

**GLACIAL LAKES CORN PROCESSORS
GLACIAL LAKES ENERGY, LLC**

METHOD 2A APPLICATION

Appendix A

Pathway Lifecycle Analysis Report

CA-GREET Model Inputs

Supporting Documentation for Monthly Summary Data used for the CA-GREET Model Inputs

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**METHOD 2A APPLICATION
LIFE CYCLE ANALYSIS REPORT**

Introduction

Glacial Lakes Energy, LLC (GLE), a subsidiary of Glacial Lakes Corn Processors, owns and operates a dry mill, corn-based, ethanol production facility in Watertown, South Dakota. The facility was constructed in 2001 as a 40 million gallon per year production facility. The facility was subsequently expanded in 2007 and currently operates an ICM designed process with a production volume of 120 million gallons per year undenatured ethanol.

Corn processed at the facility is obtained from producers located in 9 surrounding counties (Codington, Clark, Hamlin, Kingsbury, Brookings, Deuel, Grant, Roberts, and Day). Approximately 25% of the corn is shipped by truck directly to the GLE facility from the farm at which it was produced. The remaining 75% of the corn is shipped from the farm to the local grain elevator and then by truck to the GLE facility. An average¹ of 68.2% of the distillers grain and soluble (DDGS) are dried, and 31.8% are a modified wet distillers grain and soluble (MDGS) (45% dry matter). As requested in the ARB staff request dated April 18, 2011, Glacial Lakes is providing CI values for two sub-reference pathways; DDGS and MDGS. The DDGS and MDGS are produced simultaneously and thus there is not practical means in which to collect data on the emissions associated with solely DDGS or MDGS.

GLE's Life Cycle Analysis Report documents the analysis completed for the GLE facility and includes the facility data for a dry mill ethanol production facility and its corresponding carbon intensity (CI) calculation. The CaGREET model was used to calculate the CI value for the facility. The reference pathway for a mid-west dry mill facility using conventional cook process and 100% natural gas was used in the analysis. The reference CI from the low carbon fuel standard (LCFS) lookup table is 98.4 grams of carbon dioxide equivalent per megajoule (gCO₂e/MJ) for DDGS.

The specific modeling parameters used for this analysis are based on actual facility data including ethanol yield, total energy consumption, and energy consumption by fuel type. The actual usage numbers are based on plant operations from January 2008 through December 2010.

Operational Plant Data

Ethanol Yields

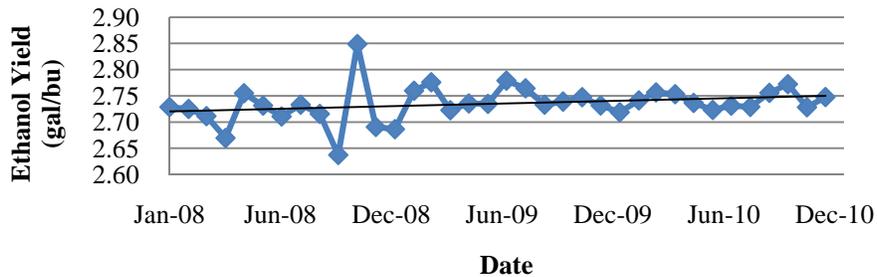
Actual ethanol yields from January 2008 through December 2010 were used to calculate the average plant operation parameters. Figure 1 presents the ethanol yield (gallons of undenatured ethanol per bushel of corn). Documentation of actual ethanol production volumes for October 2010 is provided in Appendix A of the application package. The average value was 2.73 gallons per bushel with a variance of less than 5% as shown on Figure 1.

¹ Based on average production values from January 2008 through December 2010.

