# California LCFS fuel pathway modification: World (non-EU) used cooking oil (UCO) to biodiesel in Spain 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 Midwest 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 from the default in only the following ways:

1) The feedstock is collected/transported by truck and/or ocean tanker from countries other than European Union (EU)countries. The feedstock is converted in Spain, and the fuel is shipped to California via ocean tanker for distribution and consumption
2) Electricity mix is based on conservative assumptions
3) Values specific to the Biocom Energia facility (referred to as Biocom hereafter), including the use of electricity and natural gas, are used in the calculation of fuel production energy use.

This application is for world (non-EU) UCO transported to and processed in Spain. Based on our modeling in CA-GREET, we find that the modified pathway has a carbon intensity of **26.03 $gCO_2e\ MJ^{-1}$**.

## II. Company Details

The Biocom Energia plant is a biodiesel production facility located at C/Carnissers, 28-30 (Pol. Ind. Cotes B), 46680 Algemesi, Valencia, Spain. The facility started construction on September 2, 2006 and completed construction on December 19, 2007. [redacted]. According to US EPA's RFS (Renewable Fuels Standard) code system, the plant is capable of producing biodiesel (Fuel Code 20) utilizing waste oils/fats/grease (Feedstock Code 160); non-food grade corn oil (Feedstock Code 200); soybean oil (Feedstock Code 210); canola oil (Feedstock Code 360); and, feedstock (not listed) used at a grandfathered facility (888) using palm oil as its feedstock.

The facility operates under a license to manufacture biodiesel issued by the Ministry of the Environment, Water and Urban Planning. This license limits production to 33 million gallons of biodiesel per year (110,000 metric tons of biodiesel per year). Based on this production capacity, actual peak capacity is estimated at 34.65 million gallons per year (based on 110,000 metric tons per year X 1,000 kg per metric ton X 2.205 lbs per kg X 1 gal per7.35 pounds biodiesel X 105%).

The UCO feedstock entering the Biocom biodiesel facility is collected by 3rd party companies and transported to Biocom by truck and/or ocean tanker within European Union. The water in the raw UCO collected is removed before entering the facility. Due to the lack of the energy consumption data for UCO rendering, the high energy that is associated with UCO cooking in the default Midwest CA-GREET model is adopted, as well as the energy shares [1]. After examining the transport distances and discussion with CARB, A transport distance by truck for 124 miles plus a transport distance by ocean tanker for 11,500 miles is adopted for CI calculation. This ensures that Biocom may purchase UCO from any country in the world outside the EU without having to modify CIs for individual countries.

[redacted]. The produced biodiesel is transported by truck from the biodiesel plant to Valencia port, and then shipped via ocean tankers from Valencia port to US. There are two possible options that Biocom can use to transport biodiesel from Spain to California. With option I, an ocean tanker is used to transport biodiesel from Valencia, Spain over the Atlantic Ocean to an east coast port in the United States, then the biodiesel is transported from the east coast to California by rail. With option II, biodiesel is transported to California ports by ocean tanker over the Atlantic Ocean, through the Panama Canal, and then over the Pacific Ocean.

EcoEngineers conducted an on-site 3rd party engineering review of the Biocom biodiesel facility on June 21, 2013, as required under 40 CFR Part 80, section 1450 to register under the EPA's Renewable Fuels Standard. EcoEngineers met with the following personnel: Mr. Raul Gonzalez- General Director, and Cristina Palmero Molina- Quality and Environment Department. The on-site review included a review of information provided by Biocom on the questionnaires prepared by EcoEngineers, and a tour of the quality control laboratory and renewable fuel production facility.

