

# How to Use the Efficient Producer Lifecycle Greenhouse Gas Calculator Version 1.3

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Transportation and Climate Division  
Office of Transportation and Air Quality  
U.S. Environmental Protection Agency

## 1. Introduction

The U.S. Environmental Protection Agency is providing instructions on how to use version 1.3 of the Efficient Producer Lifecycle Greenhouse Gas Calculator (the “GHG Calculator”). The GHG Calculator is a spreadsheet tool available for download through the EPA’s website for the U.S. Renewable Fuel Standard (RFS) program. It is intended to help ethanol producers with the Agency’s Efficient Producer petition process (EP3)<sup>1</sup> and associated quarterly reporting obligations.

This document provides instructions on how to fill out and submit the GHG Calculator as part of an

**Disclaimer:** This document provides general information and is not intended to contradict the RFS regulations at 40 CFR Part 80 Subpart M, or the signed determination documents issued pursuant to the petition process at 40 CFR 80.1416. To the extent there are any discrepancies, the RFS regulations and/or the petition determination documents control and override the information in this document.

Efficient Producer (EP) petition. It also explains how facilities that have already been evaluated through the EP3 can use the GHG Calculator to calculate the rolling average lifecycle GHG emissions for the fuel they produce through a qualifying facility/process.<sup>2</sup>

Section 3 includes frequently asked questions about using the GHG Calculator. Section 4 provides an overview of the GHG Calculator spreadsheet, and instructions on how to use each tab when preparing an EP petition submission or using the GHG Calculator to calculate the rolling average lifecycle GHG emissions for ethanol produced through a previously approved EP pathway.

The agency welcomes public input on improving the GHG Calculator and accompanying documentation. Please send input to the EPA Fuels Program Helpdesk.<sup>3</sup> The EPA will make updates and improvements as warranted based on public input and updates to the EP3.

## 2. Updates for Version 1.3

Version 1.3 includes updates to accommodate EP petitions from dry mill ethanol plants that produce corn starch ethanol and cellulosic ethanol from corn kernel fiber.

## 3. Frequently Asked Questions about Using the GHG Calculator

This section answers anticipated questions about the GHG Calculator and includes contact information for further questions.

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<sup>1</sup> For information about the EP3, see the following EPA web page:

<https://www.epa.gov/renewable-fuel-standard-program/how-prepare-efficient-producer-petition-under-renewable-fuel>

<sup>2</sup> EPA petition evaluations are available on the agency’s website:

<https://www.epa.gov/renewable-fuel-standard-program/approved-pathways-renewable-fuel>

<sup>3</sup> <https://www.epa.gov/renewable-fuel-standard-program/forms/contact-us-about-renewable-fuel-standards>

## What is the Purpose of the GHG Calculator?

The GHG Calculator is provided to help certain ethanol producers calculate the lifecycle GHG emissions associated with their fuel using the EPA's methodology. The GHG Calculator serves two primary functions:

1. **Help producers prepare an EP petition submission:** The GHG Calculator provides a tool that allows producers to submit the mass and energy balance data required for EP petitions. It also allows petitioners to see whether their pathway qualifies for the applicable lifecycle GHG reduction thresholds based on the mass and energy data they provide. Further, it helps expedite EPA petition reviews because the GHG results are automatically calculated. Before starting an EP petition, please carefully review the information provided on EPA's website, including the document titled How to Prepare an Efficient Producer Petition.<sup>4</sup>
2. **Help producers with an activated EP pathway calculate their fuel's 365-day rolling average lifecycle GHG emissions as part of their ongoing recordkeeping and reporting requirements:** Each of the EP determinations that EPA has completed specifies a number of conditions the petitioner must satisfy in order to generate RINs for non-grandfathered ethanol produced through an EP pathway. One of the conditions is that the petitioner must have documentation showing that RINs are only generated if, on average, all the ethanol they produced during a specified averaging time period (typically 365 days or shorter in certain circumstances) satisfies a certain lifecycle GHG reduction threshold. To satisfy this condition, the petitioner calculates their fuel's 365-day rolling average lifecycle GHG emissions according to the formulas specified in the EP determination document issued to the petitioner by EPA. The EPA has provided the GHG Calculator spreadsheet on its website to help ethanol producers calculate the 365-day rolling average lifecycle GHG emissions for their fuel.

## Why should I include the GHG Calculator as part of my EP petition submission?

The RFS regulations (see 40 CFR 80.1416) specify that all petitions for new fuel pathways must include a mass and energy balance for the requested pathway. For an EP petition this requirement is satisfied by including a GHG Calculator that has been properly filled in with data about your fuel production process. Furthermore, the GHG Calculator is set up to calculate the lifecycle GHG emissions for the ethanol produced at your facility, so it can provide a demonstration of how your facility can meet the required GHG reduction thresholds.

## What data are required to complete the GHG Calculator for an EP petition submission?

The GHG Calculator requires the following data inputs:

- Volume of feedstocks used in fuel production processes for all of the ethanol produced at your facility during a specified time period (including ethanol that does not generate RINs or is exempt from the GHG reduction requirements per 40 CFR 80.1403).
- All of the energy used for feedstock, fuel and co-product operations.<sup>5</sup>

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<sup>4</sup> <https://www.epa.gov/renewable-fuel-standard-program/how-prepare-efficient-producer-petition-under-renewable-fuel>

<sup>5</sup> Energy for feedstock, fuel and co-product operations should include all energy used in any building that is used in any part for the storage and/or processing of feedstock and all energy used in any building that is used in any part

- The volume of ethanol produced by your facility.

For your petition, data should be provided for a period of time encompassing at least 365 consecutive days. Either historical or projected data are acceptable. If you provide historical data for your facility, include at least the most recent 365-day period. Projected data may be more appropriate if your facility is undertaking process efficiency improvements or for other reasons. If projected data is provided, then it should be representative of anticipated average annual facility operations.

**Do I need to enter daily data in the GHG Calculator when submitting an EP petition?**

No, not when submitting an EP petition. However, daily data are required when using the GHG Calculator to calculate the rolling average lifecycle GHG emissions for ethanol produced through a previously approved EP pathway (and for associated recordkeeping).

When entering data into the GHG Calculator for an EP petition submission there are two options: (1) enter daily data using one row for each day, or (2) enter aggregate data using one row for a period of time encompassing at least 365-consecutive days. Examples of how each option would look for electricity use data are shown below in Figure 1 and Figure 2. In both figures, the facility uses 100 kWh of electricity each day. In Figure 1, these data are entered for 365 separate days. In Figure 2, the total electricity use during the 365-day period is entered in one row corresponding with the first day in the time period. Both approaches are equally valid when preparing the GHG Calculator for an EP petition.