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**METHOD 2A APPLICATION
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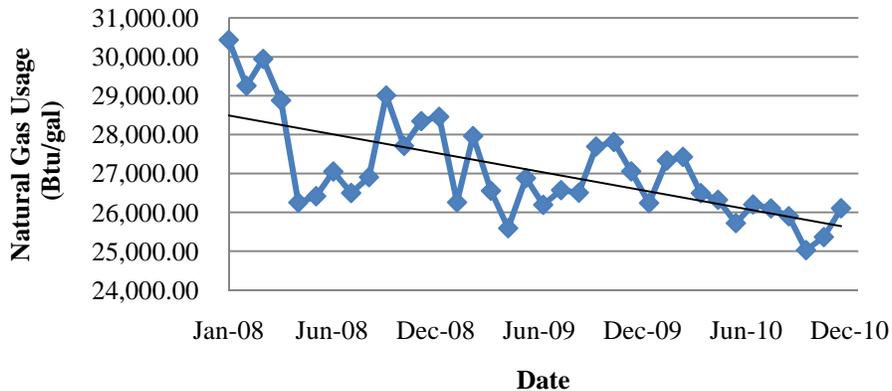
**Figure 1
Ethanol Yields for
Glacial Lakes Energy, LLC**



Natural Gas Consumption

The entire thermal requirement for the facility is generated with natural gas. Figure 2 presents the actual natural gas consumed in the facility from January 2008 through December 2010. The average natural gas consumption is 28,001.56 British thermal units (BTU) per gallon with an annual variance of less than 10%. Documentation of natural gas consumption is provided in the form of monthly utility invoices and is provided in Appendix A of the application package.

**Figure 2
Natural Gas Consumption for
Glacial Lakes Energy, LLC**



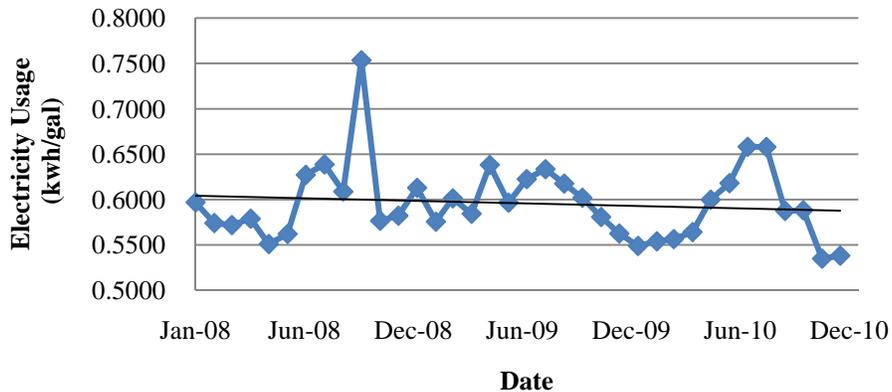
**GLACIAL LAKES CORN PROCESSORS
GLACIAL LAKES ENERGY, LLC**

**METHOD 2A APPLICATION
LIFE CYCLE ANALYSIS REPORT**

Electricity Consumption

Figure 3 presents the actual electricity consumed at the facility from January 2008 through December 2010. The average electricity consumption is 0.60 kilowatt hours (kWhr) per gallon with an annual variance of less than 5%. This electricity consumption value equates to 2,047 Btu/gal energy usage and is about 0.48 kWhr/gallon below the 1.08 kWhr/gallon energy use value used for determining the CI value for the reference pathway.

**Figure 3
Electricity Consumption for
Glacial Lakes Energy, LLC**



All operational data provided was generated from purchase or sales receipts. Documentation of electricity consumption is provided for October 2010 is provided in Appendix A of the application package. These data sets have a variance of less than 10% over three years of continuous operation and are therefore sustainable.

CaGREET Values

A spreadsheet with the actual (by month) and calculated values used as input in the CaGREET model is included as Attachment 1. In addition, Table 1 provides a summary of key input parameters and identifies them by spreadsheet, the cell location, average value, and the default value of the reference pathway used in the CaGREET model. The calculations are based on production of un-denatured ethanol. Total Thermal Energy usage is the sum of the drying energy plus other usage. For purposes of this application, GLE back-calculated the "other usage" based on total thermal energy and weighted dryer energy including the assumed drying natural gas utilization rates provided by ARB (9,900 Btu/gal (LHV) for DDGS and 4,500 Btu/gal (LHV) for WDGS). Calculated total thermal energy usage for each moisture content was then determined in accordance with ARB recommendations.

