Life-Cycle Assessment of River Birch Landfill Gas to CNG in California - San Diego Metropolitan Transit System

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BP Natural Gas and Power

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General Information

River Birch, LLC (River Birch) operates the River Birch renewable fuel production facility, a landfill gas treatment facility in Avondale, LA, to recover methane and process landfill gas to pipeline quality natural gas. River Birch owns and operates the River Birch Landfill, a 399-acre municipal solid waste facility

The anaerobic decomposition of organic wastes in landfills results in the generation of a biogas commonly referred to as landfill gas (LFG). Raw landfill gas is drawn from over 200 wells by two 100-horsepower centrifugal blowers. Previously, the LFG was discharged from the blowers to two candle flares; however, a tie-in and valves were added to redirect the LFG to the production facility.

Some LFG is drawn out from the after cooler as pilot gas for the thermal oxidizer. Waste gas out of the pressure swing adsorption process is sent to a thermal oxidizer.

Pipeline grade LFG is transported via pipeline from Avondale, Louisiana to California for compression and sale. The following pathway was produced using two (2) years (May 2013 – April 2015) of landfill gas production data and two (2) years (July 2011 – June 2013) of CNG compression data.[1]

[1] Please see Annex 2 for River Birch Facility Energy Data Analysis, Annex 5 for gas sales receipts, and Annex 4 for CNG Station Electrical Efficiency Data

Process Description

(THIS SECTION CONTAINS CONFIDENTIAL BUSINESS INFORMATION)

The following steps outline the process train for the production of pipeline quality natural gas from River Birch LFG[2]:

- [redacted]
- [redacted]
- [redacted]
- [redacted]
- [redacted]
- [redacted]
- [redacted]
- [redacted]
- [redacted]
- [redacted]
- [redacted]

[redacted] The balance is consumed in the thermal oxidizer.

[2] Information is sourced from Annex 3 Engineering Review Report, pg. 4-5

[3] Annex 2, Summary tab, cell H18. 88% is the sales gas (30.13 mmbtu/hour) divided by the landfill gas (34.28 mmbtu/hour)

Data Collection and Process Results

To estimate GHG emissions, the energy and materials necessary for the following processes needs to be determined: LFG Production Plant, Transport of Gas to California (Pipeline), and Compression.

LFG Production Plant

(THIS SECTION CONTAINS CONFIDENTIAL BUSINESS INFORMATION)

[redacted]

Table 1 below shows the available data provided by River Birch for input biogas, product biogas, biogas consumed on-site, and imported electricity for the two years' worth of data. The balance of the biogas consumed in the thermal oxidizer is calculated based on data provided by River Birch. The table also shows the provided data converted to GREET model inputs. The River Birch pathway utilizes the CA-GREET default values for LFG recovery.

[redacted] To determine combustion emissions from the consumed natural gas and landfill gas at the landfill gas plant, the GREET default values for natural gas combustion process for natural gas liquefaction (100% natural gas turbine) were chosen since they represent the processes more closely than natural gas compression (100% natural gas engine).

TABLE 1. RIVER BIRCH LFG PLANT OPERATING ENERGY AND FLARE CREDIT[6]

(THIS TABLE CONTAINS CONFIDENTIAL BUSINESS INFORMATION)

	Btu/MMBtu of Product Gas	Input Value	Btu/MMBtu of Product Gas	Changed Cells – NG Tab
[redacted]				

[4] Please see Annex 2, Inlet tab, cell P11 for the calculation of this figure
[5] Please see Annex 2, Summary tab, cell L5 for the calculation of this figure
[6] Please see Annex 2, Summary tab for the calculations of the figures presented in this table
[7] Please see Annex 5 for PDFs of gas sales invoices
[8] Please see Annex 6 for PDFs of facility electricity bills

	Btu/MMBtu of Product Gas	Input Value	Btu/MMBtu of Product Gas	Changed Cells – NG Tab
Flare [redacted]	[redacted]	[redacted]	[redacted]	

Below is a simplified process diagram of the facility that includes the estimated energy flow associated with each step of the LFG recovery process.

