar fuel pathways as Joule upon verification that the pathway is sufficiently similar, and assuming all other requirements are met.

B. Required Information in Petitions

As specified in 40 CFR 80.1416(b)(1), petitions must include all of the following information, and should also include 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, coproducts, and waste materials production.
- Information on coproducts, 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.

In addition to the requirements stated above, parties who use a feedstock not previously evaluated by EPA must also include the following, and should also include as appropriate supporting information such as state, county, or regional crop data, commodity reports, independent studies, industry or farm survey data, and reports or other documents supporting any claims:

- Type of feedstock and description of how it meets the definition of renewable biomass.
- Market value of the feedstock.
- List of other uses for the feedstock.

- List of chemical inputs needed to produce the renewable biomass source of the feedstock and prepare the renewable biomass for processing into feedstock.
- Energy needed to obtain the feedstock and deliver it to the facility. If applicable, identify energy needed to plant and harvest the source of the feedstock and modify the source to create the feedstock.
- Current and projected yields of the feedstock that will be used to produce the fuels.
- Other additional information as requested by the Administrator to complete the lifecycle greenhouse gas assessment of the new fuel pathway.

II. Available Information

A. Background on Joule Unlimited Technologies, Inc.

Joule petitioned the Agency under the RFS program to generate advanced biofuel RINs for ethanol made by cyanobacteria through the Joule Ethanol Pathway. Based on the requests in the petition, EPA is clarifying that the algal oil coproduct produced through the Joule Ethanol Pathway qualifies as an algal oil feedstock in Rows F and H of Table 1 to 40 CFR 80.1426. Analysis conducted for this determination only addresses Joule's production of ethanol from cyanobacteria. A petition is required because the production of ethanol through a process such as that used in the Joule Ethanol Pathway is not an existing approved pathway in Table 1 to 40 CFR 80.1426.

B. Information Available Through Existing Modeling

A fuel pathway under the RFS regulations (40 CFR Part 80, Subpart M) is defined by three components: (1) fuel type, (2) feedstock, and (3) production process. The pathway addressed in Joule's petition involves the production and secretion of ethanol by cyanobacteria, and subsequent collection and purification of the ethanol. The CAA specifies that "algae" qualify as renewable biomass, and in the March 2010 RFS rule EPA determined that the term "algae" broadly includes cyanobacteria (which is also known as bluegreen algae).[3] GHG emissions associated with sourcing and transporting the non-potable water, waste CO_2, and fertilizer required for the growth of cyanobacteria were considered among the upstream GHG emissions in this analysis. However, all other GHG emissions associated with growing cyanobacteria were evaluated within the fuel production stage of the lifecycle analysis since cyanobacteria production occurs simultaneously in the same reaction vessel (in this case a photobioreactor) as ethanol production. No new modeling of the emissions associated with ethanol distribution and use was required because EPA previously estimated the GHG emissions from the distribution and end use of ethanol in the March 2010 RFS rule and has used these estimates for this analysis. This petition only required EPA to evaluate a modified fuel production process (including the upstream emissions associated with the process). This was a straightforward analysis based on the modeling methods used for prior RFS rules and substituting Joule's process data. Certain

[3] Federal Register. Vol. 75; No. 58. Friday, March 26, 2010. Rule and Regulations p. 14697.

emission factors outlined in the March 2010 RFS rule, such as for natural gas and grid electricity, were applied in this analysis.

C. Information Submitted by Joule Unlimited Technologies, Inc.

Joule supplied all the information as required in 40 CFR 80.1416 that EPA needed to analyze the lifecycle GHG emissions associated with ethanol produced through the Joule Ethanol Pathway. The information submitted included a technical justification that has a description of the fuel, material inputs, and Joule's proprietary production process with modeling flow charts, a detailed mass and energy balance of the process with information on coproducts as applicable, and other additional information as needed to complete the lifecycle GHG assessment.

