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New Hope Dairy Digester GREET LCFS Pathway to Produce Electricity to Charge Electric Vehicles in SMUD Region & California

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Prepared by

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Location of New Hope Dairy Digester: Sacramento County, California

Location of EV Charging Stations: EV Fleets in SMUD Region or California

Period of Analysis:

This analysis is based on New Hope dairy digester operating data, process invoices, and audited reports covering the period from September 1, 2019 to August 31, 2020 inclusive.

Fuel Pathway Information (Tier 2, Simplified CI Calculator for Biomethane from Anaerobic Digestion of Dairy and Swine Manure)

Fuel	Feedstock	Production Process Technology	LCFS Pathway Requested
Electricity	Biogas from anaerobic digestion of dairy manure.	Covered Lagoon: Anaerobic digestion of dairy wastes at New Hope dairy farm.	Dairy manure to electricity to charge electric vehicles pathway.

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1. Fuel Pathway Summary

SMUD generates, transmits and distributes electricity to a 900-square-mile territory that includes California's capital city, Sacramento County and a small portion of the Placer County, California. SMUD has long been a leader in both energy efficiency and renewable energy, considered to be one of the most progressive utilities in the nation, while demonstrating that clean energy can be delivered at an affordable rate without compromising reliability. On July 16, 2020, the SMUD Board of Directors adopted a climate emergency declaration that commits to working toward an ambitious goal of delivering carbon neutral electricity by 2030. The associated Zero Carbon Plan to reach zero carbon emissions in our power supply by 2030 was approved by the Board of Directors on April 28, 2021. This ambitious goal puts the Sacramento Region on the map as an example to follow, and will further the region's desirability to attract innovative, climate-friendly businesses and partnerships. This Zero Carbon Plan commits SMUD to finding reductions in the quickest way possible and investing in our most vulnerable communities.

The main objective of this report is to present the full life cycle carbon intensity (CI) result for New Hope dairy digester to produce electricity and charge electric vehicles using GREET 3.0 Tier 2 Simplified CI Calculator for Biomethane from Anaerobic Digestion of Dairy and Swine Manure, LCFS Fuel New Pathway Application and to help achieve the Zero Carbon Plan.

Result Summary

The full life cycle carbon intensity (CI) result for New Hope dairy digester to produce electricity and charge electric vehicle pathway is **-750.81 gCO_2/MJ** at engine genset efficiency of [redacted] **%.** Figure 1 shows the discrete components that form the New Hope dairy digester to produce electricity and charge electric vehicles pathway.

