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ENVIRONMENTAL PROTECTION AGENCY

40 CFR Part 80

[EPA-HQ-OAR-2013-0178; FRL_9834-3]

Notice of Data Availability Concerning Renewable Fuels Produced from Barley under the RFS Program

AGENCY: Environmental Protection Agency (EPA).

ACTION: Notice of Data Availability (NODA).

SUMMARY: This Notice provides an opportunity to comment on EPA's draft analysis of the lifecycle greenhouse gas (GHG) emissions of ethanol that is produced using barley as a feedstock. EPA's draft analysis indicates that ethanol produced from barley has an estimated lifecycle GHG emissions reduction of 47% as compared to baseline conventional fuel when the barley ethanol is produced at a dry mill facility that uses natural gas for all process energy, uses electricity from the grid, and dries up to 100% of distillers grains. Such barley ethanol would therefore meet the minimum 20% GHG emissions reduction threshold for conventional biofuels under the Clean Air Act Renewable Fuel Standard (RFS) program. In addition, EPA analyzed two potential options for producing barley ethanol that would meet the 50% GHG emissions reduction threshold for advanced biofuels. Ethanol produced from dry-milling barley meet the

advanced biofuels GHG reduction threshold if it is produced at a facility that uses no more than 30,700 Btu of natural gas for process energy, no more than 4,200 Btu of biomass from barley hulls or biogas from landfills, waste treatment plants, barley hull digesters, or waste digesters for process energy, and no more than 0.84 kWh of electricity from the grid for all electricity used at the renewable fuel production facility, calculated on a per gallon basis. Ethanol produced from dry-milling barley can also meet the advanced biofuel GHG reduction threshold if the production facility uses no more than 36,800 Btu of natural gas for process energy and also uses natural gas for on-site production of all electricity used at the facility other than up to 0.19 kWh of electricity from the grid, calculated on a per gallon basis.

DATES: Comments must be received on or before [**insert date 30 days after publication in the Federal Register**].

ADDRESSES: Submit your comments, identified by Docket ID No. EPA-HQ-OAR-2013-0178, by one of the following methods:

- www.regulations.gov: Follow the on-line instructions for submitting comments.
- Email: a-and-r-docket@epa.gov
- Mail: Air and Radiation Docket and Information Center, Environmental Protection Agency, Mailcode: 2822T, 1200 Pennsylvania Ave., NW., Washington, DC 20460.
- Hand Delivery: Air and Radiation Docket and Information Center,

EPA/DC, EPA West, Room 3334, 1301 Constitution Ave., NW, Washington DC 20004. Such deliveries are only accepted during the Docket's normal hours of operation, and special arrangements should be made for deliveries of boxed information.

Instructions: Direct your comments to Docket ID No. EPA-HQ-OAR-2013-0178. EPA's policy is that all comments received will be included in the public docket without change and may be made available online at www.regulations.gov, including any personal information provided, unless the comment includes information claimed to be Confidential Business Information (CBI) or other information whose disclosure is restricted by statute. Do not submit information that you consider to be CBI or otherwise protected through www.regulations.gov or a-and-r-docket@epa.gov. The www.regulations.gov website is an "anonymous access" system, which means EPA will not know your identity or contact information unless you provide it in the body of your comment. If you send an e-mail comment directly to EPA without going through www.regulations.gov your e-mail address will be automatically captured and included as part of the comment that is placed in the public docket and made available on the Internet. If you submit an electronic comment, EPA recommends that you include your name and other contact information in the body of your comment and with any disk or CD-ROM you submit. If EPA cannot read your comment due to technical difficulties and cannot contact you for clarification, EPA may not be able to consider your comment. Electronic files should avoid the use of special characters, any form of encryption, and be free of any defects or viruses. For additional information about EPA's public docket visit the EPA Docket Center homepage at http://www.epa.gov/epahome/dockets.htm.

Docket: All documents in the docket are listed in the www.regulations.gov index. Although listed in the index, some information is not publicly available, e.g., CBI or other information whose disclosure is restricted by statute. Certain other material, such as copyrighted material, will be publicly available only in hard copy. Publicly available docket materials are available either electronically in www.regulations.gov or in hard copy at the Air and Radiation Docket and the Information Center, EPA/DC, EPA West, Room 3334, 1301 Constitution Ave., NW, Washington, DC 20004. The Public Reading Room is open from 8:30 a.m. to 4:30 p.m., Monday through Friday, excluding legal holidays. The telephone number for the Public Reading Room is (202) 566-1744, and the telephone number for the Air Docket is (202) 566-1742.

FOR FURTHER INFORMATION CONTACT: Christopher Ramig, Office of Transportation and Air Quality, Transportation and Climate Division, Environmental Protection Agency, 1200 Pennsylvania Ave., NW, Washington, DC 20460 (MC: 6041A); telephone number: 202-564-1372; fax number: 202-564-1177; email address: ramig.christopher@epa.gov.

SUPPLEMENTARY INFORMATION:

Outline of This Preamble

I. **General Information**

A. *Does this Action Apply to Me?*

Entities potentially affected by this action are those involved with the production, distribution, and sale of transportation fuels, including gasoline and diesel fuel or renewable fuels such as biodiesel and renewable diesel. Regulated categories include:

Category	NAICS[1] Codes	SIC[2] Codes	Examples of Potentially Regulated Entities
Industry	324110	2911	Petroleum Refineries
Industry	325193	2869	Ethyl alcohol manufacturing
Industry	325199	2869	Other basic organic chemical manufacturing
Industry	424690	5169	Chemical and allied products merchant wholesalers
Industry	424710	5171	Petroleum bulk stations and terminals
Industry	424720	5172	Petroleum and petroleum products merchant wholesalers
Industry	454319	5989	Other fuel dealers

[1] North American Industry Classification System (NAICS)
[2] Standard Industrial Classification (SIC) system code.

This table is not intended to be exhaustive, but rather provides a guide for readers regarding entities likely to engage in activities that may be affected by today's action. To determine whether your activities would be affected, you should carefully examine the applicability criteria in 40 CFR Part 80, Subpart M. If you have any questions regarding the applicability of this action to a particular entity, consult the person listed in the preceding section.

B. *What Should I Consider as I Prepare My Comments for EPA?*

1. *Submitting CBI.*

Do not submit this information to EPA through www.regulations.gov or e-mail. Clearly mark the part or all of the information that you claim to be CBI. For CBI information in a disk or CD ROM that you mail to EPA, mark the outside of the disk or CD ROM as CBI and then identify electronically within the disk or CD ROM the specific information that is claimed as CBI. In addition to one complete version of the comment that includes information claimed as CBI, a copy of the comment that does not contain the information claimed as CBI must be submitted for inclusion in the public docket. Information so marked will not be disclosed except in accordance with procedures set forth in 40 CFR part 2.

2. *Tips for Preparing Your Comments.* When submitting comments, remember to:

- Identify the NODA by docket number and other identifying information (subject heading, Federal Register date and page number).
- Follow directions - The agency may ask you to respond to specific questions or organize comments by referencing a Code of Federal Regulations (CFR) part or section number.
- Explain why you agree or disagree; suggest alternatives and substitute language for your requested changes.

- Describe any assumptions and provide any technical information and/or data that you used.
- If you estimate potential costs or burdens, explain how you arrived at your estimate in sufficient detail to allow for it to be reproduced.
- Provide specific examples to illustrate your concerns, and suggest alternatives.
- Explain your views as clearly as possible, avoiding the use of profanity or personal threats.
- Make sure to submit your comments by the comment period deadline identified.

II. *Analysis of Lifecycle Greenhouse Gas Emissions for Ethanol Produced from Barley*

A. *Methodology*

1. *Scope of Analysis*

On March 26, 2010, the Environmental Protection Agency (EPA) published changes to the Renewable Fuel Standard program regulations as required by 2007 amendments to Section 211(o) of the Clean Air Act (CAA). This rulemaking is commonly referred to as the "March 2010 RFS" rule.[1] As part of the March 2010 RFS rule we analyzed various biofuels production pathways to determine whether fuels produced through those pathways meet minimum lifecycle greenhouse gas reduction thresholds specified in the CAA for different categories of biofuel (i.e., 60% for cellulosic biofuel, 50% for biomass-based diesel and advanced biofuel, and 20% for other renewable fuels). The March 2010 RFS rule focused on fuels that were anticipated to contribute relatively large volumes of renewable fuel by 2022 and thus did not cover all fuels that either are contributing or could potentially contribute to the program. In the preamble to the rule, EPA indicated that it had not completed the GHG emissions analyses for several specific biofuel production pathways but that this work would be completed through a supplemental rulemaking process. Since the March 2010 rule was issued, we have continued to examine several additional pathways. This Notice of Data Availability presents our draft analysis of three pathways for producing ethanol from barley. The modeling approach EPA used in this analysis is the same general approach used in the final March 2010 RFS rule for lifecycle analyses of other biofuels.[2] The March 2010 RFS rule preamble and Regulatory Impact Analysis (RIA) provide further discussion of our approach.