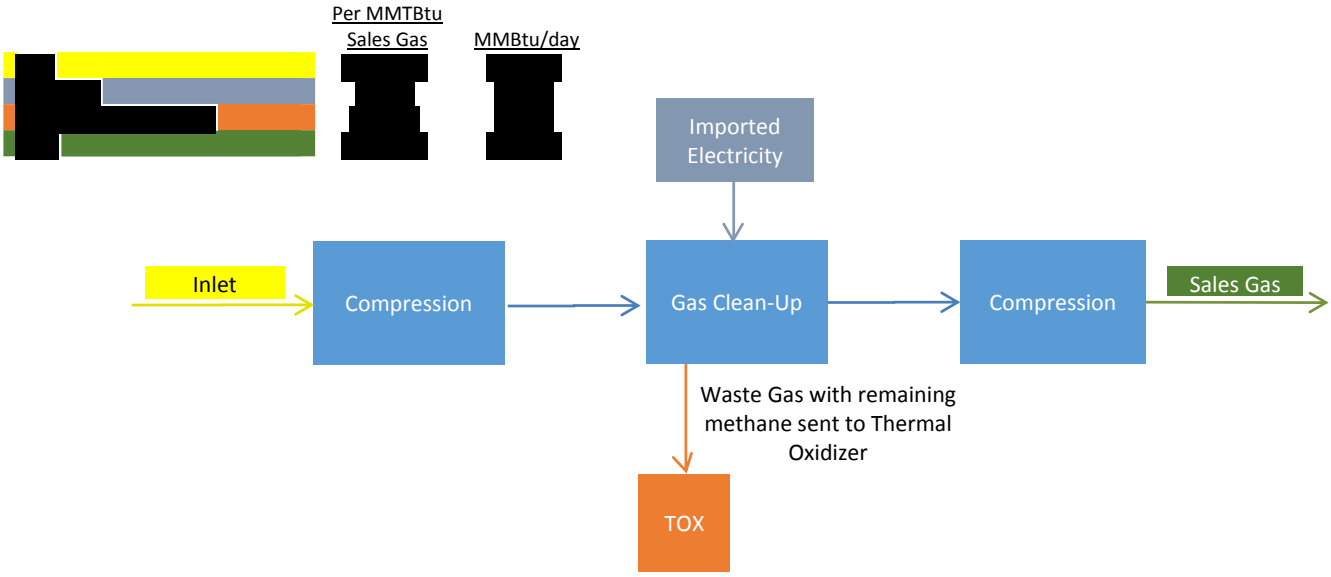


Figure 1. Monroeville Process per MMBtu and MMBtu/day Energy Flows

The GREET model LFG pathway was then modified to adjust efficiency gas and process energy shares as listed in Table 2. The Southeast Asia region on the Regional LT tab was changed to the SERC Mississippi Valley (SRMV) Region to represent the 2012 eGRID data for year 2009 (8th Edition[10]) where the River Birch facility (in Avondale, LA) is located. The ARB methodology of converting eGRID electricity mix to marginal mix was employed. This changed the electric mix cells of J83-J88 on the Regional LT tab to those shown in Table 2. The remaining values from the Southeast Asia Region (now the SRMV region) were changed to match the US Average.