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

As stated in section II, two options are possible for biodiesel transport to US. In Option I, four representative ports in different regions of the United Sates- New York City, NY; Charleston, SC; New Orleans, LA, and Houston, TX- are considered to evaluate how different biodiesel transport routes may influence the final CI value of the biodiesel. Then, the highest CI in Option I is compared to the CI in Option II and the higher between them is adopted for this pathway. 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 "Biocom World UCO Original Data File". 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 US value | Biocom UCO value | Units |
|---|---|---|---|---|
| Select Region for Analysis | Regional LT!C2 | Midwest | [redacted] | |
| Res. oil electric generation | Regional LT!J83 | 2.7% | [redacted] | % |
| Natural gas electric generation | Regional LT!J84 | 18.9% | [redacted] | % |
| Coal electric generation | Regional LT!J85 | 50.7% | [redacted] | % |
| Nuclear electric generation | Regional LT!J86 | 18.7% | [redacted] | % |
| Biomass electric generation | Regional LT!J87 | 1.3% | [redacted] | % |
| Other (renewables) electric generation | Regional LT!J88 | 7.7% | [redacted] | % |
| UCO use | UCO BD!B21 | 1.05 | [redacted] | lb UCO/lb BD |
| Glycerin coproduct yield | UCO BD!C41 | 0.105 | [redacted] | lb/lb BD |
| NG for FFA transesterification | UCO BD!E189 | 155 | [redacted] | btu/lb BD |
| Electricity for FFA transesterification | UCO BD!E192 | 16 | [redacted] | btu/lb BD |
| NG for UCO transesterification | UCO BD!F189 | 889 | [redacted] | btu/lb BD |
| Electricity for UCO transesterification | UCO BD!F192 | 47 | [redacted] | btu/lb BD |
| Ocean tanker transport distance from Valencia | | | [redacted] | |
| to New York City, NY | T&D!GB93 | NA | [redacted] | miles |
| to Charleston, SC | T&D!GB93 | NA | [redacted] | miles |
| to New Orleans, LA | T&D!GB93 | NA | [redacted] | miles |
| to Houston, TX | T&D!GB93 | NA | [redacted] | miles |
| to California (Option II) | T&D!GB93 | NA | [redacted] | miles |
| Rail transport distance to Los Angeles, CA | | | [redacted] | |
| from New York City, NY | T&D!GF93 | 1,400 | [redacted] | miles |
| from Charleston, SC | T&D!GF93 | 1,400 | [redacted] | miles |
| from New Orleans, LA | T&D!GF93 | 1,400 | [redacted] | miles |
| from Houston, TX | T&D!GF93 | 1,400 | [redacted] | miles |
| Biodiesel truck transport distance (miles) | T&D!GC93 | 50 | [redacted] | Miles |
| Biodiesel ocean tanker payload (tons) | T&D!V5 | -- | [redacted] | Tons |
| Biodiesel ocean tanker horsepower requirement | T&D!T12 | -- | [redacted] | Hp |
| Column for biodiesel ocean | T&D!GB90:132 | Move right (insert new transport column) | | |

| | | | | |
|---|---|---|---|---|
| tanker | | | | |
| Title | T&D!GB91 | -- | [redacted] | |
| Ocean tanker fraction diesel power | T&D!GB95 | -- | [redacted] | % |
| Ocean tanker fraction residual oil power | T&D!GB96 | -- | [redacted] | % |
| Ocean tanker outbound energy intensity | T&D!GB108 | -- | [redacted] | btu/ton-mile |
| Fraction of biodiesel transported by ocean tanker | T&D!CL138 | 0 | [redacted] | % |
| Fraction of biodiesel transported by ocean tanker | T&D!CL141 | 0 | [redacted] | % |
| Fraction of biodiesel transported by truck | T&D!CL142 | 80 | [redacted] | % |
| UCO transport distance by truck | T&D!II93 | 50 | [redacted] | Miles |
| Column for UCO ocean tanker | T&D!IJ90:132 | Insert new transport column | | |
| UCO transport distance by ocean tanker | T&D!IJ93 | -- | [redacted] | miles |

## 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. Electricity generation mix (2.0 Electricity Mix)
2. Fuel production and energy use (3.0 Electricity, NG Use and BD)
3. Transport modes and distances (5.0 Transportation)

Next to each item in parentheses is the supporting documentation reference in the "Biocom World UCO Original Data File".

The modified CA-GREET spreadsheets are included in the application package; results can be found in the "UCO BD Results" tabs.

For the rendering of UCO, steam and electricity are consumed. Since no detailed consumption data is available for rendering, the default value of 1,073 btu/lbs UCO for high-energy rendering scenario (cooking) in the CA GREET UCO to biodiesel pathway is adopted [1]. For electricity, the electricity mix is a conservative estimate, which is different from default CA GREET values, as mentioned previously. The adopted distance for transporting rendered UCO to biodiesel plant is 124 miles by truck plus 11,500 miles by ocean tanker.

Total grid electricity and natural gas consumption from November 2012 to October 2014 is provided in the "Biocom World UCO Original Data File". To be more conservative, the electric generation mix is assumed 5% residue oil, 15% natural gas, and 80% coal. The produced biodiesel is transported 24 miles by truck from the biodiesel plant to the Valencia port, and then shipped via ocean tanker from the Valencia port to the US. The

distances for ocean tanker transportation from the Valencia port to the four ports in Option I [3], and the distances for rail transport from these four ports to Los Angeles, CA are listed in Table 1. The distance for ocean tanker transport in Option II is 8,899 miles [3].