Using the daily data approach illustrated in Figure 1, the GHG Calculator will pull data from all of the rows encompassing the time period from 4/1/2014 to 3/31/2015. Using the aggregate data approach illustrated in Figure 2, the GHG Calculator will only use the data entered in the first row.

**Figure 1: Example of daily electricity use data entered using one row for each day**

Day	Daily Electricity Use	Meter 1		
		Previous Day Meter Reading	Daily Meter Reading	Daily Amount Used
DD/MM/YYYY	Amount (kWh)	Amount (kWh)	Amount (kWh)	Amount (kWh)
4/1/2014	100	-	100	100
4/2/2014	100	100	200	100
[...]	[...]	[...]	[...]	[...]
3/30/2015	100	36,300	36,400	100
3/31/2015	100	36,400	36,500	100

**Figure 2: Example of aggregate electricity use data entered using one row for a period encompassing at Least 365-Consecutive Days**

Day	Daily Electricity Use	Meter 1		
		Previous Day Meter Reading	Daily Meter Reading	Daily Amount Used
DD/MM/YYYY	Amount (kWh)	Amount (kWh)	Amount (kWh)	Amount (kWh)

for the production and/or storage of fuel intermediates, finished fuel or co-products. It also includes any energy related to feedstock or waste handling.

4/1/2014	36,500	-	36,500	36,500
4/2/2014	-	36,500		(36,500)
4/3/2014	-	-		-

If you use the aggregate data entry approach shown in Figure 2, in the Cover Sheet tab you must enter the first date in the time period you are entering data for in both of the Averaging Time Period fields. We also ask that you explain the time period for the aggregate data in the Notes section, as shown below in Figure 3.

**Figure 3: Example of how to fill out the Averaging Time Period fields in the Cover Sheet when entering aggregate data for a time period from 4/1/2014 to 3/31/2015**

<b>Averaging Time Period</b>	
Earliest date that you are entering data for (DD/MM/YYYY):	4/1/2014
Latest date you are entering data for (DD/MM/YYYY):	4/1/2014

<b>Notes:</b>	Data for the 365-day period from 4/1/14 to 3/31/15 are entered in one row.
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### What if the GHG Calculator shows that my fuel does not meet the applicable GHG reduction threshold?

If you are using the GHG Calculator for an EP petition submission, the data entered into the GHG Calculator and submitted as part of your EP petition should demonstrate that your fuel meets the applicable GHG reduction threshold (20% reduction for renewable fuel or 50% reduction for advanced biofuel). If you submit a GHG Calculator that does not demonstrate adequate GHG reductions, EPA will return your petition as incomplete.

Please keep in mind that should your EP pathway be approved and activated, in order to generate RINs through your activated EP pathway you will need to monitor, calculate and record your fuel’s lifecycle GHG emissions on a 365-day rolling average basis to demonstrate that it is meeting the applicable GHG reductions. If the GHG Calculator shows that your fuel does not meet the 20% GHG reduction threshold specified in the CAA, RINs may not be generated for non-grandfathered volumes of fuel.

### Are coproducts accounted for in the GHG Calculator?

In addition to producing ethanol, dry mill plants also produce distillers grains and solubles (DGS) as a coproduct. Many plants also extract corn or sorghum oil as an additional coproduct. In the GHG Calculator the GHG impacts of the DGS and oil coproducts are accounted for in the upstream GHG emissions factors for corn and grain sorghum. Our analyses of the upstream emissions attributable to corn and grain sorghum used for ethanol account for the agricultural sector impacts of the DGS and corn oil coproducts. In our modeling, the DGS are considered a replacement animal feed and thus reduce the

demand for other sources of animal feed and the GHG emissions associated with their production and use. Extracted oil is also accounted for in the vegetable oil and biodiesel markets.<sup>6</sup>

### Who should I contact if I have more questions?

Please direct any further questions to the EPA Fuels Program Helpdesk at:

<https://www.epa.gov/renewable-fuel-standard-program/forms/contact-us-about-renewable-fuel-standards>. Your questions will be delegated to appropriate EPA staff (or EPA contractor) for response.

## 4. Tab-by-Tab Instructions

This section includes an overview of the GHG Calculator spreadsheet, and instructions on how to use each tab when preparing an EP petition or using the GHG Calculator to calculate the rolling average lifecycle GHG emissions for ethanol produced through a previously approved EP pathway. It begins with an explanation of the purpose of the GHG Calculator, followed by a brief introduction to each tab in the spreadsheet.

### Overview of the Tabs in the GHG Calculator

Table 2 lists the tabs in the GHG Calculator with a brief description. The GHG Calculator includes three types of tabs: data entry tabs (green background), calculation tabs (blue background), and information tabs (clear background).

**Table 2: Overview of the Tabs in the GHG Calculator Spreadsheet**

Tab Name	Description
Cover Sheet	Basic information regarding the fuel pathway.
Instructions	Basic instructions for using the spreadsheet
Contact Info	Enter contact information for petitioner’s Responsible Corporate Officer
Corn Use Data	Data entry for corn use in bushels.
Corn Moisture Data	Data entry for the moisture content of corn deliveries.
Sorghum Use Data	Data entry for grain sorghum use in bushels.
Sorghum Moisture Data	Data entry for the moisture content of grain sorghum deliveries.
Natural Gas Use Data	Data entry for natural gas use in standard cubic feet.
Biogas Use Data	Data entry for biogas use in standard cubic feet.
Electricity Use Data	Data entry for grid electricity use in kilowatt hours.
Coal Use Data	Data entry for coal use in tons.
Biomass Use Data	Data entry for biomass use dry pounds.
Ethanol Production Data	Data entry for ethanol production in standard gallons.
CKF Ethanol Production Data	Data entry for cellulosic ethanol production from corn kernel fiber, in standard gallons.
Confirm Data	Confirm that data is entered properly for each day.
Quick Check	Automatic check for missing information
Daily Data Summary	Summary of daily feedstock and energy use, and fuel production data.
Time Series Results	Time series of daily and rolling average lifecycle GHG results.
Results Summary	Updated 365-day rolling average lifecycle GHG results.

<sup>6</sup> For more information on our corn ethanol modeling see the March 2010 rule (75 FR 14670), and for more information on our grain sorghum modeling see the December 2012 grain sorghum rule (77 FR 74592).