EPA is seeking public comment on EPA's draft analyses of lifecycle GHG emissions related to the production and use of ethanol from barley. We intend to consider all of the relevant comments received prior to taking final action that could lead

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[1] EPA, 2010. Renewable Fuel Standard Program (March 2010 RFS) Regulation of Fuels and Fuel Additives: Changes to Renewable Fuel Standard Program; Final Rule. 40 CFR Part 80, **http://www.gpo.gov/fdsys/pkg/FR-2010-03-26/pdf/2010-3851.pdf.**

[2] EPA. 2010. Renewable Fuel Standard Program (March 2010 RFS) Regulatory Impact Analysis. EPA-420-R-10-006. http://www.epa.gov/oms/renewablefuels/420r10006.pdf

to amendment of the RFS program regulations to identify barley ethanol pathways as among those which can be used to produce qualifying renewable fuel. In general, comments will be considered relevant if they pertain to the lifecycle GHG emissions of barley ethanol and especially if they provide specific information for consideration in our modeling.

2. *Models Used*

The analysis EPA has prepared for barley ethanol uses the same set of models that was used for the final March 2010 RFS rule, including the Forestry and Agricultural Sector Optimization Model (FASOM) developed by Texas A&M University and the Food and Agricultural Policy and Research Institute international models as maintained by the Center for Agricultural and Rural Development (FAPRI-CARD) at Iowa State University. For more information on the FASOM and FAPRI-CARD models, refer to the March 2010 RFS rule preamble (75 FR 14670) or the March 2010 RFS Regulatory Impact Analysis (RIA).[3] These documents are available in the docket or online at *http://www.epa.gov/otaq/fuels/renewablefuels/regulations.htm*. The models require a number of inputs and assumptions that are specific to the pathway being analyzed, including projected yields of feedstock per acre planted, projected fertilizer use, and energy use in feedstock processing and fuel production. The docket includes detailed information on model inputs, assumptions, calculations, and the results of our assessment of the lifecycle GHG emissions performance for barley ethanol.

[3] EPA. 2010. Renewable Fuel Standard Program (March 2010 RFS) Regulatory Impact Analysis. EPA-420-R-10-006. http://www.epa.gov/oms/renewablefuels/420r10006.pdf

3. Model Modifications

In the United States, barley is grown using one of two primary cropping strategies. The majority of barley production, over 90 percent every year since 1970, is "spring barley".[4] For example, in the 2010/11 crop year, spring barley represented approximately 94 percent of the total barley crop. Spring barley is primarily grown in the Great Plains, Rocky Mountains, and the Pacific Northwest regions.[5] It is planted in the spring and harvested in the fall, as are most grains in these regions. However, a significant minority of barley production (between 3 percent and 5 percent since the 2000/01 crop year, and as much as 6 percent between 1970 and 2000) comes from "winter barley", which is grown in the Southeast and Mid-Atlantic regions.[6] Historically, winter barley is "double-cropped" with soybeans, meaning that the grower plants two crops, a soybean crop and a barley crop, in one year.[7] Farmers that utilize this double-cropping method plant their soybean crop in the mid or late spring and harvest it in the early fall followed soon after with a barley crop that is planted in the fall and harvested in the early spring. Soybean acres in the Southeast and Mid-Atlantic regions of the U.S. that are not double-cropped with barley are generally left fallow during the winter months.[8] This also means that any barley that is double-cropped with soybeans in the

[4] Personal communication with USDA experts.
[5] Personal communication with USDA experts.
[6] See Memo to the Docket, EPA-HQ-OAR-2013-0178-0001, Dated June 20th, 2013 and personal communication with USDA.
[7] See Memo to the Docket, EPA-HQ-OAR-2013-0178-0001, Dated June 20th, 2013and personal communication with USDA.
[8] See Memo to the Docket, EPA-HQ-OAR-2013-0178-0001, Dated June 20th, 2013and personal communication with USDA.

Southeast and Mid-Atlantic regions of the U.S. is not replacing another double-crop practice between soybeans and another commodity.

FASOM has not previously taken the winter barley cropping strategy into account. However, given that a portion of barley ethanol production can come from winter barley and industry input indicates that winter barley is likely to be a potentially significant contributor to total barley ethanol production, it is important to consider the full range of barley production methods available. Based on information from industry stakeholders and USDA, FASOM modeling was conducted assuming that all barley produced in the Mid-Atlantic and Southeast regions of the United States is winter barley double-cropped with soybeans and that all barley grown elsewhere is spring barley.[9] Specifically, FASOM was updated such that all barley grown in the Mid-Atlantic and Southeast regions of the United States was grown in conjunction with soybean acres, rather than competing with other crops grown during the typical "spring" planting season.

Because of differences in model architecture, it was not possible to differentiate between spring and winter barley in the FAPRI-CARD model. However, we believe not modeling double cropping for barley in the Southeast and Mid-Atlantic region of the U.S. in the FAPRI-CARD model results in a conservative estimate of lifecycle GHG emissions, as it may slightly overstate the land use change and commodity market impacts of an increase in demand for barley ethanol.

4. *Scenarios Modeled for Impacts of Increased Demand for Barley*

[9] See Memo to the Docket, EPA-HQ-OAR-2013-0178-0001, Dated June 20th, 2013.

To assess the impacts of an increase in renewable fuel volume from business-as-usual (what is likely to have occurred without the RFS biofuel mandates) to levels required by the statute, we established a control case and other cases for a number of biofuels analyzed for the March 2010 RFS rule. The control case included a projection of renewable fuel volumes that might be used to comply with the RFS renewable fuel volume mandates in full. The other cases are designed such that the only difference between a given case and the control case is the volume of an individual biofuel, all other volumes remaining the same. In the March 2010 RFS rule, for each individual biofuel, we analyzed the incremental GHG emission impacts of increasing the volume of that fuel from business as usual levels to the level of that biofuel projected to be used in 2022, together with other biofuels, to fully meet the CAA requirements. Rather than focus on the GHG emissions impacts associated with a specific gallon of fuel and tracking inputs and outputs across different lifecycle stages, we determined the overall aggregate impacts across sectors of the economy in response to a given volume change in the amount of biofuel produced. For this analysis we compared impacts in the control case to the impacts in a new "barley ethanol" case. Some assumptions related to barley production and ethanol use were incorporated based on consultation with USDA, academic experts, and industry stakeholders. However, the volume of biofuels assumed to be produced in the control case used for modeling barley ethanol is the same as was assumed for the March 2010 RFS rule. Specifically, the control case used for the March 2010 RFS rule, and used for this analysis, has zero gallons of barley ethanol production. This is compared to a "barley ethanol" case that does include barley ethanol production (see paragraph below). See our "Barley Inputs and Assumptions" document, included in the docket for this NODA, for further details.[10]

For the "barley ethanol" case, our modeling analyzed a shock of 140 million gallons of barley ethanol in 2022 above the production volume observed in the control case. In FASOM, this volume was divided into 80 million gallons of "spring barley" ethanol and 60 million gallons of "winter barley" ethanol.[11] EPA chose this modeled volume based upon consultations with industry stakeholders and USDA. Input from industry stakeholders has suggested that there is interest in utilizing both spring and winter barley as ethanol feedstock, and EPA selected the 80/60 ratio of spring to winter barley for FASOM modeling based on this industry input. In the FAPRI-CARD model, as stated above, no distinction is made between winter and spring barley. For this reason, the volume in the FAPRI-CARD model is simply represented as 140 million gallons of barley ethanol.

