Siouxland Ethanol, LLC
CA-GREET Model

The applicant has conducted its analysis of direct effects on carbon intensity for this pathway using CA-GREET, v.1.8b (Dec. 2009) (See http://www.arb.ca.gov/fuels/lcfs/ca_greet1.8b_dec09.xls). The standard inputs and parameters specified in CA-GREET remain unchanged except as noted in the input table below. The input table below specifies the spreadsheet location of the CA-GREET inputs and other parameters that were claimed as confidential business information or trade secret by the applicant, but it does not disclose the actual value of such inputs and parameters because they are claimed to be confidential business information or trade secret.

Siouxland Ethanol (Jackson, NE) Plant Input data table (Locations of cells containing Confidential Business Information are shown, but the actual values of such confidential information are not disclosed):

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Actual plant data from 2010 has been used to develop the proposed sub-pathways. During 2010, the plant produced [redacted]% DDGS and [redacted]% MDGS, by co-product dry matter content. As the plant's thermal energy load is highly dependent on the amount of co-product drying that occurs, it is necessary to understand the dryer's energy load in order to extrapolate total plant energy consumption at the 100% DDGS and 100% MDGS proposed cases. Data from the plant's process designer, ICM, Inc., has been provided to support this and show that dryer gas consumption is [redacted] Btu/gal (HHV) for 100% DDGS and [redacted] Btu/gal (HHV) for 100% MDGS. These are converted to LHV and used to estimate the current dryer gas load at the 2010 average co-product shares; then the calculated dryer gas load is subtracted from the total plant thermal energy load. This result is the gas consumption required for process steam production, which is held constant. The plant thermal energy loads for the other two cases is then computed by adding the process load to known dryer gas loads, as discussed above. Table 3 presents the total plant thermal energy load for the three cases, on a lower heating value basis.

Table 3: Extrapolation of plant thermal energy load for 100% DDGS and 100% MDGS cases (BTUs shown on LHV)

	2010 Ave	*100% DDGS*	*100% MDGs*
DDGS Production (lb/gal)	[redacted]	[redacted]	[redacted]
MDGS Production (lb/gal)			
DDGS Share of Co-products (% dry matter)			
MDGS Share of Co-products (% dry matter)			
Dryer Gas (Btu/gal)			
Process Steam Gas (Btu/gal)			
Total Process Fuels (Btu/gal)			

INPUTS & MODIFICATIONS to CA-GREET 1.8b

This section summarizes the specific input values which have been used to run the CA-GREET model to develop carbon intensity results for the proposed sub-pathways. While the scope of the analysis is well-to-wheels, modifications from the CA-GREET default corn ethanol pathway are only necessary for the inbound corn transportation, the biorefinery operations, and the LFG production and transportation.

BIOREFINERY

Table 4 presents the specific modifications that have been made to the CA-GREET model pertaining to the biorefinery efficiency. The data below has been derived from annual aggregate data provided by Siouxland. For example, Siouxland reports producing [redacted] gallons of un-denatured ethanol in 2010 while purchasing [redacted] bushels of corn. Thus a yield of [redacted] gallons per bushel is used as a model input. Likewise, cumulative energy usage data has been provided and is normalized by gallon in the model. A structural change to the model was made so that the % of natural gas ([redacted]% of fuel use) can be entered without the model automatically calculating [redacted]% for biomass use as the difference. The % biomass used for process fuels has been zeroed out to accommodate this.

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Table 4: Biorefinery Operations Input Modifications

Modified Parameter	*CA-GREET Cell Reference*	*2010 Average Siouxland Ethanol, LLC – Jackson, NE*	*Midwest; Dry Mill; Dry DGS, NG*
Yield (gallon/bushel)	Fuel_Prod_TS!D277	[redacted]	2.8 or 2.72
Total Plant Energy Use (Btu/gallon)	Fuel_Prod_TS!L277		36,000
Natural Gas Use (% fuels, Btu/gallon)	Inputs!C255		92.7% * 36,000 = 33,372
Biomass Use (% fuels)	Inputs!C257		0%
Grid Electricity Use (% total, Btu/gallon)	Inputs!C241		(100% - 92.7%) * 36,000 = 2,628
Landfill Gas Consumption (% fuels, Btu/gallon)	EtOH!L153		N/A

