Duonix Beatrice LCA Analysis Report Portfolio:

In Support of LCFS Fuel Pathway Modifications for Biodiesel made from WDGS Associated Corn Oil, UCO with "cooking" and Higher Energy Rendering Tallow

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I. Introduction

The Duonix Beatrice biodiesel facility (referred to as Beatrice hereafter); owned by Duonix Beatrice, LP is applying to add a new pathway to the California LCFS fuel carbon-intensity lookup table. This pathway is a modification to the current corn-oil-producing states (COPS) corn oil to biodiesel pathway in CA-GREET model (BIOD021) that sources corn oil specifically associated with ethanol plants which produce wet distillers grains with solubles (WDGS) as a co-product [1].

Except for the points of deviation summarized below, the Beatrice pathway is identical to the default COPS corn oil to biodiesel pathway in CA-GREET model. The pathway differs from the default in only the following ways:

1) [redacted]
2) Values specific to Beatrice, including the material inputs and the use of electricity and natural gas, are used in the calculation of fuel production energy use.
3) Transport distances of corn oil feedstock and the finished biodiesel product are specific to Beatrice, and different from default values.

This application is for corn oil collected in the Midwest and processed in Beatrice, NE. Based upon the Beatrice process modelled in CA-GREET, the modified pathway has a carbon intensity of **36.22** g CO_2e/MJ^{-1}.

II. Company Details

Duonix Beatrice is a biodiesel production facility located at 722 Kinney Drive, Beatrice, Gage County, NE, 68310. The facility commenced construction on September 16th, 2014 and is expected to complete construction in [redacted]. The facility is expected to start producing biodiesel in [redacted] and has a permitted capacity of [redacted] gallons of biodiesel per year.

Beatrice will operate under an operating license issued by the State of Nebraska Department of Environmental Quality. This license limits production to [redacted] gallons of biodiesel per year.

Beatrice will be capable of producing biodiesel using multiple feedstocks, including non-food grade corn oil, used cooking oil (UCO), and tallow. This application is specifically for the non-food corn oil from Wet DGS producing facility to biodiesel pathway for the Beatrice facility.

Beatrice adopts a new technology that allows the use of lower cost, high free fatty acid (FFA) feedstocks such as tallow, used cooking oil (UCO) and distillers corn oil to produce biodiesel.

The Duonix Production Process accomplishes the conversion of fats and oils into fatty acid methyl esters with a proprietary solid catalyst that can [redacted]. The process also ensures the final product meets or exceeds all domestic and European biodiesel standards.

EcoEngineers will conduct an on-site 3rd party Engineering Review of the Beatrice facility in the Summer of 2015, as required under 40 CFR Part 80, Section 1450 to register under the EPA's Renewable Fuels Standard. EcoEngineers will work with staff in charge of the construction and facility operations. The on-site review will include a review of the information provided by the facility prior to the visit and a tour of the quality control laboratory and renewable fuel production facility.

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

The modified input values to CA GREET spreadsheet (co_bd_wdgs-greet-08252014, [1]) are all listed in Table 1, and in the "1.0 Changes made to CA GREET" tab of a separate spreadsheet named "Beatrice CO to BD W Original Data File" as well. CI calculation results can be found in the "EtOH" tab of the modified CA-GREET spreadsheet.

Table 1. Changes made to CA GREET model

Parameter	**Cell location**	**Default COPS value**	**Beatrice Value**	**Units**
Region of Analysis	Regional LT!C2	eGRID	[redacted]	
Corn oil use	BD!B19	1.04	[redacted]	lb/lb BD
Glycerin co-product yield	BD!C39	0.105	[redacted]	lb/lb BD
NG use for biodiesel production	BD!M187	889	[redacted]	btu/lb BD
Electricity use for biodiesel production	BD!M190	47	[redacted]	btu/lb BD
Methanol use for biodiesel production	BD!M192	865	[redacted]	btu/lb BD
Corn oil transport distance	T&D!IH93	50	[redacted]	miles
Biodiesel rail transport distance	T&D!GE93	1,400	[redacted]	miles

IV. Basis for the Input Values

This pathway is similar to the published CA GREET model for COPS corn oil biodiesel, with changes in the following areas as further detailed below.