Our volume scenario of approximately 140 million gallons in the barley case in 2022 is based on several factors including potential feedstock availability and other competitive uses (e.g., animal feed or exports). Our assessment is described further in the inputs and assumptions document that is available through the docket.[12] Based in part on consultation with experts at the United States Department of Agriculture (USDA) and

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[10] See Memo to the Docket, EPA-HQ-OAR-2013-0178-0001, Dated June 20th, 2013.
[11] As described in the following sections, the FASOM model projected the combined impacts on the winter/spring barley market (e.g., by allowing the increased demand for barley ethanol to be filled by reduced use of barley for feed, increased production of winter or spring barley, decrease in exports). This volume assumption did not assume that all new barley production would be "backfilled" at a ratio of 80/140 spring barley to 60/140 winter barley.
[12] See Memo to the Docket, EPA-HQ-OAR-2013-0178-0002, Dated June 20th, 2013.

industry representatives, we believe that these volumes represent a reasonable projection of how much barley ethanol could be produced by 2022 if these pathways are approved, and are therefore reasonable for the purposes of evaluating the impacts of producing ethanol from barley. However, we invite comment both regarding the assumptions made in our analysis of barley ethanol and regarding the efficacy of any alternative assumptions that could be utilized to model the impacts of barley ethanol production within the FASOM and FAPRI-CARD frameworks.

While the FASOM and FAPRI-CARD models project how much barley will be supplied to ethanol production, it should be noted that the amount of barley needed for ethanol production will likely come from a combination of increased production, decreases in others uses (e.g., animal feed), and decreases in exports compared to the control case

B. Results

As we did for our analysis of other renewable fuel feedstocks in the March 2010 RFS rule, we assessed what the lifecycle GHG emissions impacts would be from the use of additional volumes of barley for biofuel production. The information provided in this section discusses the outputs of the analysis using the FASOM and FAPRI-CARD agro-economic models to determine changes in the agricultural and livestock markets. These results from FASOM and FAPRI-CARD are then used to determine the GHG emissions impacts due to barley feedstock production. Finally, we include our analysis of the GHG emissions associated with different processing pathways and how these technologies affect the lifecycle GHG emissions associated with barley ethanol.

1. *Agro-Economic Impacts*

As demand increases for biofuel production from a particular commodity, the supply generally comes from some mix of increased production, decreased exports, increased imports, and decreases in other uses of the commodity (e.g., use in animal feed or food). The primary use for barley in the U.S. is beer malting. For example, in the 2011/12 crop year, approximately 148 million bushels of barley went to malting, out of a total U.S. supply of 261 million bushels.[13] However, barley must meet very high quality specifications for characteristics including protein and starch content to be sold as malting barley. For this reason, malting-quality barley is sold at a premium. Barley that does not meet malting specifications is generally sold at a discount to the feed markets. For example, over the last five marketing years (2007/08 to 2011/12), farmers received an average price of $4.82 per bushel for malting quality barley but only $3.78 per bushel for non-malting quality barley.[14] Because of this dynamic, we expect malting to remain the highest value use, even if EPA approved an advanced biofuels pathway for barley ethanol. To the extent that barley is drawn from other uses for ethanol production, we expect it to come from either the feed or export markets.[15]

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[13] U.S. Department of Agriculture Economic Research Service, *Feed Grains Database*, http://www.ers.usda.gov/data-products/feed-grains-database.aspx#.UcMXqDvku2k (Last accessed: June 20th, 2013).
[14] Ibid.
[15] See Memo to the Docket, EPA-HQ-OAR-2013-0178-0002, Dated June 20th, 2013.

In the case of barley, FASOM estimates that the aggregate response to an increase in barley ethanol production of 140 million gallons (requiring 3.11 billion lbs of barley) by 2022 comes from an increase in production of barley (3.08 billion lbs). The increase in barley production is made possible partially by shifting production of wheat out of some barley-producing regions and partially by reducing production of corn and hay, though other factors have some influence as well (see Table II.B.1-1).[16] As demand for barley for ethanol production increases, harvested crop area in the U.S. is predicted to increase by 824 thousand acres in 2022 (see Table II.B.1-2). The majority of this net agricultural acre expansion occurs in Montana, a major spring barley producer. Crop acreage in Montana is in long-term decline, a trend that shows no signs of reversal, creating a large stock of idle crop acres in this region.[17] In the barley scenario, Montana crop acres continue to decline, but this decline is smaller than in the control case (see Table II.B.1-3).

Table II.B.1-1 Selected Projected Changes in Production in the U.S. in 2022[18] (Millions of Lbs)

	Control Case	Barley Case	Difference
Barley	17,512	20,594	3,082
Distillers Grains	150,669	151,527	858
Wheat	152,214	152,218	4
Hay	76,657	76,643	-15
Corn	888,788	887,987	-802

[16] Table II.B.1-1 shows that wheat production remains virtually flat across cases. The increase in wheat acreage shown in Table II.B.1-2 reflects the fact that increased barley demand is forcing wheat to shift to less productive acres.
[17] U.S. Department of Agriculture, National Agricultural Statistics Service, *NASS Quick Stats*, http://quickstats.nass.usda.gov/ (Last accessed: June 20th, 2013).
[18] See Memo to the Docket, EPA-HQ-OAR-2013-0178-0002, Dated June 20th, 2013.

Table II.B.1-2 Projected Change in Crop Harvested Area by Crop in the U.S. in 2022
(Thousands of Acres)

	Control Case	Barley Case	Difference
Barley	5,115	5,886	771
Wheat	46,775	46,994	219
Soybeans	73,191	73,267	76
Corn	84,916	84,835	-81
Hay	42,059	41,881	-178
Other	59,454	59,471	17
Total*	311,511	312,335	824

*Total may differ from subtotals due to rounding.

Table II.B.1-3 Projected Change in Crop Harvested Area by Region in the U.S. in 2022
(Thousands of Acres)

	Control Case	Barley Case	Difference
Montana	6,868	7,653	785
Other	304,645	304,683	38
All*	311,511	312,335	824

*Total may differ from subtotals due to rounding.

Looking more closely at barley production specifically, although our barley ethanol production estimate assumes 60 million gallons from winter barley and 80 million gallons from spring barley, the majority of acreage expansion in all barley occurs in spring barley (approximately 95 percent). Since there is perfect substitution between spring and winter barley in the animal feed, malting, and export markets, much of the spring barley being diverted to ethanol production can be backfilled with winter barley. This does indeed happen in our analysis; all winter barley production in the control case is shifted from other uses (e.g., feed, exports) to ethanol production, with only a minor increase in overall winter barley production. Therefore, all of the additional spring barley production not only contributes to ethanol production from spring barley, but also to the feed and export markets that winter barley no longer contributes to in the barley case.

Table II.B.1-4 Changes in Barley Production and Use in the U.S. in 2022[19] (Millions of Bushels)

	Control Case	Barley Case	Difference
Winter Barley			
Production	1,236	1,389	154
Used in Biofuel Production	0	1,328	1,328
Spring Barley			
Production	16,277	19,205	2,958
Used in Biofuel Production	0	1,780	1,780
All Barley			
Production	17,512	20,594	3,082
Used in Biofuel Production	0	3,108	3,108
Used in Feed	4,151	4,150	-1
Used in Food and Malting	13,796	13,786	-7
Net Exports	-435	-453	-19

Since spring barley represents over 90 percent of annual production, we would expect to see more expansion of this growing practice. As Table II.B.1-5 below shows, spring barley production does indeed expand significantly in Oregon and Montana, two major spring barley producing regions, and to a lesser extent in the mid-tier barley producing areas of Wyoming and California. Winter barley production primarily expands in Virginia, which, along with Pennsylvania, is generally the largest producer of winter barley.[20]

Table II.B.1-5 Selected Projected Changes in Regional Barley Production in the U.S. in 2022[21]

[19] See Memo to the Docket, EPA-HQ-OAR-2013-0178-0002, Dated June 20th, 2013.
[20] In the 2010/11 crop year, Virginia harvested 48 thousand acres of barley out of a total of approximately 160 thousand nationwide. Pennsylvania harvested 45 thousand acres of winter barley. Source: U.S. Department of Agriculture Economic Research Service, *Feed Grains Database*, http://www.ers.usda.gov/data-products/feed-grains-database.aspx#.UcMXqDvku2k (Last accessed: June 20th, 2013).
[21] See Memo to the Docket, EPA-HQ-OAR-2013-0178-0002, Dated June 20th, 2013.

