



**CALIFORNIA
ENERGY COMMISSION**



California Energy Commission
Clean Transportation Program

FINAL PROJECT REPORT

Aemetis Central Dairy Cluster Biogas Cluster Cleanup Project

Prepared for: California Energy Commission

Prepared by: Aemetis Biogas, LLC

November 2025 | CEC-600-2025-038

California Energy Commission

Jessica Cardoso

Primary Author

Aemetis Biogas LLC

20400 Stevens Creek Blvd, Suite 700

Cupertino, CA 95014

www.aemetis.com

Agreement Number: LCF-19-001

Pilar Magaña

Commission Agreement Manager

Charles Smith

Branch Manager

STRATEGY EQUITY AND ECONOMIC BENEFITS

Hannon Rasool

Director

FUELS AND TRANSPORTATION

Drew Bohan

Executive Director

DISCLAIMER

This report was prepared as the result of work sponsored by the California Energy Commission (CEC). It does not necessarily represent the views of the CEC, its employees, or the State of California. The CEC, the State of California, its employees, contractors, and subcontractors make no warrant, express or implied, and assume no legal liability for the information in this report; nor does any party represent that the use of this information will not infringe upon privately owned rights. This report has not been approved or disapproved by the CEC nor has the CEC passed upon the accuracy or adequacy of the information in this report

ACKNOWLEDGMENTS

This project would not have been possible without the funding and support provided by the California Energy Commission (CEC) and our Agreement Manager Pilar Magaña. In addition, we are grateful for the support we received from:

- AC Machado Dairy
- Ackerman Dairy
- Air Liquide
- Albert Mendes Dairy
- American Chiller
- Anahau Energy
- Campos EPC
- Biogas Engineering
- Building and Construction Trades Council
- California Assembly Member Adam Gray
- Double D Dairy
- Eco Engineers
- Hartman Engineering, Inc.
- Industrial Electrical
- K&R Blount Dairy
- Machado and Sons Construction
- Merced County Farm Bureau
- Momentum
- Opportunity Stanislaus
- Pacific Gas and Electric Company
- S&S Dairy
- Stanislaus County District Supervisor Vito Chiesa
- Stanislaus County Farm Bureau
- Strategic Mechanical
- Third-Eye Capital
- Toyota Tsusho America, Inc.
- Trinkler Dairy
- Vilter
- Wickstrom Jersey Farms

PREFACE

California's on-road transportation sector accounts for roughly 41 percent of the state's greenhouse gas (GHG) emissions, and when oil production and refining are included, it is nearly 50 percent. The Low-Carbon Fuel Production Program (LCFPP), funded by the Budget Act of 2018, as amended by Senate Bill 856 (Committee on Budget and Fiscal Review, Chapter 30, Statutes of 2018), provides grants to California's vehicle fuel production industry to reduce GHG emissions associated with transportation use and advances the purposes of Assembly Bill 32 (Pavley and Núñez, Chapter 488, Statutes of 2006) and Senate Bill 32 (Pavley, Chapter 249, Statutes of 2016).

The LCFPP is funded through the California Climate Investments which is administered by the California Air Resources Board and uses Cap-and-Trade funds to prioritize projects that will reduce GHG emissions, strengthens the local economy, and improves public health and environment, particularly in disadvantaged communities. The LCFPP focuses on commercial renewable fuel production with ultra-low-carbon potential of 30 gCO₂e/MJ or lower, production capacity greater than one million DGE and considers priority populations defined by SB 535 and AB 1550.

The CEC issued Solicitation GFO-19-601 "Low-Carbon Fuel Production Program" to expand low carbon fuel production capacity. In response to GFO-19-601, the recipient submitted an application that was proposed for funding in the CEC's Notice of Proposed Awards on January 21st, 2020, and the agreement was executed as LCF-19-004 on April 30th, 2020.

ABSTRACT

Aemetis Biogas, LLC (Recipient), in cooperation with a project team consisting of Robbie Macias, Aemetis Biogas, LLC, and Momentum, sought to build a biogas upgrading facility within the existing Aemetis Ethanol Plant.