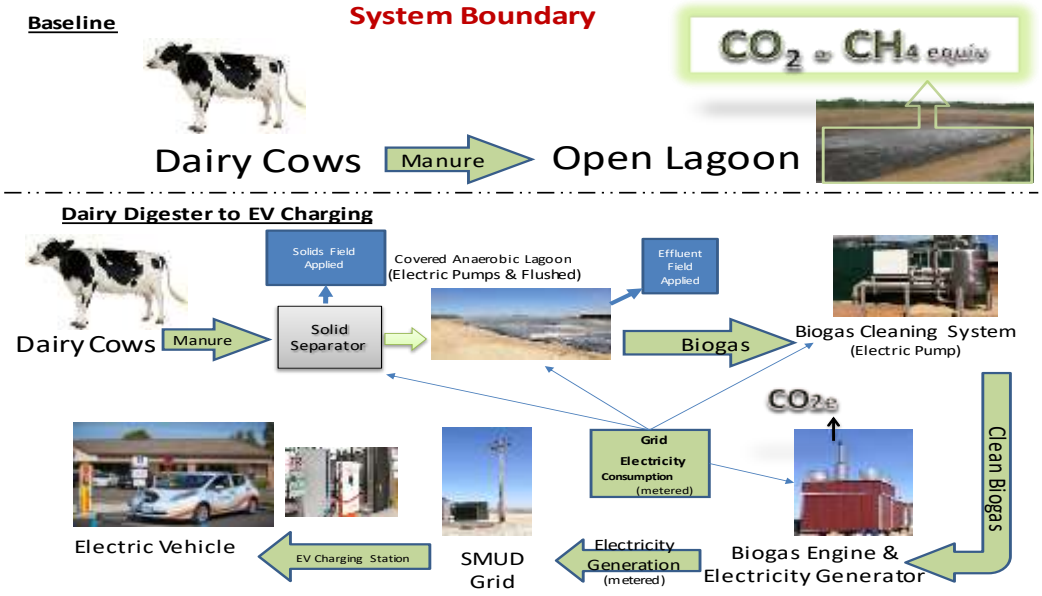

Figure 1: System Boundary Diagram for New Hope Dairy Digester to EV Pathway

1. Feedstock Phase (Biogas Production)

The feedstock for this LCFS pathway is biogas produced from anaerobic digestion of dairy manure or dairy waste using covered lagoon at New Hope dairy farm located at [redacted] (See Figure 1). New Hope dairy farm started in operation in 2005 which has currently [redacted] milking cows, [redacted] non-milking cows and [redacted] heifers. These are average number of cows from August 2019 to August 31, 2020 reporting period. The third-party owner/developer of New Hope dairy digester system is Generate Galt Digester, LLC/Maas Energy Works (MEW). Generate Galt Digester, LLC has a power purchase agreement with SMUD. Components of the feedstock as biogas production are described below that include covered lagoon digester and biogas clean-up (or upgrading system) for electricity generation.

Covered lagoon digester description: The covered lagoon digester at New Hope employs an earthen pond that was completed in 2019 by MEW. The pond is covered with a high-density polyethylene (HDPE) membrane to contain the biogas. The digester operates at ambient temperatures and is supplemented by waste heat recovered from the engine. The digester's flexible cover enables biogas storage, allowing the engine to run as operationally required.

Baseline:

The herd is housed in free stall barns with access to exercise pens. The manure collection rate is calculated in attached Supporting Document C (SD C). The manure collection rate is calculated after accounting for the amount of time the herd spends in the exercise pens. The dairy cows spend roughly four hours per day in the exercise pens during the five months out of the year that they can access the pens. Non-milking dairy cows and heifers have the same access to the exercise pens and spend an average of five hours per day in the pens. This system pumped recycled manure-water to the high end of a sloped feed lane causing the flush water to flow lengthwise along the lanes. At the low end of these lanes the manure-water was collected in an underground pipe and drained into a settling pond before passing into a series of open lagoon storage ponds before being land applied

No mechanical separation was used in the baseline and [redacted]% of the manure in the free stall barns is captured. In total, the baseline VS collection rate, after accounting for time in the exercise pens, is [redacted]% and [redacted]% for dairy cows and non-milking dairy cows/heifers respectively. The settling ponds were cleaned out annually by pumping down the liquid portion into an adjacent storage pond, which later would-be land applied. The solids where then removed, dried and then land applied. The storage lagoons were cleaned out every [redacted] years by pumping down all the liquid into another storage lagoon, which later would be land applied. The crust was scraped off the lagoon, passively dried and field applied. At no point is the entire system cleaned and for each cleanout the liquid portion of the manure is kept within the anaerobic system. So, no cleanouts have been modeled in the baseline which is consistent with the "Compliance Offset Protocol Livestock Projects" (LOP hereafter).

Project Case:

There is no change in how the barns are flushed or exercise pens are used. See attached document for VS collection rates (SD C). The manure now flows over a sand lane, then lifted to a vibrating slope screen separator which assumes a solid separation rate of [redacted]% (See Figure 1).

From the separator, the thin portion of manure-water flows into a digester. The total VS entering the digester is [redacted]% and [redacted]% for dairy cows and non-milking dairy/heifers respectively (see Figure 2 below for more details for manure flow). After remaining in the digester for some weeks, all digestate is gravity-fed to an effluent pond for use in crop irrigation. The separated solids are passively dried and then land applied. There are now no cleanouts of the storage system.