Energy use values in the submitted pathway are based on facility data from November 2012 to October 2014. This application is only for a new pathway for UCO sourced outside of the EU based biodiesel at the Biocom biofuel facility, which has a carbon intensity of **26.03 g$CO_2$e $MJ^{-1}$**. This is the higher value in the two options analyzed. Details are shown in section V.

## V. CA-GREET Model Output

For the two options analyzed, the CI values of biodiesel when it is transported to New York City, NY are the highest at 26.03 **g $CO_2$e $MJ^{-1}$** (See Table 2). Table 3 shows the CA-GREET output when CI value is 26.03 **g $CO_2$e $MJ^{-1}$**.

Table 2: CI values in different scenarios when different US ports are selected

| | Option I | Option II |
|---|---|---|
| New York City, NY | **26.03** | |
| Charleston, SC | 25.89 | |
| New Orleans, LA | 25.69 | |
| Houston, TX | 25.43 | |
| California | | 24.99 |

Table 3: Fossil energy use and emissions from UCO biodiesel produced in the Midwest U.S. and in Spain, separated by life cycle stage. Figures are rounded.

| | UCOME Cooking Required, Fuel produced in the Midwest | | UCOME Cooking Required, Fuel produced in Biocom, Spain | | % 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 | 0.00 | 0 | 0.00 | - | - |
| Rendering of UCO | 88681 | 5.69 | 83189 | 5.76 | -6% | 1% |
| UCO Transport (after rendering) | 3912 | 0.30 | 60650 | 5.01 | 1450% | 1571% |
| Biodiesel Production | 174956 | 6.06 | 158700 | 5.64 | -9% | -7% |
| Biodiesel Transport | 28384 | 2.19 | 64919 | 5.15 | 129% | 135% |
| **Total (Well To Tank)** | **295933** | **14.24** | **367458** | **21.55** | 24% | **51%** |
| **Total (Tank To Wheel)** | **1000000** | **4.48** | **1000000** | **4.48** | 0% | **-** |
| **Total (Well To Wheel)** | **1295933** | **18.72** | **1367458** | **26.03** | 6% | **39%** |

## VI. Discussion of Results

Table 3 compares energy use and emissions from the proposed pathway to those from reference [1] for UCO biodiesel produced in the U.S. For the default pathway, the most energy consuming and GHGs intensive step is biodiesel production, followed by the rendering of UCO, biodiesel transport, and UCO transport. In the proposed Biocom pathway, biodiesel transport has the highest GHG emissions, followed by rendering of UCO, biodiesel production, and UCO transport. Both the transport of UCO and biodiesel in the proposed pathway have much higher GHGs emissions than in the default pathway. This is reasonable as the distance of transport is much longer in the proposed pathway.

Overall, the Biocom UCO biodiesel process has 39% higher GHG emissions than that of the UCO biodiesel produced in Midwest U.S. Both transporting UCO feedstock and biodiesel product generate more GHG emissions from the proposed pathway than from the default pathway in US.

## VII. Production Range of the Biocom biodiesel facility

The new pathway should be applicable to the Biocom biodiesel facility for 100% (33,000,000 gallons/year) of the Permitted Capacity issued by the Ministry of the Environment, Water and Urban Planning.

## VIII. Sustainability of the Biocom biofuel facility

The Biocom biodiesel facility was designed and constructed using well-established modern designs and equipment and is managed by professional, well-qualified staff to ensure that the energy efficiency of and emissions from the facility do not deteriorate

over time. Any deterioration in efficiency 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 sourced outside of the EU at the Biocom biodiesel plant has a carbon intensity of **26.03 $gCO_2e\ MJ^{-1}$**.

## XI. References


1. *California Environmental Protection Agency, Air Resource Board, 2012. Detailed California-Modified GREET PathwayFor Biodiesel Produced in the Midwest from Used Cooking Oil (UCO) and Used in California. Last updated February 21, 2012. Available at:* http://www.arb.ca.gov/fuels/lcfs/2a2b/internal/15day-mw-uco-bd-022112.pdf (Accessed March 2nd , 2015)

2. *International Energy Agency. 2014.* http://www.iea.org/statistics/statisticssearch/report/?country=WORLD&product=electricityandheat&year=2012 (Accessed Sep 14st, 2015)

3. *Farnel Capital Incorporated. Port to port distances, 2013. Available at: http://www.searates.com/reference/portdistance/ (*Accessed March. 2nd, 2015*).*


## 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 separate spreadsheets named “Biocom World UCO Original Data File”.