Dry Mill was set to 100% to prevent the CaGREET model from including other types on ethanol mills in the calculation. Electricity was set to 6.8 % of the total energy which is equivalent to 2,047 BTU/gallon

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**METHOD 2A APPLICATION
LIFE CYCLE ANALYSIS REPORT**

or 0.60 kWhr/gallon. Natural Gas was set to 93.2% of the total energy (e.g., Total Energy – Electrical energy). Finally, Energy Type NG was set to 100% and Energy Type Coal was set to 0 so that the CaGREET model would calculate only the use of natural gas.

Table 1

**CaGREET Input Data for the Site-Specific CI Calculations for the
Glacial Lakes Energy, LLC**

Sheet	Parameter	Cell	Average Value	Default Value	Notes
DDGS					
Fuel_Prod_TS	Ethanol Yield	C271	2.73	2.72	Fill in all time series data with this value
	Total Energy	K271	31448	36,000	Fill in all time series data with this value
	Dry Mill	C285	100	85%	Fill in all time series data with this value
	Share of Coal	S271	0	20%	Fill in all time series data with this value
Inputs	Electricity	C247	6.51	7.3%	Gives 0.60 kWhr/gal
	Natural Gas	C246	93.49	92.7%	Calculated in spreadsheet
MDGS					
Fuel_Prod_TS	Ethanol Yield	C271	2.73	2.72	Fill in all time series data with this value
	Total Energy	K271	26048	36,000	Fill in all time series data with this value
	Dry Mill	C285	100	85%	Fill in all time series data with this value
	Share of Coal	S271	0	20%	Fill in all time series data with this value
Inputs	Electricity	C247	7.86	7.3%	Gives 0.60 kWhr/gal
	Natural Gas	C246	92.14	92.7%	Calculated in spreadsheet

Tables 2 and 3 show the CaGREET emissions calculations from the EtOH worksheet of the CaGREET model and the application of emission factors for the calculation of the CI in grams of carbon dioxide equivalents per mega-joule of fuel energy. The site-specific denatured ethanol carbon intensity for GLE’s facility while producing DDGS is 91.18 gCO₂e/MJ which is 7.22 gCO₂e/MJ lower than the reference pathway CI of 98.4 gCO₂e/MJ. The site-specific denatured ethanol carbon intensity for MDGS is 86.69 gCO₂e/MJ which is 11.71 gCO₂e/MJ lower than the reference pathway CI of 98.4 gCO₂e/MJ. Based on the verifiable and sustainable nature of the site-specific data used for this analysis, the CI value should also be considered verifiable and sustainable.

**GLACIAL LAKES CORN PROCESSORS
GLACIAL LAKES ENERGY, LLC**

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Table 2

**Site Specific CI Calculation for the Glacial Lakes Energy Facility
Energy and Emissions Results for DDGS**

Pathway Component:	Feedstock	Fuel	WTT	Full Fuel Cycle
Total Energy	192248	1365025	1557370	1557370
Fossil Fuels	187695	518175	705964	705964
Coal	26291	46192	72496	72496
Natural Gas	95058	438181	533286	533286
Petroleum	66346	33803	100182	100182
CH4	18	62	80	1998
N2O	42	0	42	12540
CO2	15375	33783	49166	49166
GHG (g/mmBtu)				63704
GHG (g/MJ)				60.38
			ILUC	30.0
			Denaturant	0.8
			Total	91.18

Table 3

**Site Specific CI Calculation for the Glacial Lakes Energy Facility
Energy and Emissions Results for MDGS**

Pathway Component:	Feedstock	Fuel	WTT	Full Fuel Cycle
Total Energy	192248	1289287	1481631	1481631
Fossil Fuels	187695	442467	630256	630256
Coal	26291	46018	72322	72322
Natural Gas	95058	362938	458043	458043
Petroleum	66346	33511	99890	99890
CH4	18	53	71	1768
N2O	42	0	42	12532
CO2	15375	29289	44671	44671
GHG (g/mmBtu)				58972
GHG (g/MJ)				55.89
			ILUC	30.0
			Denaturant	0.8
			Total	86.69