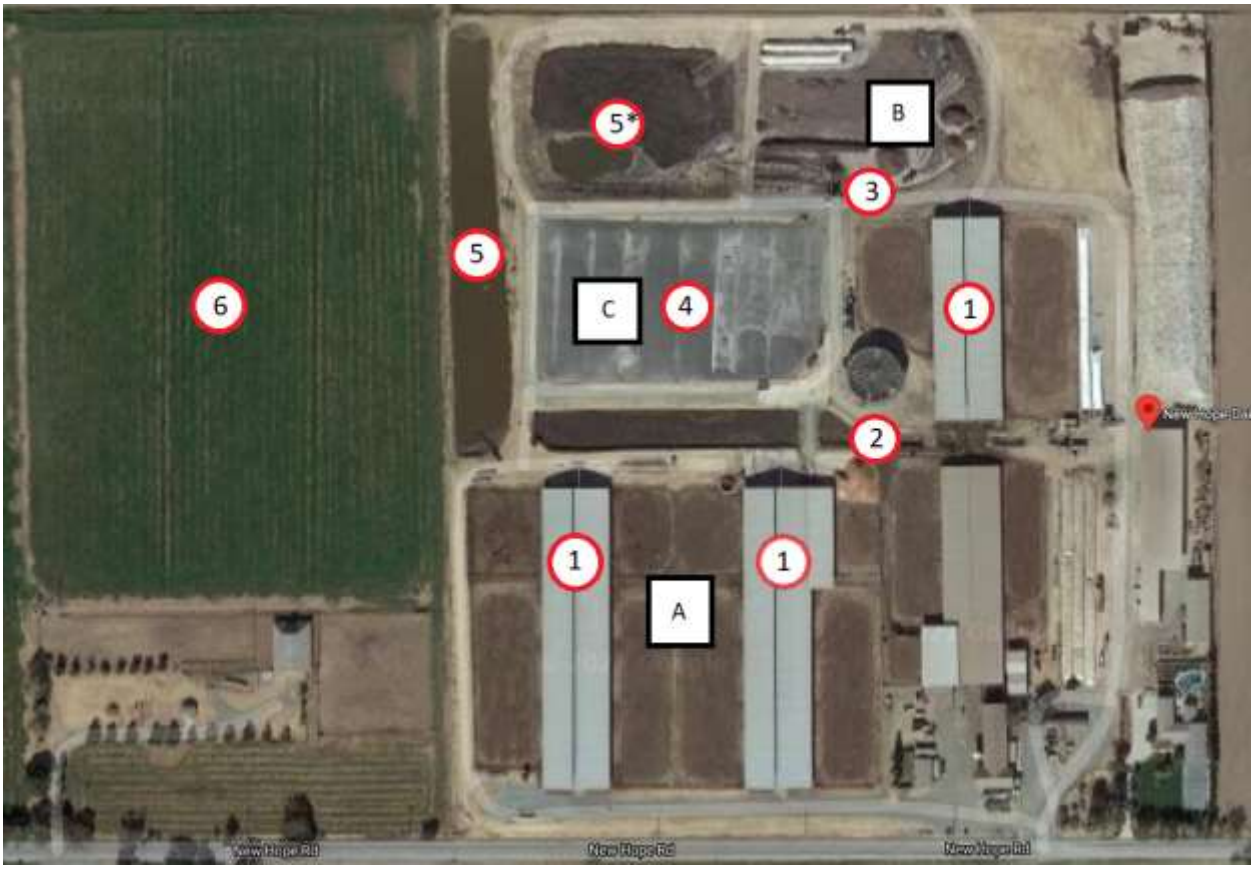

Figure 2. Aerial Image of the Dairy Farm and Covered Lagoon Digester

1. Free Stall Barns
2. Reception Pit/Sand Lane
3. Vibrating Screen Mechanical Solid Separator
4. Covered Lagoon Digester
5. Effluent Pond (5* Old storage pond/effluent pond from baseline)
6. Field for Land Application