CNG FROM LFG PRODUCTION

To compute the emissions from capture, compression and transport of landfill gas to the ethanol plant, modifications were made to the CA-GREET pathway for compressed natural gas (CNG) from landfill gas. First, LFG was selected as the feedstock for producing CNG, then the specific compression energy requirement reported by L.P. Gill Landfill of [redacted] kWh/mmBtu of LFG. This results in a compression efficiency of 94%, which updates the model's default assumption. The LFG transport distance is changed to 1.1 miles, which is the distance from the landfill to the ethanol plant. Finally, modifications have been made to the corn ethanol production emissions calculation to include the use of LFG as a process fuel. Cell references linking to liquefied petroleum gas (LPG), which aren't used in the ethanol computation, were modified to reference CNG from LFG. Emission factors for combustion of natural gas in small (10 to 100 MMBtu/hr) boilers were used to estimate LFG combustion emissions. A credit for carbon uptake corresponding to the share of methane in biogas is incorporated. These changes are summarized in Table 5.

Table 5: Modifications made to the LFG from CNG pathway

Parameter	*GREET Cell Reference*	*2010 Average Siouxland Ethanol*	*Default*
Select LFG as source for CNG in pull down menu	Inputs!C72	[redacted]	1
Compressor energy efficiency	Fuel_Prod_TS!AE41		98%
CH4 Leakage from pipeline	NG!X118		0.08% (CA specific)
Remove LFG gas upgrading from CNG pathway; change CNG processing efficiency to 100%	Fuel_Prod_TS!AR41		82.7%
Add CNG from LFG as a process fuel in EtOH production	EtOH!L151:L180		LPG
Add biomass CO2 uptake credit for LFG as process fuel	EtOH!L181		N/A

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TRANSPORTATION

Changes were made to the default assumptions for inbound transportation of corn grain to the biorefinery as well as outbound ethanol distribution to blending terminals in California. The table below summarizes the changes that were made to these two transportation legs. Ethanol shipped by truck to blending terminals has been zeroed out since the product is shipped entirely by rail and a rail spur is located at the plant. Supplier-weighted average supply distances have been estimated at [redacted] miles by truck and [redacted] by rail. During 2010, [redacted]% of all grain arrived by truck.

Parameter	*GREET Cell Reference*	*2010 Average Siouxland Ethanol*	*Default*
Corn supply by truck, distance (miles	T&D_Flowcharts!M1313	[redacted]	40
Corn supply by rail, distance (miles)	T&D_Flowcharts!M1309		400
Corn supply by rail, % by mode	T&D_Flowcharts!M1308		0%
Ethanol transport by truck to terminal, distance (miles)	T&D_Flowcharts!F1445		70

CARBON INTENSITY RESULTS

The carbon intensity for each of the 14 proposed sub-pathways are summarized in Table 6. Direct emissions summarize Well-to-Tank direct emissions results and indirect land use change (ILUC) emissions are added in for the Total Carbon Intensity. Denaturant and combustion emissions are not included in these results. These pathways represent net reductions in life cycle GHG emissions ranging from 11 - 21 gCO2e/MJ compared with the reference pathway.

Table 6: Proposed Sub-Pathways for Siouxland Ethanol, LLC

Sub-Pathway Description	*Direct Emissions (gCO_2e/MJ)*	*Total Carbon Intensity Including Indirect LUC (gCO_2e/MJ)*
Midwest, Dry Mill, 100% DDGS, 0% LFG, 100% NG	58.1	88.14
Midwest, Dry Mill, 100% DDGS, 6% LFG, 94% NG	55.9	85.91
Midwest, Dry Mill, 100% DDGS, 8% LFG, 92% NG	55.2	85.16
Midwest, Dry Mill, 100% DDGS, 11% LFG, 89% NG	54.4	84.41
Midwest, Dry Mill, 100% DDGS, 12% LFG, 88% NG	53.7	83.74
Midwest, Dry Mill, 100% DDGS, 14% LFG, 86% NG	53.1	83.06
Midwest, Dry Mill, 100% DDGS, 16% LFG, 84% NG	52.4	82.38
Midwest, Dry Mill, 100% MDGS, 0% LFG, 100% NG	53.6	83.64
Midwest, Dry Mill, 100% MDGS, 8% LFG, 92% NG	51.4	81.41
Midwest, Dry Mill, 100% MDGS, 11% LFG, 89% NG	50.7	80.66
Midwest, Dry Mill, 100% MDGS, 13% LFG, 87% NG	49.9	79.91
Midwest, Dry Mill, 100% MDGS, 16% LFG, 84% NG	49.2	79.23
Midwest, Dry Mill, 100% MDGS, 18% LFG, 82% NG	48.6	78.56
Midwest, Dry Mill, 100% MDGS, 20% LFG, 80% NG	47.9	77.88