III. Analysis and Discussion

A. Lifecycle Analysis

Determining a fuel pathway's compliance with the lifecycle GHG reduction thresholds specified in the CAA for different types of renewable fuel requires a comprehensive evaluation of the renewable fuel, as compared to the baseline gasoline or diesel that it replaces,[4] on the basis of its lifecycle GHG emissions. As mandated by the CAA, the 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 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 coproducts 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 ethanol produced through the Joule Ethanol Pathway under this petition request is consistent with the CAA's applicable requirements, including the definition of lifecycle GHG emissions and threshold evaluation requirements. It was

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[4] As specified in EISA, "The term 'baseline lifecycle greenhouse gas emissions' means the average lifecycle greenhouse gas emissions, as determined by the Administrator, after notice and opportunity for comment, for gasoline or diesel (whichever is being replaced by the renewable fuel) sold or distributed as transportation fuel in 2005."

based on lifecycle analysis modeling that EPA completed for previous RFS rules as well as information provided as part of the Joule petition submitted August 20, 2015, parts of which were submitted under claim of CBI. The Joule petition included the mass and energy balances necessary for EPA to evaluate the lifecycle GHG emissions of ethanol produced through the Joule Ethanol Pathway.

Feedstock and Fuel Production

Energy Source – The Joule Helioculture Process involves use of both steam and electricity. The electricity will come in part from a co-located photovoltaic array dedicated for Joule's use, and in part from the grid. Joule will use net metering to determine the net amount of grid electricity used. The PV array is designed such that Joule anticipates that the net grid electricity used over the course of a year will be zero. Therefore, our analysis assumes that all electricity will come from the PV array.[5] The steam will come from both CSP and natural gas. Based on the data in the Joule petition, these energy sources result in low GHG emissions for energy use, as described in the sections below.

Upstream Emissions: CO_2, Water and Fertilizer Acquisition/Production and Transport – The Joule Ethanol Pathway involves the simultaneous production of cyanobacteria and ethanol. The cyanobacteria are grown in non-potable water, and concentrated waste CO_2 and fertilizer are added to promote growth. Joule provided, as part of the information claimed as CBI, their process yields in terms of pounds of CO_2, water, and fertilizer used per pound of finished ethanol. Upstream GHG emissions include waste CO_2 compression and transport, water procurement, and fertilizer production and transport. Production of the CO_2 is not included within the lifecycle boundary because it is a waste material from an industrial process that would have been vented to the atmosphere if not collected for Joule's use. The Joule Ethanol Pathway does not include any pretreatment of this waste CO_2.[6] Given this information, lifecycle emissions associated with the capture and delivery of CO_2 were determined to be 0.4 kilograms CO_2 equivalent per million British thermal units of ethanol ("kgCO_2e/mmBtu-ethanol").

Joule's petition provided information on the energy inputs required to supply water to the Joule facility. Because PV electricity and net metering of grid electricity will be used for pumping water onsite, and net grid electricity is anticipated to be zero on an annual basis, the lifecycle emissions associated with water procurement were determined to be insignificant. If the net grid electricity is greater than zero, this would be included in the limit on net grid electricity described in Section IV.A.

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[5] In Section IV.A., we provide an upper limit on the net amount of grid electricity that could be used to still meet the 50% threshold.

[6] Joule's use of non-pretreated waste CO_2 that would have been vented to the atmosphere if not collected for use by Joule is a critical element of the Joule Ethanol Pathway considered in this document. Use of a different source of CO_2, or pretreatment of the waste CO_2 would mean producing fuel through a pathway other than the Joule Ethanol Pathway evaluated here.

The GHG emissions associated with the fertilizer used in the Joule Ethanol Pathway were estimated as the sum of the emissions associated with the production and transportation of a proprietary mix of fertilizers similar to sodium nitrate and monocalcium phosphate. For previous analyses, we have used emission factors from GREET for these fertilizers.[7] However, Joule provided emission factors that were higher than those in GREET, so we used these emission factors as a conservative estimate.[8] Based on these GHG emissions factors and data provided in the Joule petition, EPA estimated that fertilizer production and transport would contribute 4.0 kg CO_2e/mmBtu-ethanol.

Upstream Emissions: Hydrogen Peroxide - Joule's petition provided information on the amount of hydrogen peroxide required to clean the photobioreactors after each production cycle. Based on this information, an emission factor provided by Joule,[9] and an assumption that emissions from transport of hydrogen peroxide are 2% of production emissions,[10] the lifecycle emissions associated with hydrogen peroxide production and transport were determined to be 3.6 kg CO_2e/mmBtu-ethanol.