1. Fuel production and energy use (2.0 Fuel production & energy use)
2. Transport distances (3.0 Transportation)

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

For the calculation of GHGs associated with corn oil extraction, corn oil and biodiesel transport and distribution, and the reduced DGS credit, the default values in the COPS corn oil to biodiesel pathway are used, except for the transport distances of corn oil and biodiesel, which are different. The average distance for transporting corn oil to Beatrice biodiesel plant by truck is [redacted] miles. To be conservative, a round-up value of [redacted] miles is used in the calculation. The rail transport distance of biodiesel from Beatrice, NE to Los Angeles, CA is 1,543 miles based on Google Maps, and a round-up value of 1,600 miles is used for the calculation.

The energy and material inputs during biodiesel production at the facility are specific to Beatrice, based on the ASPEN model and pilot plant data provided by Beatrice.

This application is only for a new pathway for corn oil biodiesel at the Beatrice biofuel facility, which has a carbon intensity of **36.22 $gCO_2e\ MJ^{-1}$**.

V. CA-GREET Model Output

Table 2: Energy use and emissions from corn oil biodiesel produced in the COPS U.S. and in Beatrice, NE, separated by life cycle stage. Figures are rounded.

	COPS		Beatrice, NE		% difference	
	Energy (BTU/MMBTU BD)	**Emissions (gCO_2e/MJ)**	**Energy (BTU/MMBTU BD)**	**Emissions (gCO_2e/MJ)**	**Energy (BTU/MMBTU BD)**	**Emissions (gCO_2e/MJ)**
[redacted]						
Corn oil extraction	78,945	5.76	[redacted]	[redacted]	[redacted]	[redacted]
Corn oil transport and distribution	3,671	0.31	[redacted]	[redacted]	[redacted]	[redacted]
Corn oil free-fatty acids (FFA) pre-treatment	13,305	0.86	[redacted]	[redacted]	[redacted]	[redacted]
Biodiesel Transesterification	162,753	5.46	[redacted]	[redacted]	[redacted]	[redacted]
Biodiesel transportation and distribution	29,152	2.27	[redacted]	[redacted]	[redacted]	[redacted]
Reduced DGS credit due to reduced DGS mass	7,658	10.16	[redacted]	[redacted]	[redacted]	[redacted]
Total WTT	**295,485**	**24.82**	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]			[redacted]	[redacted]	[redacted]	[redacted]
Carbon in Fuel	1,000,000	N/A	[redacted]	[redacted]	[redacted]	[redacted]
Fossil Carbon in Fuel	N/A	3.67	[redacted]	[redacted]	[redacted]	[redacted]
Vehicle CH_4 and N_2O	N/A	0.78	[redacted]	[redacted]	[redacted]	[redacted]
Total TTW	**1,000,000**	**4.45**	[redacted]	[redacted]	[redacted]	[redacted]
Total (Well To Wheel)	**1,295,485**	**29.27**	[redacted]	[redacted]	[redacted]	[redacted]

VI. Discussion of Results

Table 2 compares energy use and emissions from the proposed pathway to those from reference [1] for corn oil biodiesel produced in the COPS U.S. [redacted]. Other steps are similar for the two pathways. [redacted]

VII. Production Range of the Beatrice biodiesel facility

The new pathway should be applicable to Beatrice for 100% ([redacted] gallons/year) of the Permitted Capacity issued by the State of Nebraska Department of Environmental Quality.

VIII. Sustainability of the Beatrice biofuel facility

Beatrice has been designed and will be constructed using well-established modern designs and equipment and will be managed by a 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 corn oil, a secondary co-product stream from ethanol plants, there is no land use impact. This is the same as in the default COPS corn oil to biodiesel pathway [1].

X. Conclusion

Based upon the Beatrice modeling in CA-GREET and the available data, biodiesel produced from corn oil at the Beatrice biodiesel plant has a carbon intensity of **36.22 $gCO_2e\ MJ^{-1}$**.

XI. References

[1] California Environmental Protection Agency, Air Resources Board, 2014. California-Modified GREET Fuel Pathway: Biodiesel Produced in the Midwestern and the Western U.S. from Corn Oil Extracted at Dry Mill Ethanol Plants that Produce Wet Distiller's Grains (ARB Pathway Code: BIOD021). Posted Date: October 24, 2014. Available at http://www.arb.ca.gov/fuels/lcfs/2a2b/apps/co_bd_wdgs-102414.pdf (Accessed on 11/21/2014).

