California LCFS fuel pathway modification: Used cooking oil to biodiesel in Malaysia using electricity and natural gas for processing energy

GREET modeling technical support document

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I. Introduction

We are applying to add a new pathway to the California LCFS fuel carbon-intensity lookup table. This pathway is a modification to the current used cooking oil (UCO) to biodiesel pathway in CA-GREET model [1].

Except for the points of deviation summarized below, our pathway is identical to the default Midwest UCO to biodiesel pathway in CA-GREET model. The pathway differs only in the following ways:

1) The feedstock and fuel are both produced in Malaysia and the fuel is shipped to California via ocean tanker for distribution and consumption,
2) Default electricity mix of Southeast Asia in CA-GREET is used,
3) Values specific to the Platinum Biofuels Sdn Bhd in Malaysia (referred to as Platinum hereafter) biodiesel facility, including the use of electricity and natural gas, are used in the calculation of fuel production energy use.

This application is for UCO collected and processed in Malaysia. Based on our modeling in CA-GREET, we find that the modified pathway has a carbon intensity of **26.85** $gCO_2e\ MJ^{-1}$.

II. Company Details

Platinum Green Chemicals Sdn Bhd (Company No. 162740-V) is a biodiesel production facility located at Lot 15-19 & PT 1409, Senawang Industrial Estate, Batu 4 Jalan Tampin, 70450 Seremban, Negeri Sembilan, Malaysia.

On July 2nd, 2012, the company officially changed its name from “Platinum Biofuels Sdn Bhd” to its current name, “Platinum Green Chemicals Sdn Bhd.” Due to this change, some documents submitted in this package have the old company name included within their content. As additional evidence of this name change, an official letter from Platinum Green Chemicals Sdn Bhd has been included for review in the application package.

The facility has three units: a pretreatment unit, a transesterification unit, and an esterification unit. The facility completed its construction of the pretreatment and transesterification units in January 2010, and its construction of the esterification unit in January 2011.

The technology provider of the pretreatment unit is Lurgi GmbH, Germany and retrofitted by Oceanair Environmental LLC from California, USA. Oceanair Environmental LLC is also the technology provider of the transesterification unit. The

technology provider of the esterification is Lele and Associates from India in collaboration with University Institute of Chemical Technology Mumbai, India.

The Platinum facility operates under an operating license issued by the Ministry of Plantation Industries and Commodities Malaysia. This license limits production to 60,000,000 gallons of biodiesel per year (200,000 metric tons per year,).

The Platinum biodiesel facility is capable of producing biodiesel using multiple feedstocks including UCO, palm oil mill effluent (POME), spent bleaching earth (SPE), waste vegetable oil (WVO), and palm fatty acid distillate (PFAD) via either the transesterification or esterification processes. This report only evaluates the carbon intensity of biodiesel produced from UCO at the Platinum biodiesel facility.

The UCO feedstock entering the Platinum biodiesel facility is collected by 3rd party companies. The water in the raw UCO collected is removed by heating before entering the Platinum facility. Within the Platinum facility pretreatment unit, the UCO feedstock goes through degumming, bleaching, and deacidification/deodorizing processes. Degumming and bleaching processes remove the gums contents, pigments such as Carotenoids and Chlorophyll, contaminants such as soaps, trace metal, and other impurities present naturally in the oil. The deacidification/deodorizing process is a vacuum steam distillation process to remove undesired substances, which give its unfavorable acidity, odor and color in the oil. The deacidified and deodorized oil then flows through fine filters for polishing and is transferred to the storage or transesterification section as treated feedstock. The energy consumed during degumming, bleaching and deacidificaiton/deodorizing is accounted for in the total energy consumption reflected by monthly electricity and natural gas bills. The fatty acid distilltate is used in the animal feed and laundry soap industries as well as a raw material for the oleochemicals industry.

The Platinum biodiesel facility adopts a typical transesterification method for UCO biodiesel production. Pretreated UCO feedstock is mixed with sodium methoxide and methanol at 65 ^{o}C for 30 minutes. After the reaction, crude fatty acid methyl esters (FAMEs, or biodiesel) and crude glycerin are formed and separated by adding washing water followed by gravity separation. Both the crude biodiesel and crude glycerin contain excess methanol and this methanol is removed through a demethalation process. The recovered methanol is then neutralized, purified and recycled for use in the transesterification process. The separated biodiesel is then dry washed and further dried to remove trace water and other impurities. The separated crude glycerin is acidulated to remove impurities, especially the soap.

As required under 40 CFR Part 80, section 1450 to register under the EPA’s Renewable Fuels Standard, a 3rd party Engineering Review of the Platinum biodiesel facility was

conducted by Ir. Tham Kim Swee, on June 12, 2012. Both the engineering review report and the detailed resume of Ir. Tham Kim Swee and Professional Engineer Registration Certificate are available in the attachment.

