

## Staff Summary:

# Method 2B Pathway—North American Landfill Gas to Liquefied Natural Gas (LNG) Applied Natural Gas Fuels May 28, 2013

## Plant Summary

Applied Natural Gas Fuels, Inc. (ANGF) operates a Liquefied Natural Gas (LNG) Plant in Topock, Arizona. The facility has the capacity to produce 90,000 gallons of LNG per day. In October of 2012, ARB staff approved a pathway application from ANGF for the production of LNG from North American fossil natural gas (NG) (pathway LNG011). The carbon intensity (CI) of that pathway is 85.77 gCO<sub>2</sub>e/MJ. ANGF is now applying for two pathways for the production of LNG from North American landfill gas. One would cover LNG used in LNG-powered vehicles, and the other would cover LNG that is vaporized, compressed, and used in compressed-natural-gas-powered vehicles. The second of these two fuels is known as liquefied-to-compressed natural gas (L-CNG)<sup>1</sup>.

The source biomethane for these pathways could be any landfill in the U.S. After the LFG is processed into pipeline-quality biomethane, it would be transported to the Topock plant by pipeline. In January 2013, ARB staff posted a similar Method 1 biomethane-to-CNG pathway (Pathway CNG006). This pathway has a CI of 33.02 gCO<sub>2</sub>e/MJ<sup>2</sup>.

The energy use and emissions associated with the LFG collection, processing, and transport phases of ANGF's biomethane-based pathways are assumed to be the same as the corresponding values in pathway CNG006. The emissions associated with the liquefaction, transport, dispensing, and use of biomethane in LNG-powered vehicles are assumed to be the same as the corresponding values used in pathway LNG011. The conversion of the LNG to L-CNG for use in CNG-powered vehicles requires that the energy and emissions associated with these additional steps be included in the L-CNG pathway CI. The resulting well-to-wheels pathway CIs are 49.84 gCO<sub>2</sub>e/MJ, and 50.98 gCO<sub>2</sub>e/MJ for ANGF's LNG and L-CNG pathways, respectively. ANGF may use these CIs only on the LNG and L-CNG produced from the LFG-based biomethane it purchases. These purchases are assumed to displace fossil NG in the feed gas arriving at ANGF's Topock plant. LNG and L-CNG that cannot be directly associated with purchases of biomethane must be sold under the higher fossil-NG-based CI of 85.77 gCO<sub>2</sub>e/MJ associated with pathway LNG011.

Because the biomethane supplied under this pathway is commingled with fossil NG once it is injected into the interstate pipeline system, ANGF must maintain an

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<sup>1</sup> L-CNG (Liquefied-to-Compressed Natural Gas) is produced by vaporizing the LNG and using the resulting gas to charge CNG tanks. The fuel from these tanks is used in CNG-powered vehicles.

<sup>2</sup> ARB, January 28, 2013. LCFS Life Cycle Fuel Pathway Report: North-American Landfill Gas to Compressed Natural Gas. <http://www.arb.ca.gov/fuels/lcfs/2a2b/internal/nalfg-cng-rpt-031513.pdf>

accounting system that will enable it to demonstrate unequivocally at any time that every unit of transportation fuel sold and reported under either of the two new biomethane pathways described in this staff summary can be associated with an equal unit of biomethane purchased.

ANGF's LFG-to-LNG pathways would cover the production of biomethane from landfill gas anywhere in North America. The biomethane produced under this pathway would be transported to Topock, Arizona by pipeline, liquefied, and transported to wholesale customers in California, and to two vehicle refueling distribution centers. The distribution centers—one in Barstow and one in Ontario—dispense both LNG and L-CNG.

The inputs for the upstream phases of ANGF's LFG-to-LNG and LNG to L-CNG pathways are the same as those used in the existing North American LFG to CNG pathway (see footnote 2 for information on pathway CNG006):

- A pipeline transport distance of 3,600 miles;
- An electrical energy generation mix of 100 percent coal for the LFG recovery and processing phases<sup>3</sup>.
- An LFG capture and processing efficiency of 77.2 percent—5.5 percent lower than the efficiency calculated for the original California LFG-to-CNG pathway (CNG001).<sup>4</sup>
- Fuel shares of 76.8 percent thermal and 26.2 percent electrical for LFG processing
- A NG leak fraction of 0.15 percent

The downstream phases of the pathway (LNG production, including liquefaction efficiency and energy usage) are the same as those used to prepare ANGF's fossil-NG-to-LNG pathway (Pathway LNG011)<sup>5</sup>.

### **Carbon Intensity of the Fuel Produced**

The inputs described above were entered into CA-GREET using three different electrical generation energy mixes: 100 percent coal for biomethane production, the CA-GREET 1.8b default U.S. average mix for LNG production at the Topock plant, and the California marginal mix for electricity consumed within California for L-CNG compression. As shown in Table 1, the resulting CIs are 49.84 gCO<sub>2</sub>e/MJ for LNG and 50.98 gCO<sub>2</sub>e/MJ for L-CNG.

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<sup>3</sup> The California marginal mix was used for the electricity consumed within California. This was also true of the original California LFG-to-CNG pathway (CNG001).

<sup>4</sup> The LFG processing efficiencies used in the ANGF (LNG012) and CNG001 pathways are calculated from all but one identical parameter: membrane efficiency. The extracted LFG is forced through a membrane to separate the methane from the other constituents. CNG001 assumed a membrane efficiency of 90 percent, while LNG012 assumed a membrane efficiency of 84 percent. Both efficiencies correspond to measured efficiencies of actual membranes currently in use.

<sup>5</sup> Applied Natural Gas Fuels Inc. October 3, 2012. LCFS Life Cycle Fuel Pathway Report: Method 2B Application, Topock LNG Plant. <http://www.arb.ca.gov/fuels/lcfs/2a2b/apps/angf-090612.pdf>

**Table 1: Proposed Lookup Table Entry**

Fuel/ Feedstock	Pathway Identifier	Pathway Description	Carbon Intensity in gCO <sub>2</sub> e/MJ (Including Indirect Effects)		
			Direct Emissions	Land Use or Other Indirect Effects	Total
LFG-to-LNG	LNG012	2B Application (Specific Conditions Apply): North American landfill gas to biomethane, delivered via pipeline; liquefied in Topock, AZ	49.84	0	49.84
LFG-to-CNG	CNG008	2B Application (Specific Conditions Apply): North American landfill gas to biomethane, delivered via pipeline; liquefied in Topock, AZ; LNG delivered to California via truck for compression	50.98	0	50.98

**Staff Analysis and Recommendation**

The North American LFG-to-LNG pathways summarized in this document were developed using two existing LCFS pathways: the North American LFG-to-CNG pathway published in December 2012 (Pathway CNG006) and ANGF’s fossil-NG-to-LNG pathway published in October 2012 (Pathway LNG011). All input parameters from those two pathways were left unchanged. Staff has reviewed and replicated, using CA-GREET 1.8b, the CIs calculated by ANGF.

On the basis of these findings, staff recommends that pathways LNG012 and LNG014 for North American LFG-to-LNG be approved for inclusion in the LCFS Lookup table.