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

The data supporting the annual quantities of electricity, natural use and biodiesel production, as well as the modifications to the CA-GREET model are documented in a separate spreadsheet named "Beatrice CO to BD WDGS Original Data File".

California LCFS fuel pathway modification: Used cooking oil (UCO, with cooking) to biodiesel for Duonix Beatrice facility in Beatrice, Nebraska

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I. Introduction

The Duonix Beatrice biodiesel facility (referred to as Beatrice hereafter); owned by Duonix Beatrice, LP is 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 in which cooking is used during processing [2].

Except for the points of deviation summarized below, the Beatrice 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:

4) [redacted].
5) Values specific to Beatrice, including the material inputs, the use of electricity and natural gas, and the Midwest electricity mix are used in the calculation of energy used during fuel production.
6) Transport distances of UCO feedstock and the finished biodiesel product are specific to Beatrice, and different from default values.

This application is for UCO collected in the Midwest and processed in Beatrice, NE. In this pathway, cooking is used for UCO pre-processing. Based upon the Beatrice process modelled in CA-GREET, the modified pathway has a carbon intensity of **26.28** g CO_2e/MJ^{-1}.

II. Company Details

Duonix Beatrice is a biodiesel production facility located at 722 Kinney Drive, Beatrice, Gage County, NE, 68310. The facility commenced construction on September 16th, 2014 and is expected to complete construction in [redacted]. The facility is expected to start producing biodiesel in [redacted] and has a permitted capacity of [redacted] gallons of biodiesel per year.

Beatrice will operate under an operating license issued by the State of Nebraska Department of Environmental Quality. This license limits production to [redacted] gallons of biodiesel per year.

Beatrice will be capable of producing biodiesel using multiple feedstocks, including non-food grade corn oil, used cooking oil (UCO), and tallow. This application is specifically for the UCO that undergoes cooking pretreatment to biodiesel pathway for the Beatrice facility.

Beatrice adopts a new technology that allows the use of lower cost, high free fatty acid (FFA) feedstocks such as tallow, used cooking oil (UCO) and distillers corn oil to produce biodiesel.

The Duonix Production Process accomplishes the conversion of fats and oils into fatty acid methyl esters with a proprietary solid catalyst that [redacted]. The process also ensures the final product meets or exceeds all domestic and European biodiesel standards.

EcoEngineers will conduct an on-site 3rd party Engineering Review of the Beatrice facility in the Summer of 2015, as required under 40 CFR Part 80, Section 1450 to register under the EPA's Renewable Fuels Standard. EcoEngineers will work with staff in charge of the construction and facility operations. The on-site review will include a review of the information provided by the facility prior to the visit and a tour of the quality control laboratory and renewable fuel production facility.

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

The modified input values to CA GREET spreadsheet are all listed in Table 3, and in the "1.0 Changes made to CA GREET" tab of a separate spreadsheet named "UCO to BD Cooking Original Data File" as well. CI calculation results can be found in the "UCO BD Results" tab of the modified CA-GREET spreadsheet. Cells that needed modified calculations have been marked red in the modified CA-GREET spreadsheet.

Table 3. Changes made to CA GREET model

Parameter	Cell location	Default Midwest value	Beatrice Value	Units
Glycerin coproduct yield	UCO BD!C41	0.105	[redacted]	lb/lb BD
NG use for FFA transesterification	UCO BD!E189	155	[redacted]	btu/lb BD
Electricity use for FFA transesterification	UCO BD!E192	16	[redacted]	btu/lb BD
NG use for UCO transesterification	UCO BD!F189	889	[redacted]	btu/lb BD
Electricity use for UCO transesterification	UCO BD!F192	47	[redacted]	btu/lb BD
Methanol use for biodiesel production	UCO BD!F194	865	[redacted]	btu/lb BD
UCO transport distance (miles)	T&D!IH93	50	[redacted]	miles
Biodiesel rail transport distance (miles)	T&D!GE93	1400	[redacted]	miles
Percentage of biodiesel transported by truck	T&D!CL142	80	[redacted]	%

IV. Basis for the Input Values

This pathway is similar to the CARB-published CA GREET model for UCO biodiesel in which cooking is used for preprocessing, with changes in the following areas as further detailed below. Next to each item in parentheses is the supporting documentation reference in the "UCO to BD Cooking Original Data File" reference.