(Millions of Lbs)

	Control Case	Barley Case	Difference
Oregon	1,457	2,834	1,376
Wyoming	592	1,154	562
Montana	3748	4,276	528
Virginia	284	415	131
California	735	813	77
Rest of U.S.	8,506	8,528	22

The FASOM model projects that direct use of barley for feed will decline by approximately 1 million lbs as a result of demand for ethanol production (see Table II.B.1-6). There is also a significant influx of distillers' grains (DGs) into the feed markets as a result of barley ethanol production. DG consumption in the domestic livestock sector increases by 858 million lbs. This increase primarily displaces corn and sorghum, whose use as feed declines by 477 and 178 million lbs respectively. Hay use for feed also declines by 61 million lbs. See Table II.B.1-6 below for further details.[22]

Table II.B.1-6 Selected Projected Changes in Feed Use in the U.S. in 2022[23]
(Millions of Lbs)

	Control Case	Barley Case	Difference
Distillers Grains	78,171	79,028	858
Barley	4,151	4,150	-1
Hay	182,291	182,231	-61
Sorghum	33,022	32,844	-178
Corn	310,627	310,150	-477
Other	212,310	212,271	-39
All Feed Use	820,571	820,675	103

As demand for barley use in U.S. ethanol production increases, the FAPRI-CARD model estimates that the U.S. will decrease net exports of barley by 564 million lbs.

[22] See Memo to the Docket, EPA-HQ-OAR-2013-0178-0002, Dated June 20th, 2013.
[23] See Memo to the Docket, EPA-HQ-OAR-2013-0178-0002, Dated June 20th, 2013.

Additionally, the U.S. will decrease exports of corn by 798 million lbs, wheat by 79 million lbs, and soybeans by 71 million lbs. This combination of impacts on the world trade of barley, corn, wheat, and soybeans has effects both on major importers, as well as on other major exporters. For example, Canada, a large net exporter of barley, increases its net barley exports by 227 million lbs; and Brazil, a large corn exporter, increases its net corn exports by 214 million lbs. Details for other major importers and exporters of barley and corn can be found in Table II.B.1-7 and Table II.B.1-8, respectively.[24]

Table II.B.1-7 Projected Change in Net Exports of Barley by Country in 2022 (Millions of Lbs)

	Control Case	Barley Case	Difference
U.S.	-330	-893	-564
Canada	4,486	4,713	227
Russia	6,112	6,190	78
EU	14,166	14,198	32
Australia	7,308	7,338	30
Rest of World	30,281	30,084	196

Note: A country with negative Net Exports is a Net Importer

Table II.B.1-8 Projected Change in Net Exports of Corn by Country in 2022 (Millions of Lbs)

	Control Case	Barley Case	Difference
U.S.	121,329	120,531	-798
Brazil	23,853	24,067	214
Mexico	-26,449	-26,266	182
China	12,388	12,474	85
Canada	-4,657	4,600	57
Rest of World	-125,586	-125,326	260

Note: A country with negative Net Exports is a Net Importer

[24] The FAPRI-CARD analysis conducted for this rulemaking can be accessed as a Memo to the Docket, EPA-HQ-OAR-2013-0178-0003, Dated June 20th, 2013. The Control Case was previously docketed as part of the March 2010 RFS FRM (see EPA-HQ-OAR-2005-0161-3166). See these two documents for full net export data on all major crops.

The change in trade patterns directly impacts the amount of production and harvested crop area around the world. Harvested crop area for barley is not only predicted to increase in the U.S., but also in Russia (26 thousand acres), Canada (25 thousand acres) and other parts of the world. Worldwide barley harvested area outside of the U.S. would increase by 107 thousand acres. Similarly, the decrease in U.S. corn and soy exports would lead to an increase of harvested acres outside the U.S. for these crops. EPA predicts that worldwide corn harvested area outside of the U.S. would increase by 51 thousand acres and that soybean harvested area outside of the U.S. would increase by 10 thousand acres.

Overall harvested crop area in other countries also increases, particularly in Brazil. Brazil's total harvested area is predicted to increase by 35 thousand acres by 2022. This is mostly comprised of an increase in corn of 19 thousand acres, and an increase in soybeans of 17 thousand acres, along with minor changes in other crops. More details on projected changes in world harvested crop area in 2022 can be found below in Table II.B.1-9, Table II.B.1-10, Table II.B.1-11, Table II.B.1-12, and Table II.B.1-13.[25]

Table II.B.1-9 Projected Change in International (non-U.S.) Harvested Area by Country in 2022
(Thousands of Acres)

	Control Case	Barley Case	Difference
Brazil	136,739	136,773	35
Africa & Middle East	222,669	222,357	28

[25] See our FAPRI-CARD results for full information on these tables and our other international modeling in support of this rulemaking. The analysis conducted for this rulemaking can be accessed as Memo to the Docket, EPA-HQ-OAR-2013-0178-0003, and Dated June 20th, 2013. The Control Case was previously docketed as part of the March 2010 RFS FRM (see EPA-HQ-OAR-2005-0161-3166).

Russia	96,920	96,940	20
India	332,143	332,155	12
Rest of World (non-U.S.)	1,237,730	1,237,746	17
International Total (non-U.S.)	2,026,200	2,026,312	112

Table II.B.1-10 Projected Change in International (non-U.S.) Harvested Area by Crop in 2022
(Thousands of Acres)

	Control Case	Barley Case	Difference
Barley	136,223	136,329	107
Corn	307,392	307,442	51
Soybeans	202,157	202,167	10
Other	1,380,428	1,380,373	-55
International Total (non-U.S.)	2,026,200	2,026,312	112

Table II.B.1-11 Projected Change in International (non-U.S.) Barley Harvested Area by Crop in 2022
(Thousands of Acres)

	Control Case	Barley Case	Difference
Russia	24,981	25,006	26
Canada	9,512	9,537	25
Africa & Middle East	29,522	29,538	16
Australia	10,308	10,319	11
Rest of World	61,900	61,929	29
International Total (non-U.S.)	136,223	136,329	107

Table II.B.1-12 Projected Change in International (non-U.S.) Corn Harvested Area by Crop in 2022
(Thousands of Acres)

	Control Case	Barley Case	Difference
Brazil	21,096	21,115	19
Africa & Middle East	73,081	73,095	15
China	79,471	79,479	8
India	20,156	20,162	6
Mexico	19,000	19,005	5
Rest of World	94,589	94,587	-3

International Total (non-U.S.)	307,392	307,443	51

Table II.B.1-13 Projected Change in International (non-U.S.) Soybeans Harvested Area by Crop in 2022 (Thousands of Acres)

	Control Case	Barley Case	Difference
Brazil	69,452	69,469	17
Rest of World	132,705	132,698	-7
International Total (non-U.S.)	202,157	202,167	10

2. International Land Use Change Emissions

Today's assessment of barley as an ethanol feedstock considers GHG emissions from international land use changes related to the production and use of barley and applies the same land use change modeling approach used in the March 2010 RFS rule for analyses of other biofuel pathways.

In our analysis, GHG emissions per acre of land conversion internationally (i.e., outside of the United States) are determined using the emissions factors developed for the March 2010 RFS rule following IPCC guidelines. In addition, estimated average forest carbon stocks were updated based on a new study which uses a more robust and higher resolution analysis. For the March 2010 RFS rule, international forest carbon stocks were estimated from several data sources each derived using a different methodological approach. Two new analyses on forest carbon stock estimation were completed since the release of the final March 2010 RFS rule, one for three continental regions by Saatchi et al.[26] and the other for the EU by Gallaun et al.[27] We have integrated this updated understanding of forest carbon stocks into our recent pathways analyses. More detailed information on the land use change emissions can be found in the accompanying docket.[28]

Table II.B.2-1 includes the international land use change GHG emissions results for the scenarios modeled, in terms of kilograms of carbon-dioxide equivalent emissions per million British thermal units of barley ethanol (kgCO_2e/mmBtu).

Table II.B.2-1 International Land Use Change GHG Emissions (kgCO_2e/mmBtu)[29]

Region	Emissions
Brazil	17
Asia	5
Africa and Middle East	2
Eastern Europe & Russia	2
India	2
International Total (non-U.S.)	26

3. *Barley Ethanol Processing*

[26] Saatchi, S.S., Harris, N.L., Brown, S., Lefsky, M., Mitchard, E.T.A., Salas, W., Zutta, B.R., Buermann, W., Lewis, S.L., Hagen, S., Petrova, S., White, L., Silman, M. And Morel, A. 2011. Benchmark map of forest carbon stocks in tropical regions across three continents. *PNAS* doi: 10.1073/pnas.1019576108.

