Life Cycle Associates

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October 27, 2014

California Air Resources Board
Katrina Sideco
(916) 323-1082
ksideco@arb.ca.gov

Reference: **Formula Error in Sugarcane Ethanol Analysis with CA_GREET2.0_v180**

Dear Ms. Sideco,

Life Cycle Associates would like to draw your attention to a formula error in the sugarcane to ethanol analysis with CA_GREET_2.0_v180. The error arises in the calculation of the total farming emissions for sugarcane production and transport. The calculation excludes the CO_2 uptake credit from mechanized harvesting, leading to an under-reporting of the farming GHG emissions by 202.84 g CO_2e/MJ. The formula in cell EtOH!:DT379 should be corrected as per Table 1. This error has been corrected in the ARB emissions summary array located in ETOH!:DI422:DI433, however, the model output should match the ARB summary.

Table 1. Calculation of total sugarcane farming emissions

Cell	Status	Formula
EtOH! DT379	Incorrect	SUM(DI379:DS379,DI380,DJ380,DL380,DP380)
EtOH! DT379	Correct	SUM(DI379:DS379,DI380,DJ380,DL380,DP380,DQ380)

Figure 1 shows the current and corrected CA_GREET_2.0_v180 sugarcane energy consumption and total emissions summary with the erroneous cells highlighted in yellow.

	Current CA_GREET_2.0_v180		Corrected	
Energy Consumption and Total Emissions	**Sugarcane**	**Ethanol**	**Sugarcane**	**Ethanol**
Energy Consumption, Btu/mmBtu				
Loss factor		1.000		1.000
Total energy	105,588	1,202,348	105,588	1,202,348
Fossil fuels	96,622	5,101	96,622	5,101
Coal	35	76	35	76
Natural gas	52,214	-92,844	52,214	-92,844
Petroleum	44,373	97,870	44,373	97,870
Emissions, g/mmBtu				
VOC	6.739	43.740	6.739	43.740
CO	21.211	143.627	21.211	143.627
NOx	64.443	268.250	64.443	268.250
PM10	3.484	161.631	3.484	161.631
PM2.5	2.968	81.599	2.968	81.599
SOx	12.578	0.033	12.578	0.033
CH_4	18.149	46.047	18.149	46.047
N_2O	26.683	8.177	26.683	8.177
CO_2	-204,770	2,022.56	9,239	2,023
CO_2 (w/ C in VOC & CO)	-204,715	2,385	9,293	2,385
GHGs, g CO_2e/mmBtu	**-196,310**	**5,972**	**17,699**	**5,972**
GHGs, g CO_2e/MJ	**-186.07**	**5.66**	**16.78**	**5.66**

Figure 1. Current and corrected summary of energy consumption and GHG emissions from the production of sugarcane ethanol.

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The current and corrected sugarcane farming and transport calculation arrays, which are the precursors to the total summary of energy consumption and GHG emissions, are presented in Figures 2 and 3 respectively, attached as an appendix to this letter The CO_2 mechanized harvesting uptake credit of 397,700 g/mmBtu is highlighted in both cases. The corrected array for the total farming emissions calculations has been modified as per Table 1 and now include this credit.

This comment addresses an important under-reporting issue in the CA_GEET2.0-v180 tool. Please review and do not hesitate to contact us if you have any queries.

