



Life-Cycle Assessment of Cedar Hills Landfill Gas to Delivered CNG in California

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Submitted to:

Clean Energy Renewable Fuels, LLC

Prepared by

ICF International
75 E. Santa Clara St., Suite 300
San Jose, CA 95113

POC: Jeffrey Rosenfeld; Jeffrey.rosenfeld@icfi.com

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General Information

(This Section contains Confidential Business Information)

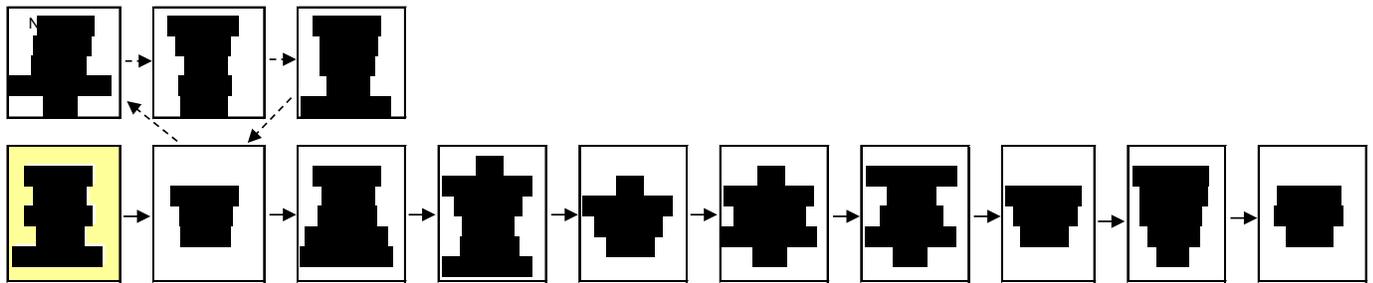


Figure 1. Biogas Flow Chart and Physical Chain of Custody

¹ [Redacted] LHV were used in the calculations, average of 97.6% methane.

Process Description

(This Section contains Confidential Business Information)

[Redacted]

[Redacted]

[Redacted]

[Redacted]

[Redacted]

This figure contains Confidential Business Information)