[27] Gallaun, H., Zanchi, G., Nabuurs, G.J., Hengeveld, G., Schardt, M., Verkerk, P.J. 2010. EU-wide maps of growing stock and above-ground biomass in forests based on remote sensing and field measurements. *Forest Ecology and Management* 260: 252-261.

[28] See Section 5, Forest Carbon Stocks in EPA-HQ-OAR-2011-0542-0058, Attachment 9.

[29] See Memo to the Docket, EPA-HQ-OAR-2013-0178-0006, and Dated June 20th, 2013

Based on information submitted by petitioners, we expect dry milling will be the most common process for producing ethanol from barley. Therefore this section focuses on a lifecycle GHG emissions analysis of several variations of the dry mill process. In the dry milling process, the barley is ground and fermented to produce ethanol. The remaining components (distillers grains) are then either left wet if used in the near-term or dried for longer term use as animal feed.

For this analysis the amount of barley used for ethanol production as modeled by the FASOM and FAPRI-CARD models was based on yield assumptions built into those two models. Specifically, the models assume barley ethanol yields of 2.16 gallons (pure ethanol) per bushel for dry mill plants (yields represent pure ethanol).

As per the analysis done in the March 2010 RFS rule, the GHG emission calculation from ethanol production needs to account for not only the renewable fuel produced, but also any co-products. For barley ethanol production, this analysis accounts for the DG co-product use directly in the FASOM and FAPRI-CARD agricultural sector modeling described above. DG are considered a replacement animal feed and thus reduce the need to make up for the barley production that went into ethanol production. Since FASOM takes the production and use of DG into account, no further allocation was needed at the ethanol plant and all plant emissions are accounted for there.

Our analysis assumed hulled barley was grown and used to produce ethanol. The hulls are abrasive and during the ethanol process they are removed prior to further processing and conversion of the barley into ethanol. Our modeling considered two scenarios for the barley hulls, either they were discarded and received no co-product benefit, or they were used beneficially as an energy source replacing some of the energy used on-site. The results of considering the beneficial use of the hulls as an energy source are shown below.

Overall fuel and electricity use for barley ethanol production was based on the energy use information for corn ethanol production from the March 2010 RFS rule analysis. For the March 2010 RFS rule, EPA modeled future plant energy use to represent plants that would be built to meet requirements of increased ethanol production, as opposed to current or historic data on energy used in ethanol production. The energy use at dry mill ethanol plants was based on ASPEN models developed by USDA and updated to reflect changes in technology out to 2022 as described in the March 2010 RFS rule RIA Chapter 1.

The work done on ethanol production for the March 2010 RFS rule was based on converting corn to ethanol. Converting barley to ethanol will result in slightly different energy use based on differences in the grains and how they are processed. For example, a barley plant requires more energy than a corn plant per gallon of ethanol produced since the starch / fiber ratio in corn is different than it is in barley. The same ASPEN USDA models used for corn ethanol in the final rule were also developed for barley ethanol. Based on the numbers from USDA, a barley ethanol plant uses 1.2 times the thermal process energy of a corn ethanol plant and 1.3 times the electrical energy per gallon of ethanol produced.

The GHG emissions from production of ethanol from barley were calculated in the same way as other fuels analyzed as part of the March 2010 RFS rule. The GHG emissions were calculated by multiplying the BTUs of the different types of energy inputs at the barley ethanol plant by emissions factors for combustion of those fuel sources. The emission factors for the different fuel types are the same as those used in the March 2010 RFS rule and were based on assumed carbon contents of the different process fuels. The emissions from producing electricity in the U.S. were also the same as used in the March 2010 RFS rule, which were taken from GREET and represent average U.S. grid electricity production emissions.

4. Results of Lifecycle Analysis for Ethanol from Barley (Conventional Ethanol Example)

Consistent with our approach for analyzing other pathways, our analysis for barley ethanol includes a mid-point estimate as well as a range of possible lifecycle GHG emission results based on an uncertainty analysis conducted by the Agency (see Section II.C.2 for further information). The graph included below (Figure II.B.4-1) depicts the results of our analysis (including the uncertainty in our land use change modeling) for barley ethanol produced in a plant that uses natural gas for process energy, electricity from the grid and produces 100% dry DG.

Figure II.B.4-1 shows the results of our barley ethanol modeling for this type of plant. It shows the percent difference between lifecycle GHG emissions for 2022 barley ethanol and those for the 2005 baseline for petroleum gasoline. Lifecycle GHG emissions equivalent to the gasoline fuel baseline are represented on the graph by the zero on the X-axis. The midpoint of the range of results is a 47% reduction in GHG emissions compared to the 2005 gasoline baseline.[30] As in the case for biofuel pathways analyzed as part of the March 2010 RFS rule, the range of results shown in Figure II.B.4-1 is based on our assessment of uncertainty regarding the location and types of land that may be impacted as well as the GHG impacts associated with these land use changes. These results, if finalized, would justify a determination that barley ethanol would meet the 20% reduction threshold required for the generation of conventional renewable fuel RINs.

[30] The 95% confidence interval around that midpoint results in range of a 36% reduction to a 56% reduction compared to the 2005 gasoline fuel baseline.

Figure II.B.4-1 Distribution of Results for Barley Ethanol Produced in Dry Mill Plants that Use Natural Gas for process energy, grid electricity and Produce 100% Dry DG

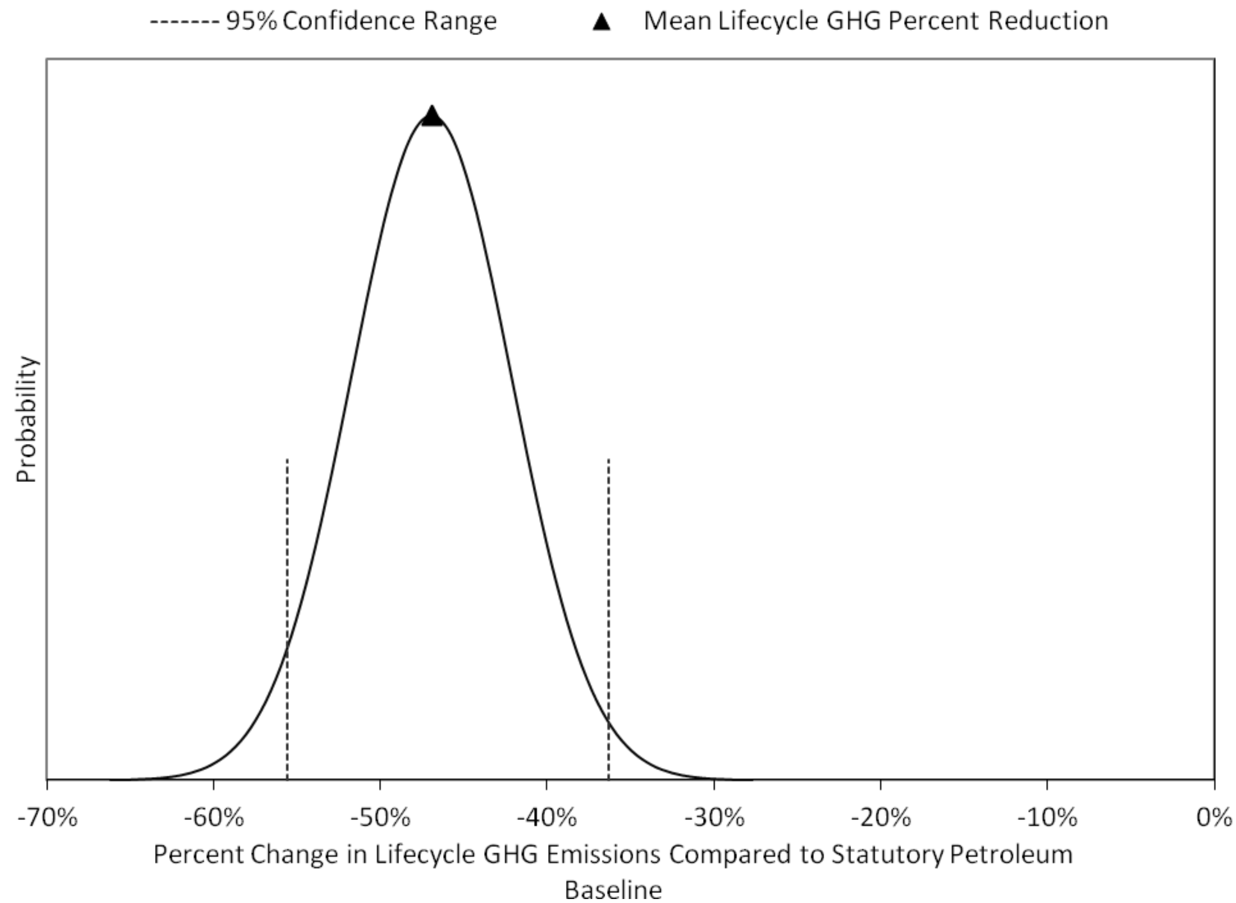

Table II.B.4-1 breaks down by stage the lifecycle GHG emissions of the 2005 gasoline baseline and of barley ethanol that is produced in 2022 in a dry mill plant using natural gas for process energy, grid electricity, and drying 100% of DG. [31] Results are included using our mid-point estimate of land use change emissions, as well as with the low and high end of the 95% confidence interval. Net agricultural emissions include impacts related to changes in crop inputs, such as fertilizer, energy used in agriculture,

[31] Totals in the table may not sum due to rounding.

livestock production and other agricultural changes in the scenarios modeled. The fuel production stage includes emissions from ethanol production plants. Fuel and feedstock transport includes emissions from transporting bushels of harvested barley from the farm to ethanol production facility.