A. Exercise pens/Dry Lot: [redacted]% VS from Dairy Cows; [redacted]% VS from non-milking cows/heifers
B. Mechanical Separation/Solid Storage: [redacted]%% VS from Dairy Cows; [redacted]%% VS from non-milking cows/heifers
C. Digester: [redacted]%% VS from Dairy Cows; [redacted]%% VS from non-milking cows/heifers

Biogas cleaning or treatment description: Biogas clean-up at New Hope dairy digester uses two systems to remove hydrogen sulfide (H_2S) from the biogas. First, a small amount of air is injected under the cover at multiple points. This very small injection of air, spread across the cover, induces naturally occurring bacteria to grow on the slurry surface and digester cover. The biogas is then routed through activated carbon media.

The total volumetric flow in standard cubic feet (SCF) of biogas combusted was recorded using a 15 min datalogger utilizing a [redacted] biogas flow meter installed in the biogas feed pipe upstream of the genset. The flow meter used for this application automatically adjusts for standard temperature and pressure, and calibrations on this unit are done once per quarter. The methane concentration was measured on a quarterly process in accordance with the LOP. MEW measured and recorded the biogas production data shown in the CI Calculator or GREET 3.0 Model.

2. Fuel Phase (Electricity)

The biogas is conveyed underground from the covered lagoon digester to fuel the engine generator system to generate electricity (as fuel for GREET 3.0 Model) and charge electric vehicles in SMUD Region, as described below.

Engine-Generator Description: The engine generator chosen for New Hope is a [redacted] engine running at [redacted] RPM producing [redacted] BHP with [redacted] kW electrical generator operating on biogas fuel with Selective Catalytic Reduction as nitrogen oxides (NOx) control technology including an oxidation catalyst capable of meeting the permit limitations. The power is delivered to SMUD's distribution feeder.

Heat Recovery Description: The genset utilizes a slurry heater to dissipate heat generated into the manure. With the digesters large volume, the lagoon can supply essentially unlimited cooling potential to the engine.

Grid Interconnection: The facility is directly connected to a SMUD's distribution feeder, which also serves the host dairy farm. Generate Galt LLC/MEW (registered as ABEC New Hope LLC (former owner) with WREGIS GU ID [redacted]) as the third-party owner of New Hope dairy digester system has a purchase agreement (PPA) with SMUD. PPA contract is attached (SD K) in this LCA Report (for additional details needed by CARB).

Process Configuration: Figure 1 shows the process configuration of New Hope dairy digester to produce electricity and charge electric vehicles pathway (see project case).

3. Data Sources and Pathway Inputs

Biogas Production

Summary results of biogas production or period of September 2019 to August 2020 (or period of 12 months) are shown in the metered raw data are shown in Supporting Document C with Methane (**CH_4**) content data.

The raw biogas and cleaned biogas are assumed as the same flow at total [redacted] **SCF** (with flow weighted average [redacted] **% CH_4** content) for September 2019 to August 2020 reporting period. Since hydrogen sulfide (H_2S) and other sulfur species that are being removed are so minimal. Thus, the total CH_4 production before and after upgrading is also [redacted] SCF for 12-month reporting period**.**

Then, the cleaned or conditioned biogas is conveyed underground to fuel the engine generator system with rated output of [redacted] kW.

Supporting Document C shows biogas production with methane concentration. These data and information can be found in relevant cells in the Biogas to RNG tab in cells 2.4 - 2.7.

Baseline Methane Emissions (without covered lagoon) for New Hope Dairy Farm

A fugitive methane emission or loss of 2 % is assumed, as indicated in GREET 3.0. This loss was taken into consideration in calculating the biogas input for conversion efficiency determination of the reciprocating engine.