III. Changes to baseline CA-GREET model inputs for Platinum biodiesel facility

The modified input values to CA GREET spreadsheet are all listed in Table 1, and in the "1.0 Changes made to CA GREET" tab of a separate spreadsheet named "Platinum original data file" as well. CI calculation results can be found in the "UCO BD Results" tab of the modified CA-GREET spreadsheet.

Table 1. Changes made to CA GREET model

Parameter	Cell location	Default Midwest value	Platinum UCO value	Units
Res. oil electric generation	Regional LT!J83	0%	CBI	%
Natural gas electric generation	Regional LT!J84	33%	CBI	%
Coal electric generation	Regional LT!J85	52%	CBI	%
Nuclear electric generation	Regional LT!J86	0%	CBI	%
Biomass electric generation	Regional LT!J87	6%	CBI	%
Other (renewables) electric generation	Regional LT!J88	9%	CBI	%
UCO use	UCO BD!B21	1.11	CBI	lbs UCO/lbs BD
Glycerin yield	UCO BD!C41	0.105	CBI	lbs glycerin/lbs BD
FFA transesterification NG use	UCO BD!E189	155	CBI	btu/lbs BD
FFA transesterification electricity use	UCO BD!E192	16	CBI	btu/lbs BD
UCO transesterification NG use	UCO BD!F189	889	CBI	btu/lbs BD
UCO transesterification electricity use	UCO BD!F192	47	CBI	btu/lbs BD
UCO transesterification methanol use	UCO BD!F194	865	CBI	btu/lbs BD
Ocean tanker transport distance (miles)	T&D!GB93	NA	CBI	Miles
Biodiesel truck transport distance (miles)	T&D!GC93	50	CBI	Miles
Biodiesel pipeline transport distance (miles)	T&D!GE93	400	CBI	Miles
Biodiesel ocean tanker payload (tons)	T&D!V5	--	CBI	Tons

Biodiesel ocean tanker horsepower requirement	T&D!T12	--	CBI	Hp
Column for biodiesel ocean tanker	T&D!GB90:132	Move right (insert new transport column)		
Title	T&D!GB91	--	CBI	
Ocean tanker fraction diesel power	T&D!GB95	--	CBI	%
Ocean tanker fraction residual oil power	T&D!GB96	--	CBI	%
Ocean tanker outbound energy intensity	T&D!GB108	--	CBI	btu/ton-mile
Fraction of biodiesel transported by ocean tanker	T&D!CL138	0	CBI	%
Fraction of biodiesel transported by truck	T&D!CL142	80	CBI	%
Fraction of biodiesel transported by pipeline	T&D!CL140	0	CBI	%

IV. Basis for the Input Values

This pathway is similar to the published CA GREET model for default Midwest UCO biodiesel, with changes in the following areas as further detailed below.

1. Fuel production and energy use (2.0 BD and Co-product production, 3.0 Electricity, and 4.0 Natural Gas)
2. Transport modes and distances (5.0 Transportation)

Next to each item in parentheses is the supporting documentation reference in the Platinum Original Data File reference. The modified CA-GREET spreadsheet is included in the application package; results can be found in the "UCO BD Results" tabs.

For the pretreatment of raw UCO, heat and electricity are consumed. Since this step is completed by 3rd party UCO collectors, no information is available as for the detailed energy consumption. Therefore, the default value of 1,073 btu/lbs UCO in the Midwest UCO to biodiesel pathway with heating is adopted [1]. Also adopted is the default share of natural gas and electricity usage.

For electricity, the electricity mix in Malaysia in 2012 is CBI residue oil, CBI natural gas, CBI coal, CBI nuclear, CBI biomass, and CBI others [2]. Starting from January 2013, the facility began using natural gas for heating, replacing the diesel fuel used previously. And the facility intends to keep using natural gas moving forward. Therefore, although the energy consumption data from January 2012 to December 2014 are provided by the facility, in this report only the data from January 2013 to December 2014 are used as they represent the current and foreseeable future most accurately.

Very often, the Platinum biodiesel facility uses multiple feedstocks for biodiesel production in a month. However, the electricity and natural gas consumption data are lumped values and are only available on monthly basis. The energy consumption is estimated by dividing the total electricity and natural gas consumption by the total biodiesel production during January 2013 to December 2014. Overall, the production of biodiesel consumes CBI btu of electricity/ lbs BD and CBI btu NG/ lbs BD. It needs to be mentioned that the energy for pretreatment is already included in above values. And no energy consumption is assigned to the fatty acid distillate produced during pretreatment. As this method of evaluation assigns all the energy burden to biodiesel and glycerine co-product and no energy burden to fatty acid distillate, it gives the most conservative estimate in regards of estimating the CI of resulting biodiesel.