This report provides an overview of the progress and impact of the biogas upgrading facility ("HUB") established by Aemetis Biogas, LLC in Keyes, CA. Designed to efficiently convert biogas from nearby dairies into renewable natural gas (RNG), the facility has achieved significant milestones since inception. Prior to the project completion, biogas from the first two operational dairies was used as process energy to produce Ethanol. The process energy is biogas that enters the boiler at the ethanol plant, where it is combusted to generate steam for the plant. Since then, Aemetis has established a standalone biogas production facility to produce pipeline quality RNG and at full build out the Aemetis Biogas Upgrading Facility is designed to process biogas from 50 dairies upon full operation. Currently the facility has already witnessed promising results. Provisional Pathways for seven (7) of the nine (9) dairies currently producing biogas have an average carbon intensity score of -351 gCO₂e/MJ the increase on the net carbon intensity is a result of additional process energy required to upgrade the biogas to renewable natural gas.

Critical to the success of the project, Aemetis Biogas, LLC has diligently executed feedstock agreements with over forty (44) local dairies to ensure a consistent supply of raw materials while establishing offtake agreements for the sale of RNG produced. The RNG, certified as carbon negative, serves as a sustainable transportation fuel, contributing significantly to reducing greenhouse gas emissions. Leveraging innovative technologies and strategic partnerships, including collaboration with the Trillium Transportation LLC, the project aligns with the objectives of the Low Carbon Fuel Production Program. Through its commitment to renewable fuel production and waste management, the biogas upgrading facility exemplifies a sustainable solution in advancing the biofuel industry while mitigating environmental impact.

Keywords: renewable natural gas, renewable fuel, biofuel, Ethanol Plant, Low Carbon Fuel Production Program

Please use the following citation for this report:

Cardoso, Jessica. 2025. Author(s) Last Name, First Name, subsequent author(s) are First Name Last Name. Year of Publication. Aemetis Central Dairy Cluster Biogas Cluster Cleanup Project. California Energy Commission. Publication Number: CEC-600-2025-038.

TABLE OF CONTENTS

Acknowledgments.....	i
Preface	ii
Abstract.....	iii
List of Figures	iv
List of Tables.....	v
Executive Summary	1
LCF-19-001: BCP Summary	2
Chapter 1: Introduction.....	5
1.1 LCF-19-001: Aemetis Biogas Upgrading Facility Summary	5
1.2 Project Overview.....	7
1.3 Project Goals	8
1.4 Ability to Meet Deadlines and Milestones.....	9
1.5 Project Objectives	12
Chapter 2: Project Context	13
2.1 Project Team	13
2.2 Business Plan: Marketing Plan	15
Chapter 3 Project Results	23
3.1 Operations	23
3.2 Biogas Upgrading Facility Operational Status Review.....	27
3.3 Total Greenhouse Gas Emissions	27
3.4 Economic Benefits.....	28
Chapter 4: Outreach and Education.....	31
4.1 Outreach	31
4.2 Project Location and Disadvantaged Communities	32
Chapter 5: Lessons Learned & Conclusions	36
5.1 Key Lessons	36
5.2 Conclusions.....	1
Glossary.....	2

LIST OF FIGURES

Figure 1: Aemetis Biogas Upgrading Facility	1
Figure 2: Top View of Aemetis Upgrading Facility	3
Figure 3: Aemetis Advanced Fuels Keyes Facility with Biogas Upgrading Facility Completed Under Overhang	4
Figure 4: Top View of Aemetis Facility	6

Figure 5: Aemetis Biogas Pipeline Connection to Aemetis Biogas Upgrading Facility.....	7
Figure 6: Process Flow Diagram for the Aemetis Cleanup Plant.....	8
Figure 7: Process Flow Diagram for Nutrient Cycle.....	8
Figure 8: Aemetis Biogas Upgrading Facility 14-Day Run Data	18
Figure 9: Aemetis Biogas Upgrading Facility Foundation.....	23
Figure 10: Aemetis Biogas Upgrading Facility Foundation	24
Figure 11: Aemetis Biogas Upgrading Facility under construction	24
Figure 12: Aemetis Setting Equipment.....	25
Figure 13: Equipment Overview	25
Figure 14: Overview of Aemetis Biogas Upgrading Facility	26
Figure 15: Dairy that transports biogas via pipeline to the Aemetis Biogas Upgrading Facility	27
Figure 16: Snapshot of CalEnviroScreen 3.0 Results for the AAFK Facility	33
Figure 17: Image of Priority Population Map for the AAFK Facility	33

LIST OF TABLES

Table 1 Goals and Objectives.....	9
Table 2 Aemetis Background	13
Table 3 Team Members.....	14
Table 4 Role of Partners and Customers	18
Table 5 Identified Needs	34