Corn Ethanol GHG Calcs	Daily and rolling average GHG calculations for corn ethanol.
Sorghum Ethanol GHG Calcs	Daily and rolling average GHG calculations for grain sorghum ethanol.
Emis Facs	Emission factors and unit conversions used in the GHG calculations.
Abbreviations	Descriptions of abbreviations used in the GHG Calculator
RFS2500-Corn	Corn starch ethanol data to be reported using the RFS Efficient Producer Data Form
RFS2500-Sorghum	Grain sorghum ethanol data to be reported using the RFS Efficient Producer Data Form
RFS2500-CKF	Corn kernel fiber ethanol data to be reported using the RFS Efficient Producer Data Form
For-EPA-Use	The data collected in this tab helps the EPA review EP petitions.

This rest of this section includes instructions for each tab of the GHG Calculator.

### Cover Sheet

The Cover Sheet asks for five categories of information to be entered in the green-shaded cells.

#### Facility information:

- Company Name: Enter the name of the company that owns the fuel production facility.
- Company ID: The company's four-digit identification number from CDX OTAQReg (if the company does not yet have an ID number enter "N/A").
- Facility Name: Enter a name for the fuel production facility (e.g., the company name followed by the name of the city where the facility is located).
- Facility ID: The facility's five-digit identification number from CDX OTAQReg (enter "N/A" if one does not exist).
- Facility City: The city where the fuel production facility is located.
- Facility State: The state where the fuel production facility is located.

#### Fuel Pathway Information:

- Has the EPA has activated an Efficient Producer pathway(s) for your fuel?

Select "No" if you are preparing the GHG Calculator as part of an EP petition.<sup>7</sup>

Select "Yes" if EPA has previously approved an EP pathway for your fuel, and the Agency has accepted your registration for the fuel pathway.<sup>8</sup>

<sup>7</sup> This also applies if you are preparing the GHG Calculator as part of a petition requesting a modification to an existing EP corn starch ethanol pathway, for a facility that seeks to co-produce cellulosic ethanol from corn kernel fiber and generate D-code 3 RINs for such ethanol.

<sup>8</sup> Your EP pathway is considered to be activated after your registration for the pathway has been accepted by EPA and you are able to access your EP pathway in EMTS. You should receive an email notification when your pathway is activated.

Some of the instructions below differ depending on your answer to this question. In these cases, if you answered “Yes” follow the instructions below for that apply “For EP petitions” and if you answered “No” follow the instructions that apply “For activated EP pathways.”

- **Petition Request:** Use the drop-down menu to select the appropriate option from the following:
  1. Efficient Producer corn starch ethanol pathway to generate D-code 6 RINs for facility that only uses only corn as feedstock
  2. Efficient Producer corn starch ethanol pathway for D-code 6 RINs for facility that uses corn and grain sorghum as feedstock
  3. Efficient Producer grain sorghum ethanol pathway for D-code 5 or 6 RINs
  
- **My facility's corn ethanol does not match any of the pathways in Table 1 to 40 CFR 80.1426 because the facility:** Use the drop-down menu to select the appropriate option from the following:
  - dries more than 65% of the DGS it markets annually and does not use two of the advanced technologies in Table 2 to 40 CFR 80.1426
  - dries more than 50% of the DGS it markets annually and does not use any of the advanced technologies in Table 2 to 40 CFR 80.1426
  - N/A

The list of advanced technologies in [Table 2 to 40 CFR 80.1426](#) is available on EPA’s web page.<sup>9</sup> If you are requesting a pathway for non-grandfathered corn ethanol and none of these options look appropriate there may be an existing pathway for your fuel. If your petition only requests a pathway for grain sorghum ethanol, select N/A.

- **My facility's sorghum ethanol does not match any of the advanced biofuel pathways in Table 1 to 40 CFR 80.1426 because the facility:** Use the drop-down menu to select the appropriate option from the following:
  - does not use biogas from landfills, waste treatment plants, and/or waste digesters for all process energy and for on-site production of all electricity used at the site
  - uses more than 0.15 kWh of electricity from the grid per gallon of ethanol produced, calculated on a per batch basis
  - N/A

If your petition only requests a pathway for corn ethanol, select N/A.

**For EP petitions:**

- **Earliest date that you are entering data for:** In the following sheets, you will enter data on feedstock use, energy use and fuel production. In this cell, enter the earliest date that you are entering data for. For example, if you are entering data for the time period from April 1, 2014, to March 31, 2015, you should enter “4/1/2014.”

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<sup>9</sup> <https://www.epa.gov/renewable-fuel-standard-program/approved-pathways-renewable-fuel>

- Latest date that you are entering data for:
  - **If you are entering daily data** in the GHG Calculator, enter the latest date that you are entering data for. For example, if you are entering daily data for the time period from April 1, 2014, to March 31, 2015, you should enter “3/31/2015” in this field.
  - **If you are entering aggregate data** in the GHG Calculator, enter the same date that you entered under “Earliest date that you are entering data for.” For example, if you are entering aggregate data for the time period from April 1, 2014, to March 31, 2015, you should enter “4/1/2014” in this field.<sup>10</sup> If you are using this approach, you should explain the time period for your aggregate data in the Notes field on the Cover Sheet (see below).
  - For details on choosing daily data or aggregate data, see the frequently asked question in this document titled: [Do I need to enter daily data in the GHG Calculator for an EP petition?](#)

**For activated EP pathways:**

- Date EPA activated your EP pathway(s): Enter the day that EPA activated your EP3 pathway.<sup>11</sup>
- Today’s date: Enter today’s date.

**Feedstock Checklist:**

- Does this facility use corn starch feedstock?
  - **For EP petitions:** Select “Yes” if your facility uses or intends to use a non-negligible amount of corn starch to produce ethanol. Note, even if your petition is requesting a pathway for ethanol made from grain sorghum, you must select “Yes” if your facility uses corn starch.
  - **For previously activated EP pathways:** Enter “Yes” if EPA evaluated corn starch as a feedstock for your facility’s EP pathway. (The signed EP determination document issued by EPA for your facility will specify whether EPA evaluated corn starch as a feedstock for your facility’s EP pathway.)
- Does this facility use grain sorghum feedstock?
  - **For petitioners:** Select “Yes” if your facility uses or intends to use grain sorghum feedstock to produce ethanol. Note, even if your petition is requesting a pathway for ethanol made from corn starch, you must select “Yes” if your facility uses grain sorghum. Also note that, at this time, co-production of D-code 3 RINs for corn kernel fiber ethanol is only valid at facilities that only process corn feedstock.
  - **For previously activated EP pathways:** Enter “Yes” if EPA evaluated grain sorghum as a feedstock for your facility’s EP pathway. (The signed EP determination document issued by EPA for your facility will specify whether EPA evaluated grain sorghum as a feedstock for your facility’s EP pathway.)
- Does this facility use corn kernel fiber feedstock to produce cellulosic ethanol and generate D-code 3 RINs for such ethanol? Select “Yes” or “No” from the drop-down options. An error will

<sup>10</sup> This is necessary because the GHG Calculator was originally designed for daily data entries.