Upstream Emissions: Bioreactor Production – Although GHG emissions associated with facility infrastructure are not typically included in EPA's lifecycle assessments for the RFS program,[11] Joule's photobioreactors are unusual in that they have scheduled replacements within the lifetime of the facility. Therefore, while steel, concrete and other materials used to construct and operate Joule's facility were not considered, the raw materials used to produce Joule's photobioreactors were assessed and are included here. The photobioreactors used by Joule are made of LDPE. The pounds of LDPE required per year, and the associated ethanol yield were provided under claim of CBI in Joule's petition. To estimate the GHG emissions associated with producing the LDPE, EPA used an emission factor provided by Joule for LDPE.[12] Based on this information, EPA estimated that bioreactor production contributes 4.1 kg CO_2e/mmBtu-ethanol.

Cyanobacteria and Fuel Production – The Joule Helioculture Process requires energy for concentrating ethanol and purifying it to fuel grade, through processes that Joule has claimed as CBI. As explained above, Joule uses PV electricity, and steam from natural gas and CSP. For the PV electricity, we assume that the emission factor is zero, because Joule plans to use net zero grid electricity on an annual basis, as measured with net metering, and the production of PV electricity does not emit greenhouse gases. Per the lifecycle greenhouse gas analysis methodology developed for the

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[7] Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation (GREET) Model. Argonne National Laboratory. https://greet.es.anl.gov/

[8] Emission factors are from the GaBi database for ammonium nitrate and monoammonium phosphate: http://www.gabi-software.com/databases

[9] The emission factor for hydrogen peroxide is from the GaBi database: http://www.gabi-software.com/databases

[10] The assumption that transport emissions are 2% of production emissions is based on GREET data for acetone and hydrochloric acid, which are also industrial chemicals.

[11] See U.S. EPA. 2010. Renewable Fuel Standard Program (RFS2) Regulatory Impact Analysis. February 2010. EPA-420-R-10-006: p.312

[12] The emission factor for LDPE is from the GaBi database: http://www.gabi-software.com/databases

March 2010 RFS rule, we typically do not include GHG emissions from infrastructure; therefore, emissions from building the PV panels are not included in our analysis. However, there are GHG emissions associated with the use of natural gas to produce steam. Based on Joule's reported process parameters and data, we estimated the GHG emissions for fuel production, based only on natural gas use, to be 3.2 kg CO_2e/mmBtu-ethanol.

Coproduct Credits – The Joule Ethanol Pathway produces algal biomass, which can be used to generate algal oil via hydrothermal liquefaction. The algal oil can be used to produce a variety of industrial products typically derived from other vegetable oils, or it can be refined into a finished transportation fuel such as biodiesel, gasoline, diesel, or jet fuel.[13] EPA considered a number of scenarios to account for avoided GHG emissions associated with Joule's algal oil coproduct, including assuming it would be refined into renewable diesel and assuming it would displace a vegetable oil. EPA determined that it is reasonable to offer a credit based on the assumption that Joule's algal oil coproduct would displace a mass equivalent amount of soybean oil, as soybean oil is the most commonly used biomass-based diesel feedstock in the United States.[14] This assumption results in a more conservative coproduct credit than assuming that the algal oil will be hydrotreated to produce renewable diesel, and is analytically preferable because it does not require us to make additional assumptions about the algal oil's downstream processing and end-use.

For this analysis, EPA applied a credit of 0.7 kg CO_2e per pound of soybean oil, based on EPA's lifecycle analysis of soybean oil biodiesel for the March 2010 RFS rule. When normalized for the energy content of ethanol generated by the Joule Helioculture Process, EPA determined that a credit of 2.9 kg CO_2e/mmBtu-ethanol is appropriate for Joule's algal oil coproduct.

Fuel distribution and use – The fuel type, ethanol, and hence the fuel distribution and use for ethanol, was already considered as part of the March 2010 RFS rule. Therefore, we applied the existing fuel distribution and use lifecycle GHG impacts for ethanol to our analysis of Joule's petition. The emissions factor for ethanol distribution and use is 2.1 kg CO_2e/mmBtu-ethanol.

Lifecycle GHG Results – Based on the analysis described above, we estimated the total lifecycle GHG emissions associated with ethanol produced through the Joule Ethanol Pathway. The results are set forth in Table 1, as compared to the lifecycle GHG emissions associated with the 2005 gasoline baseline.

[13] Rows F and H of Table 1 to 40 CFR 80.1426 list approved biomass-based diesel and advanced biofuel pathways that involve use of algal oil feedstocks, such as the algal oil coproduct produced in the Joule Ethanol Pathway.