Table II.B.4-1 Lifecycle GHG Emissions for Barley Ethanol Produced in Dry Mill Plants that Use Natural Gas for process energy, grid electricity and Produce 100% Dry DG (g CO_2-eq / mmBtu)

Fuel Type	Barley Ethanol	2005 Gasoline Baseline
Net Agriculture (w/o land use change)	-3,975	
Land Use Change, Mean *(Low/High)*	11,290 *(2,784 /21,679)*	
Fuel Production	39,069	19,200
Fuel and Feedstock Transport	4,861	*
Tailpipe Emissions	880	79,004
Total Emissions, Mean *(Low/High)*	**52,124 *(43,618/62,513)***	**98,204**
Midpoint Lifecycle GHG Percent Reduction Compared to Petroleum Baseline	**47%**	

*Emissions included in fuel production stage.

It should be noted that there are a number of reasons why the estimated land use change emissions attributed to any given feedstock may differ from those estimated for another feedstock that has been analyzed in the past. Chief among these are differences in inputs required for production; differences in markets for a given commodity, and how they are impacted; and differences in regional production patterns and the relationships to markets and other commodities in those regions (domestically and internationally). The FASOM and FAPRI-CARD model take all of these differences into account in our analysis. The docket for this NODA provides more details on our key model inputs and assumptions (e.g., crop yields, biofuel conversion yields, and agricultural energy use).

These inputs and assumptions are based on our analysis of peer-reviewed literature and consideration of recommendations of experts from within the barley and ethanol industries, USDA, and academic institutions. EPA invites comment on all aspects of its modeling of barley ethanol, including all assumptions and modeling inputs.

5. Impacts of different process technology approaches on barley ethanol lifecycle results

There are a number of process technologies that could be employed in the production of barley ethanol that would result in lower GHG emissions than shown in the previous section for a natural gas barley plant that uses grid electricity and produces 100% dry DG. Three different approaches are examined here with their associated GHG emissions.

- Production of wet DG.
- Replacement of purchased grid electricity with electricity having a lower GHG emissions factor.
- Replacement of natural gas with lower GHG emitting fuel source.

One of the energy drivers of ethanol production is drying of the DG. Plants that are located close to feedlots have the ability to provide the co-product without drying and thus reducing their natural gas use and associated GHG emissions. This energy use and GHG reduction has a large enough impact on overall results in previous analyses that in the March 2010 RFS rule we established separate pathways for corn ethanol when the co-product DG was wet versus dry. The amount of fuel used to dry DG is related to percent of DG that are dried, but some dry mills can dry DG more efficiently (i.e., use less natural gas per pound of DG dried) and/or replace the natural gas used to dry DG with lower-GHG emitting fuel sources. As the GHG calculations related to fuel use at processing facilities are based on the amount of fuel used times an emission factor plus the amount of electricity used from the grid times an emission factor, the percent of DG dried only matters to the extent that it impacts the amount of fuel and electricity used per batch of ethanol produced. Therefore, instead of analyzing and proposing a pathway for barley ethanol that is based on reduced DG drying as an option to produce fuel that qualifies as advanced biofuel (minimum 50% GHG reduction), we are instead proposing to ascertain the amount and types of process fuel used and the amount of grid electricity used per gallon of barley ethanol produced that would be consistent with a 50% GHG reduction.

Production facilities that utilize combined heat and power (CHP) systems can also reduce GHG emissions relative to less efficient system configurations. CHP, also known as cogeneration, refers to industrial processes in which waste heat from the production of electricity is used for process energy in the renewable fuel production facility. The most common configuration in ethanol plants, and the one considered here, involves using the boiler to power a turbine generator unit that produces electricity and using waste heat to produce process steam. While the thermal energy demand for an ethanol plant using CHP technology is slightly higher than that of a conventional plant, the additional energy used is far less than what would be required to produce the same amount of electricity in an offsite (central) power plant. The increased efficiency is due to the ability of the ethanol plant to effectively utilize the waste heat from the electricity generation process. Since CHP technologies on natural gas plants replace some of the purchased electricity but increase process energy use emissions (because of increased natural gas use on-site), the net result is a small reduction in overall emissions. The difference between CHP and non-CHP plants is reflected in their use of different amount of primary energy (natural gas, biogas, etc.) and the amount of electricity used from the grid. Because the only advanced biofuel pathways we are proposing today for the production of barley ethanol specify maximum amounts of primary energy and grid electricity that can be used per gallon of ethanol produced, we are not proposing a pathway that specifies the use of CHP. However, we believe that CHP is likely to be one of the technologies used to meet these energy and electricity use thresholds.

Use of an alternative fuel source to replace natural gas for process energy can also reduce the GHG emissions of a barley ethanol plant. As shown in the "Supplemental Determination for Renewable Fuels Produced Under the Final RFS2 Program From Grain Sorghum" Published December 17, 2012 (77 FR 242), hereafter the "Sorghum rule," switching from natural gas to biogas can reduce lifecycle GHG emissions from ethanol production. Use of such biogas would also provide a way for barley ethanol plants to reduce their GHG emissions. We have assumed for purposes of this NODA that biogas used for process energy comes from landfills, waste treatment plants or waste digesters. Such biogas is assumed to have zero upstream GHG impacts, as discussed in the sorghum rule. Our modeling shows that even if a dry mill plant uses grid electricity and dries 100% of its DGs, that plant may be able to replace enough natural gas with biogas from a landfill, waste treatment plant or waste digester to lower their GHG emissions enough to meet a 50% lifecycle GHG reduction compared to the baseline petroleum gasoline replaced. As such, today we are proposing two pathways that would allow barley ethanol to qualify as advanced biofuel if it is produced at dry mills that keep their use of natural gas and grid electricity below certain levels, as specified below. Because the use of biogas results in some lifecycle GHG emissions, although significantly lower than the use of fossil-based natural gas, the advanced biofuel pathways for barley ethanol proposed in today's NODA specify maximum amounts of biogas that can be used in combination with natural gas and grid electricity while still meeting the 50% lifecycle GHG reduction threshold.

Specific to the barley ethanol process is the possibility of using barley hulls as an energy source. In the case of barley hulls, the upstream CO_2 emissions from the hulls are already accounted for as part of the land use change calculations for the barley as a renewable fuel feedstock. Furthermore, since none of the barley ethanol emissions were allocated to the hulls, as discussed above, the beneficial use of the hulls would not require any adjustment to the barley lifecycle results. Therefore, similar to GHG emissions associated with use of biogas from the sources listed above, the use of barley hulls either directly as an energy source or in digesters producing biogas would not result in additional CO_2 emissions, and can replace the use of higher-GHG emitting sources of energy, such as natural gas and grid electricity. Because the use of barley hulls results in some lifecycle GHG emissions, although significantly lower than the use of fossil-based natural gas, the advanced biofuel pathways for barley ethanol proposed in today's NODA specify maximum amounts of barley hulls that can be used in combination with natural gas and grid electricity while still meeting the 50% lifecycle GHG reduction threshold.

The following Table II.B.5-1 shows the mean lifecycle GHG reductions compared to the baseline petroleum fuel for a number of different barley ethanol pathways.