<sup>11</sup> The day your EP pathway was activated is the day that your registration for the pathway was accepted by EPA and you were able to access your EP3 pathway in EMTS. You should have received an email notification when your EP pathway was activated.

appear if your facility uses grain sorghum feedstock as, at this time, co-production of D-code 3 RINs for corn kernel fiber ethanol is only valid at facilities that only process corn feedstock.

- **Does this facility use any other feedstocks?** Select “Yes” or “No” from the drop-down options. If you select “Yes” an error message will appear in the next row of the spreadsheet. This is because the EP3 currently only allows for the use of corn starch, corn kernel fiber or grain sorghum feedstocks.<sup>12</sup>

#### Other Information:

- **Baseline volume per 40 CFR 80.14003:** Enter the “grandfathered” baseline volume for your facility in gallons. If your facility does not qualify as a grandfathered facility (e.g., if it was not in operation or had not commenced construction prior to December 19, 2007) leave this field blank. This information is for EPA’s reference only; it does not impact the GHG Calculator results.<sup>13</sup>
- **Notes:** Use this field to enter important notes about the data entered in the GHG Calculator. For example, if data are not provided on a daily basis, use this field to explain how the data are reported (for details see: [Do I need to enter daily data in the GHG Calculator for an EP petition?](#)).

#### Contact Info

Use this tab to enter information about the responsible corporate officer (RCO) and the point of contact (POC) for the petitioning facility. The signed determination document responding to your petition will be addressed and mailed to the RCO using the information provided in this tab. Questions during the petition review process will be sent to the POC. (The POC and RCO may be the same person.) The entry fields on this tab (e.g., name, address, city) should be self-explanatory. Please spell out job titles, street names, etc., and refrain from using unnecessary abbreviations. If you have questions about how to enter data on this tab, please send them to the [Fuels Programs Support Line](#).<sup>14</sup>

#### Corn Use Data

On this tab enter your facility’s corn use, in bushels, in the green-shaded cells. Two data entry methods are available (use only one):

- **Inventory approach:** Enter the starting inventory, shipments received and ending inventories. All units are entered in bushels.
- **Direct measurement approach:** Enter the amount used each day (or for a multi-day period if entering aggregate data, see [Section 4\(A\)](#) of this document for details)

The GHG Calculator is designed for users to choose one data entry method (inventory or direct measurement) and use that method for all data entry in the sheet. The tool does not support using both methods on a single day or switching between methods for different entry dates.

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<sup>12</sup> Parties who use other feedstocks and seek a new fuel pathway, may submit a standard petition pursuant to 40 CFR 80.1416. For information on how to submit a standard petition see: <https://www.epa.gov/renewable-fuel-standard-program/how-submit-complete-petition-approved-pathway-under-renewable-fuel>

<sup>13</sup> For more information on what is meant by “grandfathered” fuel see: <https://www.epa.gov/renewable-fuel-standard-program/program-overview-renewable-fuel-standard-program>

<sup>14</sup> <https://www.epa.gov/renewable-fuel-standard-program/forms/contact-us-about-renewable-fuel-standard-program>

For each entry method there is an optional notes column to provide additional information about how the data were collected.

### Corn Moisture Data

Enter all of the corn deliveries to your facility including the moisture content, in mass percent, of each and every delivery. This information is used to calculate the standardized bushels of corn at 15.5% moisture.

The dates in column A are entered manually. If your facility receives more than one shipment on a given day, you can use multiple rows to record shipments for that day. If your facility does not receive corn shipments for a given day you can skip to the next day. Examples of this are illustrated below in Figure 3. Optional columns are provided to record additional information about each delivery, including time, number, type and other notes.

**Figure 3: Example data entry in the Corn Moisture Data tab**

Day	[...]	Amount of Corn in Delivery	Moisture Content
DD/MM/YYYY	[...]	Bu	Mass %
4/1/2014	[...]	100	15.5%
4/1/2014	[...]	200	14%
4/5/2014	[...]	100	15.5%

For the calculator to work properly, a delivery amount greater than zero and a moisture content must be entered for the date listed in cell A4 (i.e., the earliest date that you are entering data for). If there were no corn deliveries on the date listed in cell A4 then enter the previous day inventory and the average moisture content for the corn in inventory.

### Sorghum Use Data

On this tab enter your facility's grain sorghum use, in bushels. Two data entry methods are available: inventory approach or direct measurement approach (for explanation see the instructions for the [Corn Use Data tab](#), above). The GHG Calculator is designed for users to choose one data entry method (inventory or direct measurement) and use that method for all data entry in the sheet. The tool does not support using both methods on a single day or switching between methods for different entry dates.

For each entry method there is an optional notes column to provide additional information about how the data were collected.

### Sorghum Moisture Data

On this tab enter all of the grain sorghum deliveries to your facility including the moisture content, in mass percent, of each and every delivery. This information is used to calculate the standardized bushels of grain sorghum at 13% moisture. (See the data entry example given above for the [Corn Moisture Data tab](#).)

For the calculator to work properly, a delivery amount greater than zero and a moisture content must be entered for the date listed in cell A4 (i.e., the earliest date that you are entering data for). If there were no sorghum deliveries on the date listed in cell A4 then enter the previous day inventory and the average moisture content for the sorghum in inventory.

## Natural Gas Use Data

On this tab enter your facility's natural gas use in standard cubic feet.

Space is provided for you to record data from as many meters as necessary. For example, to add data from an additional meter, copy columns H-J and paste them into columns L-N. Relabel the meter number or give it a new name. Repeat these steps as many times as needed moving from left to right in the spreadsheet. Finally, revise the formula in column B so that it sums the "Daily Amount Used" from all of the meters you have added (make sure to use the fill down in Excel so the formula is accurate for all of the applicable rows).

## Biogas Use Data

On this tab enter your facility's biogas use in standard cubic feet. You must specify the methane content, in volume percent, for the biogas your facility uses. If methane is measured directly, then enter 100% in the percent methane column for each meter.

Space is provided for you to record data from as many meters as necessary. For example, to add data from an additional meter, copy columns J-N and paste them into columns P-T. Relabel the meter number or give it a new name. Repeat these steps as many times as needed moving from left to right in the spreadsheet. Finally, revise the formula in column B so that it sums the "Daily Amount CH<sub>4</sub> Used" from all of the meters you have added (make sure to "fill down" the formula so that it is accurate for all of the applicable rows).