3. Fuel production and energy use (2.0 Fuel Production & Energy Use)
4. Transport modes and distances (3.0 Transportation)

The modified CA-GREET spreadsheet is 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. The default value of 1,073 btu/lbs UCO (963 btu NG/lb and 110 btu electricity/lb) for high-energy rendering scenario (cooking) in the CA GREET UCO to biodiesel pathway is adopted [2]. Also adopted is the Midwest electricity mix.

In the Beatrice pathway, the collection, transport by truck, and conversion of UCO all occur in the Midwest. The produced biodiesel is transported to California by rail and further distributed in California by truck. The average distance for transporting UCO to the Beatrice biodiesel plant by truck is [redacted] miles. To be conservative, a round-up value of [redacted] miles has been used in the calculation. The rail transport distance of

biodiesel from Beatrice, NE to Los Angeles, CA is 1,543 miles based on Google Maps, and a round-up value of 1,600 miles has been used for the calculation.

The energy and material inputs during biodiesel production at the facility are specific to Beatrice, and were based on the ASPEN model and pilot plant data provided by Beatrice.

This application is only for a new pathway for biodiesel produced from UCO at the Beatrice biofuel facility in which cooking is used for preprocessing of UCO. Biodiesel produced using this pathway has a carbon intensity of **26.28 $gCO_2e\ MJ^{-1}$**.

V. CA-GREET Model Output

Table 4: GHG emissions comparison from UCO biodiesel produced in the default pathway in Midwest U.S. and in Beatrice, NE, separated by life cycle stage. Figures are rounded.

	UCOME Cooking Required, Fuel produced in the Midwest		**UCOME Cooking Required, Fuel produced in Beatrice, NE**		**% 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	[redacted]	[redacted]	[redacted]	[redacted]
Rendering of UCO	88681	5.69	[redacted]	[redacted]	[redacted]	[redacted]
UCO Transport (after rendering)	3912	0.30	[redacted]	[redacted]	[redacted]	[redacted]
Biodiesel Production	174956	6.06	[redacted]	[redacted]	[redacted]	[redacted]
Biodiesel Transport	28384	2.19	[redacted]	[redacted]	[redacted]	[redacted]
Total (Well To Tank)	**295933**	**14.24**	[redacted]	[redacted]	[redacted]	[redacted]
Total (Tank To Wheel)	**1000000**	**4.48**	[redacted]	[redacted]	[redacted]	[redacted]
Total (Well To Wheel)	**1295933**	**18.72**	[redacted]	[redacted]	[redacted]	[redacted]

VI. Discussion of Results

Table 4 compares energy use and emissions from the proposed pathway to those from reference [2] for UCO biodiesel produced through the default pathway in Midwest U.S. [redacted]

[redacted], but the **26.28 g $CO_2e\ MJ^{-1}$** still greatly reduces the GHG emissions compared to its counterpart derived from fossil fuels.

VII. Production Range of the Beatrice biodiesel facility

The new pathway should be applicable to Beatrice for 100% ([redacted] gallons/year) of the Permitted Capacity issued by the State of Nebraska Department of Environmental Quality.

VIII. Sustainability of the Beatrice biofuel facility

Beatrice has been designed and will be constructed using well-established modern designs and equipment and will be managed by a 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 the food industry, there is no land use impact.

X. Conclusion

Based upon the Beatrice modeling in CA-GREET and the available data, biodiesel produced at the Beatrice biodiesel plant from UCO that is associated with cooking used during preprocessing has a carbon intensity of **26.28 $gCO_2e\ MJ^{-1}$**.

XI. References

[2] California Environmental Protection Agency, Air Resource Board, 2012. Detailed California-Modified GREET Pathway For 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 Dec 12th, 2014)

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

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

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I. Introduction

The Duonix Beatrice biodiesel facility (referred to as Beatrice hereafter); owned by Duonix Beatrice, LP is applying to add a new pathway to the California LCFS fuel carbon-intensity lookup table. This pathway is a modification to the current default tallow to biodiesel pathway developed by National Biodiesel Board [3] in which the same "higher energy" for rendering is assumed as is in the tallow to renewable diesel pathway published by California Air Resources Board (CARB) [4].