Best Regards,

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Appendix

	Sugarcane Farming											
Energy Use: Btu/mmBtu of fuel throughput, except as noted	Sugarcane Farming	Sugarcane Farming Fertilizer Use by Nutrient (grams of nutrient/tonne)				Sugarcane Farming Pesticide Use (grams/tonne)		Sugarcane Straw Field Burning	Mechanized Harvesting	Sugarcane Transportation	Sugarcane Filtercake Transportation	Total: Sugarcane Farming and Transportation
Total energy	111,922	49,055	3,041	7,509	1,457	10,112	667			9,681	309	193,752
Fossil fuels	102,730	47,829	2,461	5,383	1,320	8,579	562			8,126	308	177,298
Coal	46	3	1	2	1	4	0			6	0	64
Natural gas	43,752	44,381	1,167	2,319	157	3,034	203			769	29	95,812
Petroleum	58,932	3,445	1,293	3,062	1,163	5,540	359			7,352	278	81,423
Total Emissions: grams/mmBtu of fuel throughput, except as noted	Per tonne											
VOC	5.650	5.451	0.085	0.125	0.034	0.098	0.009	1,499.400	-1,499	0.905	0.010	12.367
CO	28.574	5.837	0.269	0.488	0.127	0.431	0.037	19,706.400	-19,706	3.122	0.035	38.921
NOx	60.696	6.644	1.481	1.817	0.407	1.268	0.090	535.500	-536	11.121	0.126	118.251
PM10	3.317	1.449	0.422	0.200	0.054	0.327	0.019	1,670.760	-1,671	0.598	0.007	6.393
PM2.5	2.938	1.195	0.331	0.172	0.036	0.248	0.016	835.380	-835.38	0.505	0.006	5.446
SOx	1.399	1.162	19.116	0.270	0.021	0.631	0.008	85.680	-85.68	0.468	0.005	23.079
CH_4	20.067	8.384	0.323	0.673	0.128	1.018	0.067	578.340	-578.34	2.615	0.030	33.303
N_2O	0.218	6.128	0.004	0.008	0.001	0.010	0.001	14.994	-14.99	0.033	0.000	48.962
CO_2	7,410	3,068	177	391	104	650	42	355,469	-355,469	2,158	24	-375,747
CO_2 from Land use change		642	CO_2 from	2,288	CO_2 from $CaCO_3$ use			-392,700	392,700	CO_2 uptaken from the air		
VOC from bulk terminal		34.601	NO from N fertilizer and above/below ground biomass									
VOC from refueling station		42.557	N_2O from N fertilizer and above/below ground biomass									

Figure 2. Current calculation array for determination of the total sugarcane farming and transport energy consumption and GHG emissions.

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	Sugarcane Farming											
Energy Use: Btu/mmBtu of fuel throughput, except as noted	**Sugarcane Farming**	**Sugarcane Farming Fertilizer Use by Nutrient (grams of nutrient/tonne)**				**Sugarcane Farming Pesticide Use (grams/tonne)**		**Sugarcane Straw Field Burning**	**Mechanized Harvesting**	**Sugarcane Transportation**	**Sugarcane Filtercake Transportation**	**Total: Sugarcane Farming and Transportation**
Total energy	111,922	49,055	3,041	7,509	1,457	10,112	667			9,681	309	193,752
Fossil fuels	102,730	47,829	2,461	5,383	1,320	8,579	562			8,126	308	177,298
Coal	46	3	1	2	1	4	0			6	0	64
Natural gas	43,752	44,381	1,167	2,319	157	3,034	203			769	29	95,812
Petroleum	58,932	3,445	1,293	3,062	1,163	5,540	359			7,352	278	81,423
Total Emissions: grams/mmBtu of fuel throughput, except as noted	**Per tonne**											
VOC	5.650	5.451	0.085	0.125	0.034	0.098	0.009	1,499	-1,499	0.905	0.010	12.367
CO	28.574	5.837	0.269	0.488	0.127	0.431	0.037	19,706	-19,706	3.122	0.035	38.921
NOx	60.696	6.644	1.481	1.817	0.407	1.268	0.090	536	-536	11.121	0.126	118.251
PM10	3.317	1.449	0.422	0.200	0.054	0.327	0.019	1,671	-1,671	0.598	0.007	6.393
PM2.5	2.938	1.195	0.331	0.172	0.036	0.248	0.016	835.38	-835.38	0.505	0.006	5.446
SOx	1.399	1.162	19.116	0.270	0.021	0.631	0.008	85.68	-85.68	0.468	0.005	23.079
CH_4	20.067	8.384	0.323	0.673	0.128	1.018	0.067	578.34	-578.34	2.615	0.030	33.303
N_2O	0.218	6.128	0.004	0.008	0.001	0.010	0.001	14.99	-14.99	0.033	0.000	48.962
CO_2	7,410	3,068	177	391	104	650	42	355,469	-355,469	2,158	24	16,953
CO_2 from Land use change		642	CO_2 from	2,288	CO_2 from $CaCO_3$ use			-392,700	392,700	CO_2 uptaken from the air		
VOC from bulk terminal		34.601	NO from N fertilizer and above/below ground biomass									
VOC from refueling station		42.557	N_2O from N fertilizer and above/below ground biomass									

Figure 3. Corrected calculation array for determination of the total sugarcane farming and transport energy consumption and GHG emissions.