To qualify for the EP3, all biogas used for process heat fuel must meet the RFS regulatory definition for biogas or treated biogas at 40 CFR 80.1041. Furthermore, the biogas must be sourced from one or a combination of the following sources: landfills, municipal wastewater treatment facility digesters, agricultural digesters, separate municipal solid waste (MSW) digesters, or other waste digesters. See the July 2014 RFS rule (79 FR 42128) for more information on qualifying sources of biogas.

## Electricity Use Data

On this tab enter your facility's use of grid electricity in kilowatt hours. Space is provided for you to record data from as many meters as necessary (See the instructions for the [Natural Gas Use Data](#) for details on how to add meters).

## Coal Use Data

On this tab enter your facility's coal use in tons. Two data entry methods are available: inventory approach or direct measurement approach (for explanation see the instructions for the [Corn Use Data tab](#), above). The GHG Calculator is designed for users to choose one data entry method (inventory or direct measurement) and use that method for all data entry in the sheet. The tool does not support using both methods on a single day or switching between methods for different entry dates.

## Biomass Use Data

On this tab enter the amount of biomass used by your facility as process heat fuel in dry pounds. Two data entry methods are available: inventory approach or direct measurement approach (for explanation see the instructions for the [Corn Use Data tab](#), above). For both data entry methods, you must enter the mass and average moisture content (weight percent) of the biomass used by your facility.

The GHG Calculator is designed for users to choose one data entry method (inventory or direct measurement) and use that method for all data entry in the sheet. The tool does not support using both methods on a single day or switching between methods for different entry dates.

At this time to qualify for the EP3, all biomass used for process heat fuel must meet the RFS regulatory definition for crop residue at 40 CFR 80.1401.<sup>15</sup> See the [July 2014 RFS rule](#) (79 FR 42128) for more information on what EPA considers to be a crop residue for the RFS program.<sup>16</sup>

### Ethanol Production Data

On this tab enter the amount of all ethanol produced at your facility. Two data entry methods are provided:

- **Direct Measurement Approach:** Enter the standardized volume of undenatured (200 proof) ethanol produced at your facility, in gallons adjusted to 60° F.
- **Actual Temperature and Volume Approach:** Enter the actual volume of undenatured ethanol produced at your facility, in gallons, and the average temperature of the ethanol in degrees Fahrenheit (volume and temperature should be measured at the same time).

The GHG Calculator allows users to switch between measurement approaches, and/or use both approaches for the same day.

### CFK Ethanol Production Data

On this tab enter the amount of cellulosic ethanol produced from corn kernel fiber feedstock at your facility, for which D-code 3 RINs have been, or shall be, generated. See the instructions for the previous tab on the two available data entry methods. Note that if your facility uses grain sorghum feedstock all of the entries in this tab will be treated as zero in the lifecycle GHG calculations, as co-production of D-code 3 RINs for corn kernel fiber ethanol is only valid at facilities that only process corn feedstock.

### Confirm Data

After reviewing the data entered in the tabs listed above select from the following two options for each day that you entered data for:

1. **CONFIRMED:** For this date valid data were properly collected through continuous monitoring and accurately recorded in this spreadsheet.
2. **MISSING DATA:** On this date one or more of the required data inputs were not properly collected or reported.

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<sup>15</sup> Per 40 CFR 80.1401: Crop residue means biomass left over from the harvesting or processing of planted crops from existing agricultural land and any biomass removed from existing agricultural land that facilitates crop management (including biomass removed from such lands in relation to invasive species control or fire management), whether or not the biomass includes any portion of a crop or crop plant. Biomass is considered crop residue only if the use of that biomass for the production of renewable fuel has no significant impact on demand for the feedstock crop, products produced from that feedstock crop, and all substitutes for the crop and its products, nor any other impact that would result in a significant increase in direct or indirect GHG emissions.

<sup>16</sup> Examples of materials that EPA considers crop residue are sugarcane and sweet sorghum bagasse; kernel fiber from barley, corn, oats, rice, rye, grain sorghum and wheat; and stover from corn and grain sorghum; straw from barley, oats, rice, rye, soybeans and wheat.

When submitting a GHG Calculator as part of a petition, you should select option one (confirmed) for all of the dates that you entered data for. If you choose MISSING DATA for any of the dates that you entered data for your petition will be returned as incomplete.

If you choose MISSING DATA or leave this cell blank for any of the dates, the GHG Calculator will evaluate all of the ethanol produced on that date as having lifecycle greenhouse gas emissions of 98.2 kgCO<sub>2</sub>e/mmBtu, the lifecycle GHG emissions for the gasoline baseline.<sup>17</sup>

### Quick Check

Provides a quick check of whether you are missing required information.

For EP petitions, if this tab identifies any missing information (marked as “ERRORS”) your petition will be returned as incomplete.

This tab is meant as a tool to help users do a quick check for missing information. It is not meant as full check of the completeness or accuracy of the information entered in the GHG Calculator. Even if this tab does not identify missing or erroneous information, EPA may still return your petition as incomplete if we find missing or incorrect data. It is the petitioner’s responsibility to ensure that the data provided are complete and accurate. Similarly, for producers with an activated EP pathway, it is the fuel producer’s responsibility to ensure that the data provided are complete and accurate.

### Daily Data Summary

This tab provides a summary of the data entered in the preceding data entry tabs. We recommend reviewing the information on this tab as a way to help identify and prevent errors.

### Time Series Results

This tab provides a time series look at your fuel’s lifecycle GHG emissions based on the data you entered. Daily and rolling average results are provided for corn and grain sorghum ethanol. The 365-day rolling average GHG results are based on the average lifecycle GHGs for the fuel produced over the preceding 365 days. Results are provided for corn ethanol and grain sorghum ethanol in terms of kgCO<sub>2</sub>e/mmBtu. The tab also shows on which days the corn ethanol produced at your facility meets the 20% GHG reduction threshold and the days when the grain sorghum ethanol meets the 50% GHG reduction threshold. The percent GHG reductions compared to the gasoline baseline are also displayed here.

### Results Summary

After all of the data is properly entered in the data entry tabs, this tab provides a summary of the 365-day rolling average lifecycle GHG emissions during the specified averaging time period for the corn and/or grain sorghum ethanol produced at your facility.

For an EP petition, the results on this tab should show that your fuel meets the applicable GHG reduction threshold (20% reduction for renewable fuel or 50% reduction for advanced biofuel). If you submit a GHG Calculator that does not demonstrate adequate GHG reductions, EPA will return the petition as incomplete.

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<sup>17</sup> Details on what constitutes valid versus missing data should be provided in the EP determination document for your facility and the Compliance Monitoring Plan included as part of your registration for the EP3 pathway.