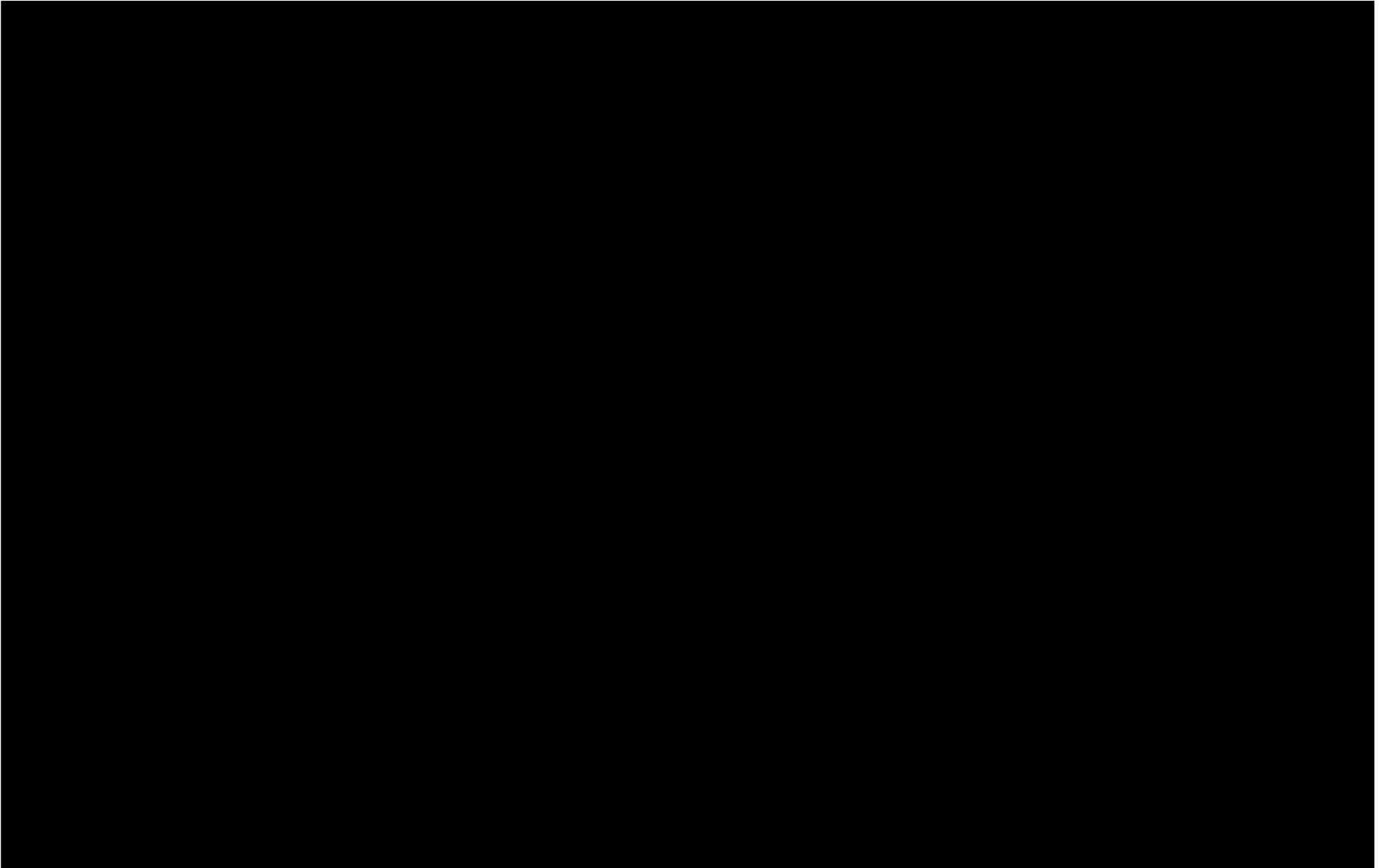


Figure 2. Cedar Hills LFG Plant Process Flow Diagram (This figure is Confidential Business Information)

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)

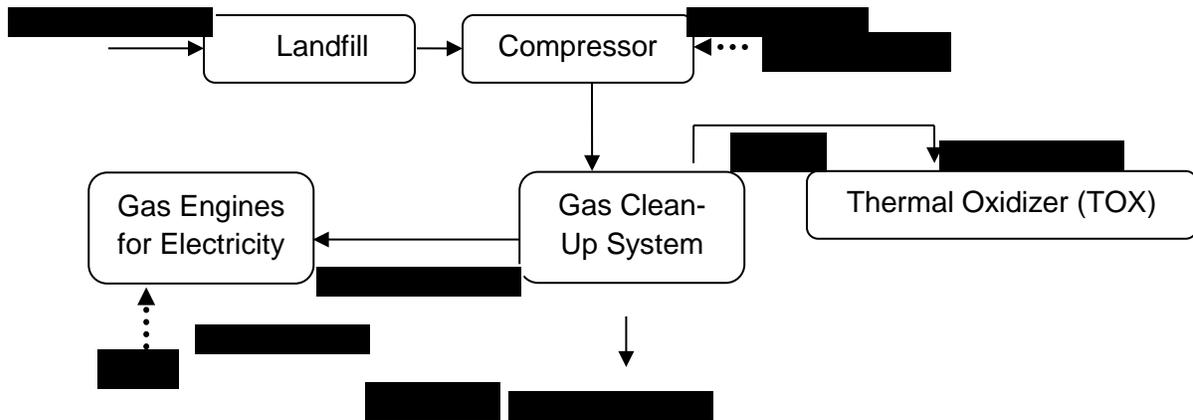
[Redacted]

[Redacted]

Table 1. CedarHill LFG Plant Operating Energy and Flare Credit

(This Table contains Confidential Business Information)

	Jan – Mar 2013 Data	Btu/MMBtu of Product Gas	Input Value	Changed Cells – NG Tab
LFG Produced	[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]	Calculated w/in GREET	[REDACTED]



The GREET model LFG pathway was then modified to adjust efficiency gas and process energy shares as listed in Table 1. The Southeast Asia region on the Regional LT tab was changed to Washington State and this was used for Cedar Hills. After discussions with ARB, the eGRID 2012 (2009 data) for NWPP-WECC Northwest Sub region average electricity mix was used. This changed the electric mix cells of J83-J88 on the Region LT tab to those shown in Table 2. The remaining values from the Southeast Asia Region (not the Washington State Region) were changed to match the US Average.

Table 2. Washington Electricity Grid Mix

	eGRID Mix	CA-GREET Cell Regional LT Tab
Residual oil	[REDACTED]	[REDACTED]
Natural gas	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]

This produced the results for LFG to LNG shown in the table below taken from cells on the NG Tab. 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.

Table 3. Cedar Hills LFG Plant Greenhouse Gas Emissions

(This Table contains Confidential Business Information)

	Recovery Emissions	Cedar Hills LFG Plant	CA-GREET Cell NG Tab
gVOC/MMBTU	[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]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]

Transportation to California by Pipeline

The pipeline transport distance was modified to 1,117 miles from Maple Valley, WA to Boron, CA, the same transport distance used for the Clean Energy pathway to LNG. 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-5 route most similar to the pipeline map. The emissions were determined by linked cell E148 on the NG tab to cell F487 on the T&D_Flowcharts tab for LFG to CNG, and this same distance will be used for LNG and CNG. The table below shows the pipeline transport emissions from cells F151-F157 on the NG Tab.

Table 4. Cedar Hills LFG Transport Greenhouse Gas Emissions

(This Table contains Confidential Business Information)

Transport Emissions	Cedar Hills LFG Transport
[REDACTED]	[REDACTED]

Compression

(This Section contains Confidential Business Information)

Based on the submitted Confidential Business Information from Clean Energy Fuels, Clean Energy will be submitting for one pathway for their CNG Stations based on two (2) years of data (2011-2012). The weighted average energy consumption is [REDACTED] 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
CNG Produced	[REDACTED]		
[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]

Table 6. CNG Compression Greenhouse Gas Emissions

(This Table contains Confidential Business Information)

Recovery and Processing Emissions	Compression
[REDACTED]	[REDACTED]

² 109,772 Btu/GGE default CA-GREET value