Except for the points of deviation summarized below, the Beatrice pathway is identical to the default tallow to biodiesel pathway [3]. The pathway differs from the default in only the following ways:

1) Values specific to Beatrice, including the material inputs, the use of electricity and natural gas and the Midwest electricity mix, are used in the calculation of fuel production energy use.
2) Transport distances of tallow feedstock and the finished biodiesel product are specific to Beatrice, and different from default values.

This application is for tallow collected in the Midwest, U.S. and processed in Beatrice, NE. In this pathway, higher energy is assumed to be consumed for tallow rendering. Based upon the Beatrice process modelled in CA-GREET, the modified pathway has a carbon intensity of **50.05** g CO_2e/MJ^{-1}.

II. Company Details

Duonix Beatrice is a biodiesel production facility located at 722 Kinney Drive, Beatrice, Gage County, NE, 68310. The facility commenced construction on September 16th, 2014 and is expected to complete construction in [redacted]. The facility is expected to start producing biodiesel in [redacted] and has a permitted capacity of [redacted] gallons of biodiesel per year.

Beatrice will operate under an operating license issued by the State of Nebraska Department of Environmental Quality. This license limits production to [redacted] gallons of biodiesel per year.

Beatrice will be capable of producing biodiesel using multiple feedstocks, including non-food grade corn oil, used cooking oil (UCO), and tallow. This application is specifically for the high energy rendering tallow to biodiesel pathway for the Beatrice facility.

Beatrice adopts a new technology that allows the use of lower cost, high free fatty acid (FFA) feedstocks such as tallow, used cooking oil (UCO) and distillers corn oil to produce biodiesel.

The Duonix Production Process accomplishes the conversion of fats and oils into fatty acid methyl esters with a proprietary solid catalyst that can [redacted]. The process also ensures the final product meets or exceeds all domestic and European biodiesel standards.

EcoEngineers will conduct an on-site 3rd party Engineering Review of the Beatrice facility in the Summer of 2015, as required under 40 CFR Part 80, Section 1450 to register under the EPA's Renewable Fuels Standard. EcoEngineers will work with staff in charge of the construction and facility operations. The on-site review will include a review of the information provided by the facility prior to the visit and a tour of the quality control laboratory and renewable fuel production facility.

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

The modified input values to CA GREET spreadsheet are all listed in Table 5, and in the "1.0 Changes made to CA GREET" tab of a separate spreadsheet named "Tallow to BD High Energy Original Data File" as well. CI calculation results can be found in the "Tallow BD Results" tab of the modified CA-GREET spreadsheet. Cells that needed modified calculations have been marked red in the modified CA-GREET spreadsheet.

Table 5. Changes made to CA GREET model

Parameter	Cell location	Default value	Beatrice Value	Units
Region for analysis	Regional LT!C2	U.S. Average	Midwest	
Tallow use	Tallow RD!B19	1.04	[redacted]	lb tallow/lb BD
Glycerin coproduct yield	Tallow RD!C39	0.105	[redacted]	lb/lb BD
NG use for tallow rendering	Tallow RD!B187	3200	[redacted]	btu/lb Tallow
Electricity use for tallow rendering	Tallow RD!B190	423	[redacted]	btu/lb Tallow
NG use for transesterification	Tallow RD!D187	889	[redacted]	btu/lb BD
Electricity use for transesterification	Tallow RD!D190	47	[redacted]	btu/lb BD
Methanol use for biodiesel production	Tallow RD!D192	865	[redacted]	btu/lb BD
Tallow transport distance by truck	T&D!IE93	10	[redacted]	miles
Tallow transport distance by rail	T&D!IF93	1400	[redacted]	miles
Biodiesel rail transport distance (miles)	T&D!GE93	1400	[redacted]	miles
Percentage of biodiesel transported by rail	T&D!CL141	0	[redacted]	%
Percentage of biodiesel transported by truck	T&D!CL142	80	[redacted]	%

IV. Basis for the Input Values

This pathway is similar to the default CA GREET model for tallow biodiesel with changes in the following areas as further detailed below. Higher energy is assumed for tallow rendering, as is in reference [4]. Next to each item in parentheses is the supporting documentation reference in the "Tallow to BD High Energy Original Data File" reference.