## Corn Ethanol GHG Calcs

This tab is used to calculate the daily and 365-day rolling average lifecycle GHG emissions for corn ethanol based on the data entered in the preceding tabs. This tab is protected from editing.

## Sorghum Ethanol GHG Calcs

This tab is used to calculate the daily and 365-day rolling average lifecycle GHG emissions for grain sorghum ethanol based on the data entered in the preceding tabs. This tab is protected from editing.

## Emis Facs

This information tab includes the GHG emissions factors used by the GHG Calculator. These values are for reference and protected from editing.

## Abbreviations

This tab includes a list of abbreviations used on other tabs. It also stores list data used on other tabs and is protected from editing.

## RFS2500-Corn

Corn starch ethanol data are automatically generated on this tab to help with quarterly reporting using the RFS Efficient Producer Data Form (RFS2500).<sup>18</sup> To assist with reporting, the data from this tab can be copied and pasted in the Unified Report Form.<sup>19</sup> Note that fields 2-10 are not automatically generated and need to be completed by the reporting party. This tab is meant to assist with reporting – reporters are responsible for the accuracy of all the data they report.

## RFS2500-Sorghum

Grain sorghum ethanol data are automatically generated on this tab to help with quarterly reporting using the RFS Efficient Producer Data Form (RFS2500). See the instructions for the previous tab for more information.

## RFS2500-CKF

Corn kernel fiber ethanol data are automatically generated on this tab to help with quarterly reporting using the RFS Efficient Producer Data Form (RFS2500). The only data generated for corn kernel fiber ethanol is the volume cellulosic ethanol produced from corn kernel fiber. Data fields 14-21 for rows associated with corn fiber ethanol production can remain blank for reporting.

## For-EPA-Use

The EPA uses this tab to expedite review of GHG Calculators that are submitted as part of EP3 petitions. It is protected from editing.

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<sup>18</sup> <https://www.epa.gov/fuels-registration-reporting-and-compliance-help/rfs2500-rfs-efficient-producer-data-report>

<sup>19</sup> <https://www.epa.gov/fuels-registration-reporting-and-compliance-help/unified-report-form>

## Appendix 1: Abbreviations and Acronyms

<b>Abbreviation or Acronym</b>	<b>Description</b>
Btu	British Thermal Units
bu	Bushel
CAA	Clean Air Act
CFR	Code of Federal Regulations
CH <sub>4</sub>	Methane
DGS	Distillers grains and solubles
EISA	Energy Independence and Security Act
EP	Efficient Producer
EP3	Efficient Producer petition process
EPA	Environmental Protection Agency
F	Fahrenheit
FR	Federal Register
gal	Gallon
GHG	Greenhouse gas
Hr	Hour
kgCO <sub>2</sub> e	Kilograms of carbon dioxide-equivalent emissions
kWh	Kilowatt hour
lb	Pound
LCA	Life cycle assessment
LHV	Lower heating value
mmBtu	Million British Thermal Units
RFS	Renewable Fuel Standard
RIN	Renewable Identification Number
scf	Standard cubic feet
std. gal	Standardized gallon of ethanol at 60° F

## Appendix 2: Lifecycle GHG Equations

The GHG Calculator uses the following equations to calculate the lifecycle GHG emissions for corn and grain sorghum ethanol.

### Corn Starch Ethanol Produced at Facility That Only Uses Corn Feedstock

The 365-day rolling average lifecycle GHG emissions are calculated using the following formula:

$$LC_{GHGc} = GHG_{Uc} + GHG_{Pc} + GHG_D$$

Where:

$LC_{GHGc}$  = Lifecycle GHG emissions, in kgCO<sub>2</sub>e/mmBtu, of the volume of all corn ethanol produced at the facility during the averaging time period.

$GHG_{Uc}$  = Upstream GHG emissions, in kgCO<sub>2</sub>e/mmBtu, related to the production and transport of the volume of corn starch feedstock used to produce all corn ethanol produced at the facility during the averaging time period, calculated per the formula below.

$GHG_{Pc}$  = Process GHG emissions, in kgCO<sub>2</sub>e/mmBtu, related to the processes used for conversion of corn into ethanol during the averaging period, including energy used for feedstock, fuel and co-product operations, as calculated per the formula below.

$GHG_D$  = Downstream GHG emissions, in kgCO<sub>2</sub>e/mmBtu, related to the distribution and use of all corn ethanol produced during the averaging period, calculated per the formula below.

$GHG_{Uc}$  is calculated according to the following formula:

$$GHG_{Uc} = \frac{10.11 * B_c}{(V_{CSS} * 0.076)}$$

Where:

9.73 = Upstream emissions factor for corn, in kgCO<sub>2</sub>e per bushel, based on the lifecycle GHG modeling done by EPA for the March 2010 RFS rule.

$B_c$  = Bushels of corn used as feedstock to produce ethanol during the averaging time period in terms of a standard bushel at 15.5% moisture.  $B_c$  is calculated according to the following formula:

$$B_c = B_{cm} * \left( \frac{1 - m_c}{1 - 0.155} \right)$$

Where:

$B_{cm}$  = Bushels of corn used to produce ethanol during the averaging time period.

$m_c$  = Average moisture content of corn, in mass percent, for the corn delivered for use as feedstock to produce ethanol during the averaging time period.

0.155 = Moisture content of a standard bushel of corn at 56 pounds per bushel.

$V_{CSS} = V_S - V_{CFS}$ , the standardized volume of corn starch ethanol produced during the averaging time period, in gallons of undenatured ethanol.

$V_S$  = Standardized volume of all ethanol produced at the facility during the averaging time period (including both corn starch and grain sorghum ethanol), in gallons of undenatured ethanol. In determining the standardized volume, the actual volumes of ethanol shall be adjusted to a standard temperature of 60 degrees Fahrenheit using the following formula:

$$V_S = V_A * \left( 1 - \left( 0.00114 * \left( \left[ \{T + 459.67\} * \frac{5}{9} \right] - \left[ \{60 + 459.67\} * \frac{5}{9} \right] \right) \right) \right)$$

Where:

$V_A$  = Actual volume of undenatured ethanol, in gallons.

T = Actual temperature of ethanol, in degrees Fahrenheit, measured at the same time that  $V_A$  is measured.

0.00114 = Coefficient to standardize volumes of undenatured ethanol.

60 = Standard temperature, in degrees Fahrenheit, for volumes of ethanol.