The produced biodiesel is transported by pipeline and trucks from the biodiesel plant to the Malaysian port, and then transported using ocean tankers from Malaysian port to CA port, and finally distributed in CA using trucks. The distance traveled by pipeline is CBI mile, and that by truck is CBI miles. The distance between Kakinada and Oakland is CBI miles [3].

This application is only for a new pathway for UCO biodiesel at the Platinum biofuel facility, which has a carbon intensity of **26.85 $gCO_2e\ MJ^{-1}$**.

V. CA-GREET Model Output

Table 2: Energy use and emissions from UCO biodiesel produced in the U.S. and in Malaysia, separated by life cycle stage. Figures are rounded.

	UCOME, Cooking Required, Fuel produced in the Midwest [4]		**UCOME Cooking Required, Fuel produced in Malaysia**		**% difference**	
	Energy (BTU/MMBTU BD)	**Emissions (gCO2e/MJ)**	**Energy (BTU/MMBTU BD)**	**Emissions (gCO2e/MJ)**	**Energy (BTU/MMBTU BD)**	**Emissions (gCO2e/MJ)**
UCO Transport to Rendering Plant	0.00	0.00	0.00	0.00	0	0
Rendering of UCO	88,681	5.69	84,660	5.44	-5%	-4%
UCO Transport (after rendering)	3,912	0.30	3,806	0.29	-3%	-2%
Biodiesel Production	174,956	6.06	207,633	8.08	19%	33%
Biodiesel Transport	28,384	2.19	103,806	8.55	266%	290%
Total (Well To Tank)	**295,933**	**14.24**	**399,906**	**22.37**	**35%**	**57%**
Total (Tank To Wheel)	**1,000,000**	**4.48**	**1,000,000**	**4.48**	**0**	**0**
Total (Well To Wheel)	**1,295,933**	**18.72**	**1,399,906**	**26.85**	**8%**	**43%**

VI. Discussion of Results

Table 2 compares energy use and emissions from the proposed pathway to those from reference [1] for UCO biodiesel produced in the Midwestern U.S.

For default Midwest UCO to biodiesel pathway, the most energy consuming and GHGs intensive step in the well-to-tank stage is the biodiesel production, followed by rendering of UCO, biodiesel transport, and UCO transport. While for the proposed pathway in Platinum, biodiesel transport and biodiesel production are the two most GHG intensive steps, followed by rendering of UCO and UCO transport. Biodiesel production and biodiesel transport have 33% and 290% higher GHG emissions, respectively, for the Platinum facility than that for the Midwest UCO pathway. This is reasonable as the Platinum facility consumes more energy during biodiesel production, and the distance of transport is much longer in the proposed pathway.

Overall, the Platinum biodiesel process consumes 8% more energy than that of the U.S., and has 43% higher GHG emissions than that of the U.S.

VII. Production Range of the Platinum biodiesel facility

The new pathway should be applicable to the Platinum biodiesel facility for 100% (60,000,000 gallons/year) of Permitted Capacity.

VIII. Sustainability of the Platinum biofuel facility

The Platinum biodiesel facility was designed and constructed using well-established modern designs and equipment and is managed by professional staff well-qualified to assure that over time the energy efficiency of and emissions from the facility do not deteriorate. Any deterioration would result in a less profitable business. Thus the sustainability of the plant is well aligned with the business objectives of the owners.

IX. Impact on Land Use

Since the raw material discussed is UCO, a waste stream from food industry, there is no land use impact.

X. Conclusion

Based on our modeling in CA-GREET and the available data, we find that biodiesel produced from UCO at the Platinum biodiesel plant has a carbon intensity of **26.85 $gCO_2e\ MJ^{-1}$**.

XI. References

1. *CA-GREET 1.8b. Dec. 2009. Available at: http://www.arb.ca.gov/fuels/lcfs/lcfs-background.htm* (Accessed September 20th, 2014).

2. *Malaysia Energy Statistics Handbook 2014. Available at: http://meih.st.gov.my/publications (Accessed May 31st, 2015)*

3. *Ports.com. Sea route & distance. 2014. SURUHANJAYA TENAGA (ENERGY COMMISSION). ISSN No.: 2289-6953. Available at: http://ports.com/sea-route/#/?a=0&b=2285&c=klang&d=Port%20of%20Long%20Beach,%20United%20States (*Accessed September 20th, 2014*).*

4. *Detailed California-Modified GREET Pathway for Biodiesel Produced in California from Used Cooking Oil.* Version 2.0. California Environmental Protection Agency Air Resources Board, 2009.

XII. Data supporting Annual Quantities of electricity, natural gas use and biodiesel production

The data supporting the annual quantities of electricity, natural gas use and biodiesel production, as well as the modifications to the CA-GREET model are documented in a separate spreadsheet named “Platinum Original Data File”.