Table II.B.5-1. Lifecycle GHG Emission Reductions for Dry Mill Barley Ethanol Facilities
(% change compared to petroleum gasoline)

Fuel Type and Technology	% Change
Dry mill process, using natural gas for process energy, grid electricity, and producing up to 100% dry DG	47%
Dry mill process using, on a per gallon basis averaged over the number of gallons in each batch, no more than 30,700 Btu of natural gas for process energy, no more than 4,200 Btu of biomass from barley hulls or biogas (biogas must be from landfills, waste treatment plants, barley hull digesters, or waste digesters) for process energy, and no more than 0.84 kWh of electricity from the grid for all electricity used at the renewable fuel facility	>50%
Dry mill process using no more than 36,800 Btu natural gas for process energy calculated on a per gallon basis averaged over the number of gallons in each batch, and using natural gas for on-site production of all electricity used at the renewable fuel facility other than up to 0.19 kWh of electricity from the grid calculated on a per gallon basis averaged over the number of gallons in each batch	>50%

As stated above, the docket for this NODA provides more details on our key modeling assumptions. EPA invites comment on all aspects of its modeling of advanced barley ethanol configurations, including all assumptions and modeling inputs.[32]

C. Consideration of Lifecycle Analysis Results

1. *Implications for Threshold Determinations*

As discussed above, EPA's analysis shows that, based on the mid-point of the range of results, ethanol produced from barley using a variety of processing technologies has the potential to meet the 50 percent GHG emissions reduction threshold needed to qualify as an advanced biofuel.[33] Barley ethanol meets the 20% lifecycle GHG emissions reduction threshold for conventional biofuels when assuming natural gas is used as the process fuel in a dry mill plant using grid electricity and drying 100% DG. If finalized, Table 1 to Section 80.1426 would be modified to add these new pathways. Table II.C.1-1 illustrates how these new pathways would be included in the existing table. Data, analysis and assumptions for each of these processing technologies are provided in the docket for this NODA. We invite comment on all aspects of this analysis.

Table II.C.1-1. Proposed Applicable D Codes for Barley Ethanol Produced with Different Processing Technologies

[32] See Memo to the Docket, EPA-HQ-OAR-2013-0178-0001, Dated June 20th, 2013.

[33] As with our analysis showing that barley ethanol meets the 20 percent threshold to qualify as conventional biofuel, our analysis here included a 95 percent confidence interval that represents the uncertainty in our modeling. See Memo to the Docket, EPA-HQ-OAR-2013-0178-0005, Dated June 20th, 2013.

Fuel Type	Feedstock	Production Process Requirements	D-Code
Ethanol	Barley	Dry mill process, using natural gas for process energy and grid electricity, and producing up to 100% DG.	6
Ethanol	Barley	Dry mill process using, on a per gallon basis averaged over the number of gallons in each batch, no more than 30,700 Btu of natural gas for process energy, no more than 4,200 Btu of biomass from barley hulls or biogas from landfills, waste treatment plants, barley hull digesters, or waste digesters for process energy, and no more than 0.84 kWh of electricity from the grid for all electricity used at the renewable fuel production facility	5
Ethanol	Barley	Dry mill process using no more than 36,800 Btu natural gas for process energy calculated on a per gallon basis averaged over the number of gallons in each batch, and using natural gas for on-site production of all electricity used at the renewable fuel production facility other than up to 0.19 kWh of electricity from the grid calculated on a per gallon basis averaged over the number of gallons in each batch	5

The advanced biofuel pathways for barley ethanol proposed in Table II.C.1-1, specify maximum amounts of different types of energy and grid electricity that can be used for the fuel to qualify as advanced biofuel. In the RFS March 2010 rule, EPA used a technology-based approach for determining whether a fuel from a specific feedstock met the lifecycle GHG emissions reduction thresholds required by CAA (o). As outlined in §80.1426 Table 1, EPA specified the feedstock (e.g., corn starch), fuel (e.g., ethanol), and process type (e.g., dry mill process using natural gas and two advanced technologies in Table 2) needed to generate a conventional (D-6) RIN. Examples of advanced corn ethanol technologies in Table 2 include membrane separation, corn oil fractionation and combined heat and power configurations. This technology based approach included certain assumptions about conversion yields and energy use, and how advanced technologies could reduce average GHG emissions. The regulations also specified a time period over which application of advanced technologies would be averaged. For example, the corn ethanol pathways specify that the amount of DG drying was to be calculated on an annual basis.

As discussed above and as was done in the sorghum rule, our analysis finds a range of possible technologies and process configurations for barley ethanol production that could meet a 50% lifecycle GHG reduction. As such, instead of prescribing certain types of technologies that producers must use to meet the thresholds, we are proposing pathways (like we did for sorghum) that are based on the maximum amount of different sources of energy that can be used to produce the barley ethanol.

This approach generates a number of questions, therefore, we discuss and invite comment on several aspects of the proposed advanced biofuel pathways for barley ethanol, including what energy should be included in the calculation and how the calculation should be conducted. Beyond the specifics of the calculations, however, is also how compliance is to be measured and reported, along with the associated record keeping requirements. We specifically invite comments from producers, obligated parties, and parties that purchase and verify RINs regarding how we should structure the regulations to attribute energy inputs to specific batches of fuel, and from parties that purchase and verify RINs regarding how to structure requirements that will enable them to efficiently evaluate whether RINs generated under the proposed pathways are valid before they purchase or verify the validity of the RINs.

The two advanced biofuel pathways for barley ethanol proposed in Table II.C.1-1 specify maximum amounts of different types of energy and grid electricity that can be used for the fuel to qualify as advanced biofuel, calculated on a per gallon basis averaged over the number of gallons of ethanol in each batch. A key element of this approach is the ability of renewable fuel producers to accurately calculate each type of energy used on a per batch basis. Evaluating ethanol on a batch-by-batch basis allows parties to evaluate whether such requirements have been met at the time of RIN generation. The structure of the RFS program is already set up in several respects to consider compliance on a batch basis for qualifying renewable fuels. Similarly, the EPA Moderated Transaction System (EMTS) used to manage RIN transactions was designed for batch-by-batch record-keeping, reporting and transactions.

The main benefit of batch-by-batch compliance is that it allows parties to know whether the requirements for the advanced biofuel pathways are being met at the time of RIN generation. Since invalid RINs cannot be transferred or used for compliance, EPA puts a high priority on ensuring that any new pathways will allow parties to evaluate the validity of RINs at the time they are generated.

The main concern with evaluating compliance with the GHG thresholds for barley on a batch-by-batch basis, however, is that it may allow cherry-picking in the production of barley ethanol, allowing more energy consumption to be associated with some fuel batches and less with others. This might allow some barley ethanol to qualify as advanced (D5), while over time barley ethanol production may not otherwise meet the advanced threshold. Alternatively, evaluating compliance on a batch-by-batch basis may result in reduced volumes of advanced biofuel being produced if during times of abnormal operations energy consumption spiked. The result would be batches of biofuel produced temporarily that would not meet the lifecycle thresholds while over the course of weeks, months, or years such aberrations would not cause the pathway to satisfy the lifecycle performance thresholds.

In addition, batch-by-batch compliance means that parties would have to have the ability not only to express things like energy consumption on a batch specific basis, but also to measure, and verify that things like energy consumption met the requirements for each and every batch despite operational changes and fluctuations. Energy use is ongoing as is fuel production; however there are energy intensive operations associated with a certain gallon of ethanol produced that may occur on a different timeframe than ethanol production. For example, if DG is produced from a certain gallon but then set aside and not dried until a later date, the energy used to dry the DG would not occur at the same time as ethanol production. Furthermore, energy use could be ongoing during times when no ethanol is produced. There is concern that energy use would not be accounted for if it occurred in between production of batches. EPA seeks comment on how renewable fuel producers should assign energy use to each batch, and on whether the regulations should specify the formula or allow RIN generators to provide a plan that demonstrates and documents how a facility would calculate energy use on a per batch basis. EPA is seeking comment on whether the renewable fuel producer would be able to accurately track (and account for the energy use) that is associated with any particular batch of ethanol. While EPA is taking comment on a number of different options in this NODA, it is our intent to codify only one approach in the final rule.