1. Fuel production and energy use (2.0 Fuel Production & Energy Use)
2. Transport modes and distances (3.0 Transportation)

The modified CA-GREET spreadsheet is included in the application package; results can be found in the "Tallow BD Results" tabs.

For the rendering of tallow, steam and electricity are consumed. The value of 6,026 btu/lbs tallow (4,956 btu NG/lb, 399 btu Tallow/lb and 671 btu electricity/lb) for high-energy rendering scenario in the CA GREET tallow to renewable diesel pathway is adopted [4]. Also adopted is the Midwest electricity mix.

In the Beatrice pathway, the collection, transport by truck, and conversion of tallow all occur in the Midwest. The produced biodiesel is transported to California by rail and

further distributed in California by truck. The average distance for transporting tallow to the Beatrice biodiesel plant by truck is [redacted] miles. To be conservative, a round-up value of [redacted] miles has been used in the calculation. The rail transport distance of biodiesel from Beatrice, NE to Los Angeles, CA is 1,543 miles based on Google Maps, and a round-up value of 1,600 miles has been used for the calculation.

The energy and material inputs during biodiesel production at the facility are specific to Beatrice, and were based on the ASPEN model and pilot plant data provided by Beatrice.

This application is only for a new pathway for biodiesel produced from tallow at the Beatrice biofuel facility in which higher energy is used for tallow rendering. This biodiesel has a carbon intensity of **50.05 $gCO_2e\ MJ^{-1}$**.

V. CA-GREET Model Output

Table 6: GHG emissions comparison from tallow biodiesel produced in the NBB pathway [3] for average U.S. and in Beatrice, NE, separated by life cycle stage. Figures are rounded.

	Tallow, Fuel produced in the U.S.	**Tallow, Fuel produced in Beatrice, NE**	**% difference**
	Emissions (gCO2e/MJ)	**Emissions (gCO2e/MJ)**	**Emissions (gCO2e/MJ)**
Rendering of Tallow	28.11	[redacted]	[redacted]
Tallow Transport (after rendering)	0.47	[redacted]	[redacted]
Biodiesel Production	5.20	[redacted]	[redacted]
Biodiesel Transport	1.95	[redacted]	[redacted]
Total (Well To Tank)	35.73	[redacted]	[redacted]
Total (Tank To Wheel)	4.45	[redacted]	[redacted]
Total (Well To Wheel)	40.18	[redacted]	[redacted]

VI. Discussion of Results

Currently, California Air Resources Board (CARB) provides a single pathway for mixed animal fats to be converted to biodiesel, listed as pathway BIOD008 [3]. Table 6 compares GHG emissions from the proposed pathway to those from the NBB pathway for tallow biodiesel produced in the U.S. [3]. [redacted].

[redacted], but the **50.05 g $CO_2e\ MJ^{-1}$** still greatly reduces the GHG emissions compared to its counterpart derived from fossil fuels.

VII. Production Range of the Beatrice biodiesel facility

The new pathway should be applicable to Beatrice for 100% ([redacted] gallons/year) of the Permitted Capacity issued by the State of Nebraska Department of Environmental Quality.

VIII. Sustainability of the Beatrice biofuel facility

Beatrice has been designed and will be constructed using well-established modern designs and equipment and will be managed by a 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 tallow, a waste stream from the food industry, there is no land use impact.

X. Conclusion

Based upon the Beatrice modeling in CA-GREET and the available data, biodiesel produced at the Beatrice biodiesel plant from tallow that uses higher energy for tallow rendering has a carbon intensity of **50.05 $gCO_2e\ MJ^{-1}$**.

XI. References

[3] National Biodiesel Board, 2011. National Biodiesel Board (NBB) Method 2B Application for Mixed-Animal-Fat to Biodiesel. Available at: http://www.arb.ca.gov/fuels/lcfs/2a2b/apps/nbb-121511.pdf (Accessed Dec. 13th, 2014)CA-

[4] California Environmental Protection Agency, Air Resource Board, 2009. Detailed California-Modified GREET Pathway for Co-Processed Renewable Diesel Produced from Tallow (U. S. Sourced) Version 2.0. September 23, 2009. Available at: http://www.arb.ca.gov/fuels/lcfs/092309lcfs_tallow_rd.pdf (Accessed Dec. 13th, 2014)

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

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