459.67 and 5/9 = Conversion factors for Fahrenheit to Kelvin

$V_{CFS}$  = Standardized volume of ethanol produce from corn kernel fiber at the facility during the averaging time period, in gallons of undenatured ethanol, determined in accordance with the methods and techniques specified in the facility's activated registration on file with EPA for the crop residue (i.e., corn kernel fiber) ethanol pathway in row K of Table 1 to 40 CFR 80.1426.

0.076 = Energy content of ethanol, in mmBtu/gallon (lower heating value).

$GHG_{PC}$  is calculated according to the following formula:

$$GHG_{PC} = \frac{GHG_{THERM} + GHG_{ELEC}}{V_S * 0.076}$$

Where:

$GHG_{THERM}$  = GHG emissions, in kgCO<sub>2</sub>e, associated with producing and using thermal energy used for feedstock, fuel and co-product operations during the averaging period.  $GHG_{THERM}$  is calculated according to the following formula:

$$GHG_{THERM} = \sum_{p=1}^3 (PE_p * LHV_{PE,p} * EF_{PE,p}) + BIO * EF_{bio}$$

Where:

p = Type of fuel used.

$PE_p$  = a measure of the amount of fuel p used as energy used for feedstock, fuel and co-product operations, as follows:

PE<sub>1</sub> = Standard cubic feet (scf) of natural gas used in feedstock, fuel and co-product operations.

PE<sub>2</sub> = Standard cubic feet (scf) of biogas CH<sub>4</sub> from landfills, waste treatment plants and/or waste digesters used as energy used for feedstock, fuel and co-product operations.

PE<sub>3</sub> = Tons of coal, used as energy used for feedstock, fuel and co-product operations.

LHV<sub>PE,p</sub> = Lower Heating Value factor for fuel type p, as follows:

LHV<sub>PE,1</sub> = 983 Btu per scf of natural gas.

LHV<sub>PE,2</sub> = 983 Btu per scf of biogas CH<sub>4</sub>.

LHV<sub>PE,3</sub> = 19,546,300 Btu per ton of coal.

EF<sub>PE,p</sub> = Lifecycle GHG emissions factor for fuel type p, (based on lower heating value) as follows:

EF<sub>PE,1</sub> = 7.34 \* 10<sup>-5</sup> kgCO<sub>2</sub>e per Btu of natural gas.

EF<sub>PE,2</sub> = 1.15 \* 10<sup>-6</sup> kgCO<sub>2</sub>e per Btu of biogas CH<sub>4</sub>.

EF<sub>PE,3</sub> = 1.06 \* 10<sup>-4</sup> kgCO<sub>2</sub>e per Btu of coal.

BIO = Dry pounds (0% moisture) of biomass used as energy used for feedstock, fuel and co-product operations.

EF<sub>bio</sub> = 1.98 \* 10<sup>-2</sup> kgCO<sub>2</sub>e per dry lbs of crop residue biomass.

GHG<sub>ELEC</sub> = GHG emissions, in kgCO<sub>2</sub>e, associated with producing and using electrical energy for feedstock, fuel and co-product operations during the averaging period. GHG<sub>ELEC</sub> is calculated according to the following formula:

$$GHG_{ELEC} = ELEC * EF_{elec}$$

Where:

ELEC = kWh of Grid electricity used as energy used for feedstock, fuel and co-product operations.

EF<sub>elec</sub> = 0.467 kgCO<sub>2</sub>e per kWh of grid electricity, based on the United States grid average.

#### Days with missing data

For all corn ethanol produced by the facility during a day where there is missing data on any of the factors described above, the corn ethanol produced on all such days is assessed as having lifecycle GHG emissions of 99.0 kgCO<sub>2</sub>e per mmBtu. In the spreadsheet, this is done by adjusting GHG<sub>D</sub> so that the lifecycle GHG emissions for those days equals 99.0 kgCO<sub>2</sub>e per mmBtu.

#### Corn Starch Ethanol Produced at Facility That Also Uses Grain Sorghum Feedstock

Note that facilities that process grain sorghum are not currently eligible to co-produce cellulosic biofuel (D-code 3) RINs for ethanol produced from corn kernel fiber. Thus, the GHG estimation formulas for

these facilities do not include parameters to account separately for ethanol volumes that may be produced from corn kernel fiber.

The 365-day rolling average lifecycle GHG emissions are calculated using the following formula:

$$LC_{GHGc} = GHG_{Uc} + GHG_{Pc} + GHG_D$$

Where:

$LC_{GHGc}$  = Lifecycle GHG emissions, in kgCO<sub>2</sub>e/mmBtu, of the volume of all corn ethanol produced at the facility during the averaging time period.

$GHG_{Uc}$  = Upstream GHG emissions, in kgCO<sub>2</sub>e/mmBtu, related to the production and transport of the volume of corn starch feedstock used to produce all corn ethanol produced at the facility during the averaging time period, calculated per the formula below.

$GHG_{Pc}$  = Process GHG emissions, in kgCO<sub>2</sub>e/mmBtu, related to the processes used for conversion of corn into ethanol during the averaging period, including energy used for feedstock, fuel and co-product operations, as calculated per the formula below.

$GHG_D$  = Downstream GHG emissions, in kgCO<sub>2</sub>e/mmBtu, related to the distribution and use of all corn ethanol produced during the averaging period, calculated per the formula below.

$GHG_{Uc}$  is calculated according to the following formula:

$$GHG_{Uc} = \frac{10.11 * B_C}{(V_S * 0.076 * R_C)}$$

Where:

9.88 = Upstream emissions factor for corn, in kgCO<sub>2</sub>e per bushel, based on the lifecycle GHG modeling done by EPA for the March 2010 RFS rule.

$B_C$  = Bushels of corn used as feedstock to produce ethanol during the averaging time period in terms of a standard bushel at 15.5% moisture.  $B_C$  is calculated according to the following formula:

$$B_C = B_{Cm} * \left( \frac{1 - m_c}{1 - 0.155} \right)$$

Where:

$B_{Cm}$  = Bushels of corn used to produce ethanol during the averaging time period.

$m_c$  = Average moisture content of corn, in mass percent, for the corn delivered for use as feedstock to produce ethanol during the averaging time period.

0.155 = Moisture content of a standard bushel of corn at 56 pounds per bushel.

$V_S$  = Standardized volume of all ethanol produced at the facility during the averaging time period (including both corn starch and grain sorghum ethanol), in gallons of undenatured ethanol. In determining the standardized volume, the actual volumes of ethanol shall be adjusted to a standard temperature of 60 degrees Fahrenheit using the following formula:

$$V_S = V_A * \left( 1 - \left( 0.00114 * \left( \left[ \{T + 459.67\} * \frac{5}{9} \right] - \left[ \{60 + 459.67\} * \frac{5}{9} \right] \right) \right) \right)$$

Where:

$V_A$  = Actual volume of undenatured ethanol, in gallons.