[14] Compared to other commonly used biomass-based diesel feedstocks, such as used cooking oil and waste grease, it is more likely that soybean oil would be displaced because it is a higher cost feedstock and can alternatively be used as cooking oil.

Table 1: Lifecycle GHG Emissions from the Joule Ethanol Pathway (kgCO2e/mmBtu)[15]

	Lifecycle GHG Emissions	
Lifecycle Stage	Joule Ethanol (kg CO_2eq/mmBtu-ethanol)	2005 Gasoline Baseline (kg CO_2eq/mmBtu-diesel)
Upstream emissions	12.2	--
Fuel production	3.2	19.2
Fuel distribution and use	2.1	79.0
Coproduct credit	-2.9	--
Total emissions	14.7	98.2
Change from gasoline baseline	**85.1%**	

B. Application of the Criteria for Petition Approval

Joule provided all necessary information required for this type of petition request. Based on the data submitted and information already available through analyses conducted for previous RFS rulemakings, EPA conducted a lifecycle assessment and determined that ethanol produced pursuant to the Joule Ethanol Pathway meets the 50% lifecycle GHG threshold requirement specified in the CAA for advanced biofuel (D-code 5 RINs).

Compared to the statutory petroleum baseline, ethanol produced pursuant to the Joule Ethanol Pathway results in an 85% reduction in lifecycle GHG emissions. These results justify allowing the generation of advanced biofuel RINs for ethanol produced through the Joule Ethanol Pathway, assuming that the fuel meets the other definitional criteria for renewable fuel (e.g., for use as transportation fuel, heating oil or jet fuel) specified in the CAA and EPA implementing regulations.

IV. Conditions and Associated Regulatory Provisions

The authority for Joule to generate RINs pursuant to the Joule Ethanol Pathway is expressly conditioned on Joule satisfying all of the applicable requirements for renewable fuel producers set forth in the RFS regulations and all of the conditions set forth in this document. The conditions specified herein 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

[15] Lifecycle GHG emissions are normalized per mmBtu of RIN-generating fuel produced. Totals may not be the sum of the rows due to rounding.

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 for any violations, EPA may revoke this pathway approval if it determines that Joule has failed to comply with any of the conditions specified herein.

A. Registration

In addition to the general registration provisions in 40 CFR Part 80, Subpart M, that apply to renewable fuel producers, the EPA is specifying, pursuant to 40 CFR 80.1450(i) and 80.1416(b)(1)(vii), that for registration of the pathway for production of ethanol through the Joule Ethanol Pathway, Joule must have registration materials accepted by EPA that include a plant specific plan detailing how Joule intends to demonstrate on an ongoing basis, and document through records to be maintained for a minimum of five years from the date of RIN generation, that its material inputs, process operations, energy demands, and fuel and coproduct outputs conform to the definition of the "Joule Ethanol Pathway" in this decision document, including the requirement that on a 365-day rolling average, Joule use no more than 10,780 Btu of natural gas per gallon of ethanol produced, and no more than 9,660 Btu of net grid electricity per gallon of ethanol produced,[16] as well as the requirement that Joule use waste CO_2 without pretreatment. The calculation of 365-day rolling average natural gas and net grid electricity use per gallon of ethanol produced shall consider all of the natural gas and net grid electricity used for feedstock, fuel and co-product operations[17] during the averaging period,[18] and all of the ethanol produced during the averaging period, whether or not RINs are generated for some or all of the ethanol.

B. Reporting

Joule must adhere to the general reporting requirements in 40 CFR Part 80, Subpart M that apply to renewable fuel producers. As part of the quarterly RIN generation reports required under 40 CFR

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[16] To account for the fact that during some periods, the PV system will be exporting energy to the grid, and during other periods, such as after dark, Joule will use energy from the grid, Joule's grid electricity use shall reflect net grid electricity use, calculated as the amount of electricity purchased from the grid minus electricity exported to the grid, as measured through net metering.

[17] Energy used for feedstock, fuel and co-product operations means energy used in all buildings or other areas that are used in any part for the storage and/or processing of feedstock, the production and/or storage of fuel intermediates, the production and/or storage of finished fuel or co-products, and the handling of feedstocks, fuel, co-products and wastes. It includes any energy used offsite for these purposes, including for example energy used offsite to distill ethanol before it is sold to the ultimate consumer.