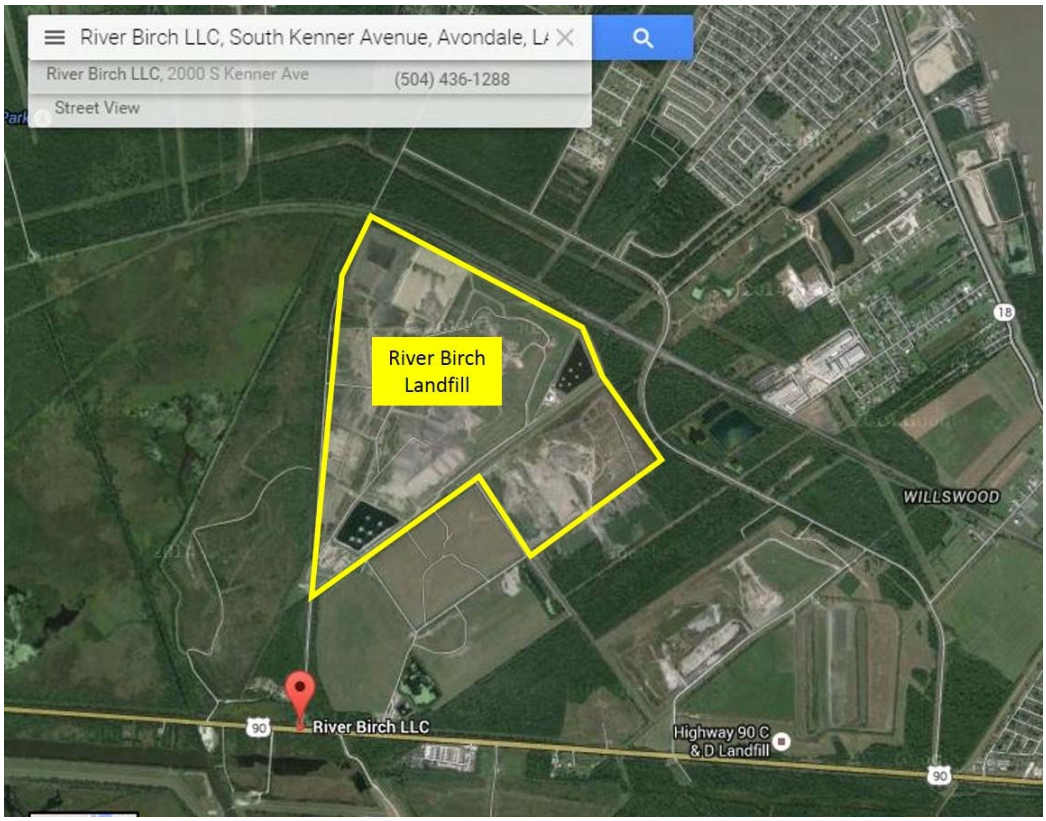
[9] Please see Annex 1 for the Modified GREET model referred to in this report
[10] eGrid 8th Edition Version 1.0, Year 2009 Summary Tables, created May 2012.
www.epa.gov/cleanenergy/documents/egridzips/eGRID_8th_edition_V1-0_year_2009_Summary_Tables.pdf

TABLE 2. SRMV ELECTRICITY GRID MIX

	eGRID CY2009 Grid Mix	Marginal Grid Mix	CA-GREET Cell Regional LT Tab
Residual oil	2.31%	2.31%	J83
Natural gas	45.09%	73.03%	J84
Coal	22.73%	22.73%	J85
Nuclear	25.97%	0.00%	J86
Biomass	1.93%	1.93%	J87
Other (renewables)	1.73% (w/ hydro)	0.00% (w/o hydro)	J88

This produced the results for LFG to pipeline biogas shown in Table 3 below. These values are taken from the NG Tab of the Modified GREET model which can be found in Annex 1 of the supporting documents submitted in conjunction with this report. Conversion from g/MMBtu to g/MJ was done using the conversion factor of 1055.055 MJ/MMBTU as is done in the CA-GREET model.

The recovery energy and emissions are based on ARB LFG pathway defaults of 4,621.25 Btu of electricity/MMBtu of landfill gas.[11] The default LFG transport distance of one mile was used since the distance between River Birch LLC and the River Birch landfill is less than 1 mile, as can be seen in Figure 2 below.



[11] http://www.arb.ca.gov/fuels/lcfs/022709lcfs_lfg.pdf; page 9.

Figure 2. Proximity between River Birch LLC (identified location) and the River Birch Landfill

TABLE 3. RIVER BIRCH LFG PLANT GREENHOUSE GAS EMISSIONS
(THIS TABLE CONTAINS CONFIDENTIAL BUSINESS INFORMATION)

	Recovery Emissions	River Birch LFG Plant	CA-GREET Cell NG Tab
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]		[redacted]	[redacted]
[redacted]		[redacted]	[redacted]

Transportation to California by Pipeline

The pipeline transport distance was modified to 1,819 miles from Avondale, LA to San Diego, CA where the gas will be compressed. The distance was determined by the using the driving route most similar to the pipeline map. Google Maps was used to determine the driving routes with the I-10 route most similar to the pipeline map. The emissions were determined by linked cell E148 on the NG tab to cell F479 on the T&D_Flowcharts tab for LFG to CNG. The table below shows the pipeline transport emissions from cells F151-F157 on the NG Tab.