Other LCFS Calculator Inputs for Baseline and Project

Milking cows spend one hour per day in the milking parlor and the rest of the time is spent in the Free Stall Barns with access to exercise pens. The herd has access to the exercise pens 5 months of the year for 10 hours per day. For milking cows in the baseline scenario (no mechanical separation) this yields a VS capture rate of [redacted]% compared to [redacted]% for all others. The remaining VS is not captured and left in the dry lot.

In the project scenario, the slope screen separator removes [redacted]% of VS based on Table A.9 on the Reference tab of the calculator as shown in Section L2 and L5. To allocate the VS disposition following mechanical separation (Section L4, the 15% collection rate is applied to the baseline VS collection rates for milking and non-milking cows as determined in L1 ([redacted]% * [redacted]% and [redacted]% * [redacted]%).

Conversion Efficiency of New Hope Dairy Digester Engine Genset

The conversion efficiency of New Hope Dairy Digester Engine Genset is calculated based on the 12-month metered data for electricity and biogas production, as shown below.

$$Engine\ Efficiency = \frac{kWh\ production\ x\ 3.6/1055.056}{Biogas\ Production\ x\ Lower\ Heating\ Value\ of\ Biogas}$$

The total electricity production for 12 months (September 2019 and August 2020) was [redacted] kWh (See Supporting Document F for electricity production). These data are recorded using MEW datalogger. SMUD meter recorded export electricity production and were invoiced to SMUD for revenue generation for the developer/owner or operator.

Using the total kWh production and the total biogas production with corresponding lower heating value of biogas as indicated in GREET 3.0 Reference Table, the resulting efficiency of New Hope Dairy Digester Engine Genset = [redacted]**%** (LHV) (or [redacted]% HHV). For the proposed pathway, the efficiency of [redacted]**%** is used as input in the GREET 3.0 model to calculate CI.

Supporting Documents F & J show the summary of utility statements for kWh production and process energy usage or electricity usage data. These data and information can be found in relevant cells in the Biogas to RNG tab in cells 2.4 - 2.26

Electricity Usage.

The electricity usage for all auxiliary (like pumps, lights, motors, thermal load, etc.) have a separate meter and were recorded at New Hope digester facility (Biogas to RNG tab cells 2.18). See Supporting Document J for receipts of electricity usage data. The parasitic load (Biogas to RNG tab in cells 2.17) is the difference between the gross onsite electricity generation and the export electricity.

4. Life Cycle Results for Carbon Intensity

The calculated Carbon Intensity for New Hope dairy digester system to charge electric vehicles = **-750.81 gCO_{2e}/MJ**, see table below.

[redacted]

5. Supporting Documents (SD)

SD A. Attestation Letter

SD B. Modified GREET 3.0 Model with CI Calculations

SD C. Biogas Production Metered Data and Methane Concentration. August 2019 to July 2020 (or period of 12 months), Manure collection rates and VS collection rates. CI Calculator for site biogas production.

SD D. Baseline Methane Data Documents , See SD B.

SD E. Air and Operating Permits, See ATC

SD F. Electricity Production Data/Utility Invoices/Electricity Bills. September 2019 to August 2020 (or period of 12 months).

SD G. GPS Map of the Project Location

SD H. Third Party Engineering Reports (if available)

SD I. Source Test & Emission Data from Reciprocating Engine (if available)

SD J. Receipts of Electricity Usage or Consumption

SD K. PPA & WREGIS Screen Shots

6. References

6.1 Anil Baral, Personal Communications on Greet 2 Model, Tier 2 Method 2 B (September 2020)
6.2 Low Carbon Fuel Standard Regulation and requirements https://www.arb.ca.gov/regact/2015/lcfs2015/lcfsfinalregorder.pdf
6.3 LCFS Guidance 19-06 https://ww2.arb.ca.gov/sites/default/files/classic//fuels/lcfs/guidance/lcfsguidance_19-06.pdf

7. Disclaimer

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