[18] The averaging time period for the 365-day rolling average shall be the 365 calendar days prior to the day that Joule wishes to generate RINs for ethanol produced during the averaging period through the Joule Ethanol Pathway, or the number of days since EPA activated the pathway, whichever is less. "Activated" refers to the day the pathway is allowed to be used in the EPA Moderated Transaction System (EMTS), i.e., the date of activation of Joule's registration for the new pathway described in this document.

80.1451(b), Joule shall report to EPA the amount of natural gas and net amount of grid electricity in Btu used during the relevant quarter.[19]

C. Recordkeeping

Joule must adhere to the general recordkeeping requirements in 40 CFR Part 80, Subpart M that apply to renewable fuel producers. EPA is interpreting the requirements related to the type and quantity of fuel used for process heat pursuant to 40 CFR 80.1454(b)(3)(vii) to refer to the amount of natural gas and net grid electricity used to produce ethanol via the Joule Ethanol Pathway. Use by Joule of any other energy type, other than the PV and CSP energy sources described in Joule's petition, in the production of ethanol would be inconsistent with this pathway approval. In addition, Joule must adhere to the recordkeeping elements of the plant-specific plan developed and accepted at registration, and referenced in Paragraph IV.A.

D. RIN Generation

Joule must adhere to the general RIN generation requirements specified in 40 CFR 80.1426. In addition, Joule may not generate RINs for non-grandfathered ethanol produced pursuant to the Joule Ethanol Pathway unless it can demonstrate, through records produced in accordance with 40 CFR 80.1454(b)(3) that are available as of the date of RIN generation, that all of the ethanol produced during the averaging period meets all the requirements associated with the Joule Ethanol Pathway as defined in this document, including the requirement, as specified above in Section IV.A of this document, that on a 365-day rolling average basis Joule use no more than 10,780 Btu of natural gas per gallon of ethanol produced, and no more than 9,660 Btu of grid electricity per gallon of ethanol produced.

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 2010 RFS rule, we took public comment on our lifecycle assessment of pathways involving the production of ethanol, including all models used and all modeling inputs and evaluative approaches. In the March 2010 RFS rule we acknowledged that it was unlikely that our final regulations would address all possible qualifying fuel production pathways, and

[19] Since the information prepared pursuant to Section IV.C. must be included in the Joule's quarterly RIN generation reports to EPA, it follows that this information is subject to attest engagement requirements pursuant to 80.1464(b).

we took comment on allowing the generation of RINs using a temporary D code in certain circumstances while EPA was evaluating such new pathways and updating its regulations. After considering comments, we finalized the current petition process, where we allow for EPA approval of certain petitions without going through additional rulemaking if we can do so as a reasonably straightforward extension of previous assessments, whereas rulemaking would typically be conducted to respond to petitions requiring significant new modeling. See 58 FR 14797 (March 26, 2010).

In responding to this petition, we have largely relied on the same modeling that we conducted for prior rules, and have simply adjusted the analysis to account for Joule's data. This analysis did not require additional feedstock modeling, and when applicable, involved use of the same emission factors that were used in prior RFS rules. Thus, the fundamental analyses relied on for this decision have been made available for public comment as part of previous rulemakings, consistent with the reference to notice and comment in the statutory definition of "advanced biofuel." Our approach today is also consistent with our description of the petition process in the preamble to the March 2010 RFS rule, as our work in responding to the petition was a logical extension of analyses already conducted.

VI. Conclusion

Based on our assessment, ethanol produced through the Joule Ethanol Pathway qualifies under the CAA for advanced biofuel (D-Code 5) RINs, assuming that the fuel meets the other definitional criteria for renewable fuel (e.g., for use as transportation fuel, heating oil or jet fuel) specified in the CAA and EPA's implementing regulations.

This approval applies specifically to Joule Unlimited Technologies, Inc., and to the process, materials used, fuel produced, coproducts produced, and process energy sources as outlined and described in the petition request submitted by Joule.[20] This approval is effective as of signature date. EPA will consider extending a similar approval to other petitioners utilizing similar fuel pathways as Joule, but will do so on a case-by-case basis upon verification that the pathway described in the petition meets the applicable CAA requirements. RINs may only be generated for ethanol produced pursuant to the Joule Ethanol Pathway after the date of activation of Joule's registration for this pathway.

The OTAQ Reg: Fuels Programs Registration and OTAQEMTS: OTAQ EMTS Application will be modified to allow Joule to register and then generate RINs for advanced ethanol produced from cyanobacteria through the Joule Ethanol Pathway using a production process of "Joule Helioculture Process."

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