TABLE 4. RIVER BIRCH LFG TRANSPORT GREENHOUSE GAS EMISSIONS
(THIS TABLE CONTAINS CONFIDENTIAL BUSINESS INFORMATION)

Transport Emissions	River Birch LFG Transport
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]

Compression

(THIS SECTION CONTAINS CONFIDENTIAL BUSINESS INFORMATION)

Based on the submitted Confidential Business Information from SD Metro, SD Metro will be submitting for one pathway for their CNG Stations based on two (2) years of data (July 2011-June 2013). [redacted] Table 5 and

Table 6 below show the calculation from kWh/GGE to process efficiency and the cells that were changed and the results from cells G151- G157.

TABLE 5. CNG STATION PLANT OPERATING EFFICIENCY
(THIS TABLE CONTAINS CONFIDENTIAL BUSINESS INFORMATION)

All Units in Btus per GGE	Compression	Input Value	Changed Cells – NG Tab
[redacted]			

TABLE 6. CNG COMPRESSION GREENHOUSE GAS EMISSIONS
(THIS TABLE CONTAINS CONFIDENTIAL BUSINESS INFORMATION)

Recovery and Processing Emissions	Compression
[redacted]	

[12] Please see Annex 4 for the CNG station Electrical Efficiency Data
[13] 109,772 Btu/GGE default CA-GREET value

River Birch Fuel Pathway Results

When the CA-GREET model is run completely with the modifications listed above, the table below shows the complete pathway results. The WTT pathway gCO2e/MJ results were taken from cell H158 which is the sum of cells E158 – G158 on the “NG” tab for CNG. The TTW gCO2e/MJ was taken from the Detailed California-Modified GREET Pathway for Compressed Natural Gas (CNG) from Landfill Gas[14].

TABLE 7. RIVER BIRCH PATHWAY RESULTS

GHG Emissions (gCO2e/MJ)	River Birch LFG Plant to CNG
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
gCO2e/MJ WTW	**23.36**

[14] http://www.arb.ca.gov/fuels/lcfs/022709lcfs_lfg.pdf

Appendix A: Summary of CA-GREET Inputs

Parameter	Unit	Value	CA-GREET Cell Changed
LFG Recovery and Transport			
Thermal	Btu/MMBtu	0	CA-GREET Default (L85)
Electricity	Btu/MMBtu	4,639	CA-GREET Default[15] (L91)
Total Energy	Btu/MMBtu	4,639	N/A
LFG Plant			NG Tab
[redacted]			
[redacted]			
[redacted]			
[redacted]			
[redacted]			
[redacted]			
[redacted]			
[redacted]			
Electricity Grid Mix			Regional LT Tab
Residual oil	%	2.31	J83
Natural gas	%	73.03	J84
Coal	%	22.73	J85
Nuclear	%	0.0	J86
Biomass	%	1.93	J87
Other (renewables)	%	0.0	J88
Natural Gas Transport			T&D Flowcharts Tab (via NG Tab)
[redacted]			
Compression			NG Tab
[redacted]			
[redacted]			
[redacted]			
[redacted]			
[redacted]			

[15] http://www.arb.ca.gov/fuels/lcfs/022709lcfs_lfg.pdf, pages 9-10.

Appendix B: List of Supporting Annexes

River Birch Pathways Annex 1 - Modified GREET model_LFG to CNG

River Birch Pathways Annex 2 - Facility Energy Data Analysis

River Birch Pathways Annex 3 - Engineering Review Report

River Birch Pathways Annex 4 - SD Metro Calculation Summary File

River Birch Pathways Annex 4a - SD Metro Invoices

River Birch Pathways Annex 5 –Sales Gas Invoices

River Birch Pathways Annex 6 –Electricity Invoices