$T$  = Actual temperature of ethanol, in degrees Fahrenheit, measured at the same time that  $V_A$  is measured.

0.00114 = Coefficient to standardize volumes of undenatured ethanol.

60 = Standard temperature, in degrees Fahrenheit, for volumes of ethanol.

459.67 and 5/9 = Conversion factors for Fahrenheit to Kelvin

0.076 = Energy content of ethanol, in mmBtu/gallon (lower heating value).

$R_C = \left( \frac{B_C}{B_C + B_{GS}} \right)$ , which is the ratio of corn feedstock used, on a mass basis.

Where:

$B_{GS}$  = Bushels of grain sorghum used as feedstock to produce ethanol during the averaging time period in terms of a standard bushel at 13% moisture.  $B_{GS}$  is calculated according to the following formula:

$$B_{GS} = B_{GSm} * \left( \frac{1 - m_{gs}}{1 - 0.13} \right)$$

$B_{GSm}$  = Measured bushels of grain sorghum used as feedstock to produce ethanol during the averaging time period.

$m_{gs}$  = Average moisture content of grain sorghum, in mass percent, for the grain sorghum delivered for use as feedstock to produce ethanol during the averaging time period.

0.13 = Moisture content of a standard bushel of grain sorghum at 56 pounds per bushel.

$GHG_{PC}$  is calculated according to the following formula:

$$GHG_{PC} = \frac{\frac{GHG_{THERM}}{0.963 * R_{GS} + R_C} + \frac{GHG_{ELEC}}{0.993 * R_{GS} + R_C}}{V_S * 0.076}$$

Where:

$GHG_{THERM}$  = GHG emissions, in kgCO<sub>2e</sub>, associated with producing and using thermal energy used for feedstock, fuel and co-product operations during the averaging period.  $GHG_{THERM}$  is calculated according to the following formula:

$$GHG_{THERM} = \sum_{p=1}^3 (PE_p * LHV_{PE,p} * EF_{PE,p}) + BIO * EF_{bio}$$

Where:

p = Type of fuel used.

PE<sub>p</sub> = a measure of the amount of fuel p used as energy used for feedstock, fuel and co-product operations, as follows:

PE<sub>1</sub> = Standard cubic feet (scf) of natural gas used in feedstock, fuel and co-product operations.

PE<sub>2</sub> = Standard cubic feet (scf) of biogas CH<sub>4</sub> from landfills, waste treatment plants and/or waste digesters used as energy used for feedstock, fuel and co-product operations.

PE<sub>3</sub> = Tons of coal, used as energy used for feedstock, fuel and co-product operations.

LHV<sub>PE,p</sub> = Lower Heating Value factor for fuel type p, as follows:

LHV<sub>PE,1</sub> = 983 Btu per scf of natural gas.

LHV<sub>PE,2</sub> = 983 Btu per scf of biogas CH<sub>4</sub>.

LHV<sub>PE,3</sub> = 19,546,300 Btu per ton of coal.

EF<sub>PE,p</sub> = Lifecycle GHG emissions factor for fuel type p, (based on lower heating value) as follows:

EF<sub>PE,1</sub> = 7.34 \* 10<sup>-5</sup> kgCO<sub>2</sub>e per Btu of natural gas.

EF<sub>PE,2</sub> = 1.15 \* 10<sup>-6</sup> kgCO<sub>2</sub>e per Btu of biogas CH<sub>4</sub>.

EF<sub>PE,3</sub> = 1.06 \* 10<sup>-4</sup> kgCO<sub>2</sub>e per Btu of coal.

BIO = Dry pounds (0% moisture) of biomass used as energy used for feedstock, fuel and co-product operations.

EF<sub>bio</sub> = 1.98 \* 10<sup>-2</sup> kgCO<sub>2</sub>e per dry lbs of crop residue biomass.

R<sub>GS</sub> =  $\left(\frac{B_{GS}}{B_C + B_{GS}}\right)$ , which is the ratio of grain sorghum feedstock used, on a mass basis.

GHG<sub>ELEC</sub> = GHG emissions, in kgCO<sub>2</sub>e, associated with producing and using electrical energy for feedstock, fuel and co-product operations during the averaging period. GHG<sub>ELEC</sub> is calculated according to the following formula:

$$GHG_{ELEC} = ELEC * EF_{elec}$$

Where:

ELEC = kWh of Grid electricity used as energy used for feedstock, fuel and co-product operations.

EF<sub>elec</sub> = 0.467 kgCO<sub>2</sub>e per kWh of grid electricity, based on the United States grid average.

0.963 = Adjustment factor for grain sorghum processing using 3.7% less thermal energy than corn ethanol processing.

0.993 = Adjustment factor for grain sorghum processing using 0.7% less electrical energy than corn ethanol processing.  $GHG_D$  is calculated to be 2.1 kgCO<sub>2e</sub> per mmBtu of ethanol.

#### Days with missing data

For all corn ethanol produced by the facility during a day where there is missing data on any of the factors described above, the corn ethanol produced on all such days is assessed as having lifecycle GHG emissions of 99.0 kgCO<sub>2e</sub> per mmBtu. In the spreadsheet, this is done by adjusting  $GHG_D$  so that the lifecycle GHG emissions for those days equals 99.0 kgCO<sub>2e</sub> per mmBtu.

#### Grain Sorghum Ethanol

The 365-day rolling average lifecycle GHG emissions are calculated using the following formula:

$$LC_{GHG_{GS}} = GHG_{UGS} + GHG_{PGS} + GHG_D$$

Where the terms in the equation are the similar to the terms specified above for corn ethanol lifecycle GHG emissions, but with references to corn replaced with grain sorghum.

$GHG_{UGS}$  is calculated according to the following formula:

$$GHG_{UGS} = \frac{8.82 * B_{GS}}{(V_S * 0.076 * R_{GS})}$$

Where:

8.76 = Upstream emissions factor for grain sorghum, in kgCO<sub>2e</sub> per bushel, based on the lifecycle GHG modeling done by EPA for the December 2012 grain sorghum rule.

$GHG_{PGS}$  is calculated according to the following formula:

$$GHG_{PGS} = \frac{\frac{GHG_{THERM}}{0.963 * R_{GS} + R_C} * 0.963 + \frac{GHG_{ELEC}}{0.993 * R_{GS} + R_C} * 0.993}{V_S * 0.076}$$

#### Days with missing data

Days with missing data for grain sorghum ethanol are treated the same as days with missing data for corn ethanol (see above).