An alternative approach that EPA is considering calculates the energy use per gallon over a time period instead of over the number of gallons in each batch. For example, energy use per gallon of barley ethanol could be calculated on a weekly, monthly, quarterly or annual basis. This approach may make it more difficult for a party who purchases RINs that are generated during the averaging period (e.g., during a particular quarter if calculations are done on a quarterly basis) to have confidence in the validity of the RINs. One advantage of requiring the energy use to be calculated on a quarterly basis is that the RFS program currently requires biofuel producers to report certain data on a quarterly basis. The quarterly reports require a more comprehensive set of information from fuel producers than what is currently collected on a batch-by-batch basis. As such, calculating the energy use per gallon of barley ethanol on a quarterly or annual basis may allow for closer alignment with the types of information that are already reported at such intervals. The primary reason that EPA is not proposing to use a quarterly or annual basis to calculate average energy use per gallon of barley ethanol for the advanced pathways is that it would not always allow parties purchasing or verifying barley ethanol RINs to know whether the requirements for the advanced biofuel pathways are being met at the time of RIN generation. If it was determined at the end of the averaging period that the pathway requirements were not met, then all RINs generated during the time period would be invalid. We invite comment on whether a weekly, monthly, quarterly or annual basis for calculating average energy use per gallon would be better than the proposed batch-by-batch basis for barley ethanol.

Another alternative that we seek comment on is whether to calculate average energy use per gallon as a rolling average for all gallons of barley ethanol in the batch in question and all gallons of barley ethanol produced at the facility during a preceding time period. If the rolling average period was one year, this approach would average the total amount of energy used for the current batch with the average amount of energy used in all batches produced in the preceding 364 days. This approach would still calculate average energy use at the time that each batch of barley ethanol was produced, so it would also have the advantage of being well-aligned with the RFS regulations at §80.1426. The use of a rolling average would provide the additional benefit of smoothing out variability in energy use at barley ethanol facilities. For example, energy use could fluctuate significantly in the winter compared to the summer, or due to other circumstances. A rolling average approach could allow a barley ethanol producer who consistently maintained energy use below the maximum levels to continue generating advanced biofuel RINs if their energy use increased during one season or month of the year.

Under the rolling average approach, no special requirements would be needed for facilities that dry DG in batches as compared to facilities that dry them continuously. This is because the rolling average approach is designed to account for temporal variability in energy use. For example, if a facility stockpiled and dried a large enough batch of DG to push their energy use above the maximum levels specified in the advanced biofuel pathways, then they would not be able to generate RINs until their rolling average came back down to compliant levels. This approach would provide parties who purchase RINs with the information that they need to evaluate the validity of the RINs before the purchase them, and would reduce the risk that the RIN would later be found to be invalid. This illustrates one example of where the rolling average approach may have significant advantages. However, using a rolling average approach might create reporting challenges if a plant is coprocessing barley with another feedstock. For example, if the rolling average is done on a fuel-specific basis, a producer could attempt to allocate high energy activities to the fuel produced from the other feedstock, making energy used to produce barley ethanol look less intensive than it actually is.

EPA invites comment on whether the proposed advanced biofuel pathways for barley ethanol should calculate average energy use per gallon as a rolling average for all gallons of barley ethanol produced at the facility during a preceding time period and whether this approach would be preferable to other approaches. This includes comment on methods for preventing any sort of gaming of the system under a rolling average approach.

EPA seeks comment on the best approach for calculating the average energy use per gallon of ethanol for the proposed advanced biofuel pathways for barley ethanol. The Agency asks commenters to consider the complexity of any proposed approach, how well it fits within the existing RFS regulations, and how well it addresses the issues (e.g., temporal variation in energy use) discussed above.

EPA also seeks comment on the most appropriate way for renewable fuel producers to track and report the energy use associated with a batch of renewable fuel. One possible approach is for a renewable fuel producer to take meter readings at the start and end of a batch, documentation of which would need to be included in the recordkeeping requirements. EPA seeks comment on the practicability of this approach, especially considering that any drying of DG associated with a given batch of ethanol would necessarily need to be completed by the time energy use is calculated for a given batch. EPA is proposing to attribute all the energy used (e.g., lights, administrative offices) at the renewable fuel facility to the batch, for ease in tracking and compliance purposes. EPA is also taking comment on whether there are practical ways to limit the energy use more directly to the batch of fuel. If all energy use should not be attributed to production of the renewable fuel, EPA seeks comments on which equipment should be included, and how the renewable fuel producer would be able to track and report the energy use for renewable fuel separate from ancillary functions. We also seek comment on whether the energy use associated with ancillary functions significantly contributes to the GHG emissions associated with a renewable fuel.

EPA proposes to prohibit parties that use multiple pathways to produce a single batch of fuel from generating RINs under the proposed advanced barley pathways. We do not believe that it is practical to determine if a producer meets the energy usage limitations required by the Barley pathways if it is using multiple pathways to produce a given batch of fuel.

EPA also invites comment on whether, if the annual average, batch-by-batch or rolling average approaches to compliance for the advanced barley pathways raise significant implementation concerns that cannot be addressed, it would be more appropriate to use the technology based approach currently in place for corn ethanol facilities.

EPA is also proposing a record-keeping and reporting system that will allow eligible barley ethanol producers using the proposed advanced biofuel pathways to demonstrate compliance with the 50% GHG reduction threshold. The proposed record-keeping and reporting approach will allow producers to show compliance with the new pathway by reporting and keeping records, on an ongoing basis regarding their process energy and electricity use and fuel production yields. The details of EPA's proposed new pathways and potential accompanying compliance approach (including registration, recordkeeping, and reporting) are described in a Memo to the Docket.[34]

2. *Consideration of Uncertainty*

[34] See Memo to the Docket, EPA-HQ-OAR-2013-0178-0012.

Because of the inherent uncertainty and the state of evolving science regarding lifecycle analysis of biofuels, any threshold determinations that EPA makes for barley ethanol will be based on an approach that considers the weight of evidence currently available. For this pathway, the evidence considered includes the mid-point estimate as well as the range of results based on statistical uncertainty and sensitivity analyses conducted by the Agency. EPA will weigh all of the evidence available to it, while placing the greatest weight on the best-estimate value for the scenarios analyzed.

As part of our assessment of the barley ethanol pathway, we have identified key areas of uncertainty in our analysis. Although there is inherent uncertainty in all portions of the lifecycle modeling, we focused our analysis on the factors that are the most uncertain and have the biggest impact on the results. The indirect, international emissions are the component of our analysis with the highest level of uncertainty. The type of land that is converted internationally and the emissions associated with this land conversion are critical issues that have a large impact on the GHG emissions estimates.

Our analysis of land use change GHG emissions includes an assessment of uncertainty that focuses on two aspects of indirect land use change – the types of land converted and the GHG emissions associates with different types of land converted. These areas of uncertainty were estimated statistically using the Monte Carlo analysis methodology developed for the March 2010 RFS rule.[35] Figure II.B.4-1 shows the results of our statistical uncertainty assessment.

[35] The Monte Carlo analysis is described in EPA (2010a), Section 2.4.4.2.8

Based on the weight of evidence considered, and putting the most weight on our mid-point estimate results, the results of our analysis indicate that barley ethanol would meet the minimum 20% GHG performance threshold for qualifying renewable fuel under the RFS program when using natural gas for all process energy, grid electricity, and drying 100% DG, and would meet the minimum 50% GHG performance threshold for advanced biofuels under the RFS program when using technologies that either reduce energy use or rely on low GHG-emitting energy sources. This conclusion is supported by our midpoint estimates, our statistical assessment of land use change uncertainty, as well as our consideration of other areas of uncertainty.

An additional source of uncertainty is the distribution of ethanol production between spring and winter barley. EPA has worked to mitigate this source of uncertainty through extensive consultation with public and private sector barley experts and stakeholders. This consultation led to the determination that approximately 140 million gallons of barley ethanol production by 2022 would be a reasonable assumption, as would the assumption that approximately 80 million gallons will come from spring barley and approximately 60 million gallons will come from winter barley. However, we acknowledge that there remains uncertainty regarding how much ethanol will be produced from each of the two regional growing practices. We also acknowledge that this pathway would be applicable to international production. Based on our consultation of USDA and other experts, we do not anticipate any significant international production of barley ethanol. But that is an additional source of potential uncertainty. We therefore invite comment regarding the magnitude and significance of this uncertainty with regards to our analysis, as well as potential alternative methods of accounting for any significant uncertainty in our analytical framework.

The docket for this NODA provides more details on all aspects of our analysis of barley ethanol. EPA invites comment on all aspects of its modeling of barley ethanol. We also invite comment on the consideration of uncertainty as it relates to making GHG threshold determinations.

Dated: July 8, 2013

Christopher Grundler, Director
Office of Transportation & Air Quality

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