EXECUTIVE SUMMARY

Aemetis Biogas LLC (ABGL)—a wholly owned subsidiary of Aemetis, Inc.—sought \$4,183,000 from California. Energy Commission’s Low Carbon Fuel Production Program to support the construction of a new Biogas Cleanup Plant (BCP) at its Aemetis Advanced Fuels Keyes (AAFK) low-carbon fuel production facility in Keyes, California. The BCP’s purpose is to upgrade dairy biogas pipelined from more than 50 nearby anaerobic dairy digesters and convert it to renewable natural gas (RNG) for use as transportation fuel. By early to mid-2025, Aemetis anticipates the BCP will produce 1.0 million MMBTU/year of RNG with an estimated carbon intensity (CI) below -400 gCO₂e/MJ, displacing more than 6.8 million diesel gallon equivalents (DGE) every year. Importantly, the BCP is in an AB 1550 low-income community and an SB 535 disadvantaged community, suffering from poor air quality and high poverty and unemployment. The BCP has created ten permanent, full-time positions with competitive pay plus full benefits, as well as support over 150 temporary, full-time positions during project construction, installation, and commissioning. Ultimately, the BCP is serving as a key component in enabling the Aemetis Central Dairy Digester Cluster (ACDDC) to become a key driver of GHG and criteria pollutant emission reductions and economic activity throughout California’s Stanislaus and Merced Counties.

Figure 1: Aemetis Biogas Upgrading Facility



Source: Aemetis Biogas, LLC

This report solely focuses on the aspects of the project funded by the Recipient by Aemetis and the CEC through and the LCF-19-001 this grant agreement; it is referred to throughout the report as Aemetis Biogas Upgrading Facility. The Recipient received \$4,183,000 in funding through Agreement LCF-19-001 from the Energy Commission and matched that with \$7,804,780 in cost share, for a total project budget of \$11,987,780. Construction started in Q4 2021 and ended in Q3 2022. Commissioning of the equipment purchased was completed in Q4 2022.

LCF-19-001: BCP Summary

The Recipient, in cooperation with a project team consisting of Aemetis Biogas, LLC, and Momentum, sought to build a biogas cleanup plant at the existing Aemetis Ethanol Facility in the first phase of the project. The project team expanded upon the existing Facility to install new equipment that can produce RNG from dairy biogas from cow manure. When fully operational (50+ dairies), this new biogas cleanup facility will produce 7.2M DGE per year of carbon negative RNG. Carbon Intensity (CI) scores of -300 gCO₂e/MJ is the expected average on most dairies depending on their waste management. The current structure works for the nine (9) operational sites and additional personnel are expected to join the team in Q3'2024 as new sites come online. Additionally, it is important to note that the Biogas Operations team experienced less than three days of unscheduled downtime in all of 2023 and have experienced zero (0) unscheduled downtime in 2024. In fact, since the project initiated 24/7 operations in April 2023 we have had only 11 days of downtime, including scheduled downtime for GUS/PGE maintenance. We are very proud of the Operations Teams' success. The CI scores based on available data collection and confirmed by California Air Resource Board (CARB). This life-cycle carbon intensity (CI) analysis was performed to support a California LCFS Tier 2 pathway application for the compressed natural gas (CNG) produced by Aemetis Biogas, LLC at the Aemetis Biogas LLC renewable natural gas (RNG, or biomethane) facility (referred to as Aemetis Biogas hereafter). Currently we have seven pathways which cover the CNG produced from the biogas generated from digesters at seven different farms. Based on the life-cycle modeling using a modified Tier 1 Simplified CI Calculator for Biomethane from Anaerobic Digestion of Dairy and Swine Manure [1], and the operational data from November 2022 to September 2023, the CIs of the RNG for these pathways are:

- i. Ackerman Dairy -323.13 g CO₂e MJ-1
- ii. A C Machado (Ahlem) Dairy -366.91 g CO₂e MJ-1
- iii. Double D Dairy -369.02 g CO₂e MJ-1
- iv. Pinnacle (KR Blount) Dairy -368.06 g CO₂e MJ-1
- v. S&S Dairy -359.55 g CO₂e MJ-1
- vi. Trinkler Dairy -322.15 g CO₂e MJ-1
- vii. Albert Mendes Dairy -321.08 g CO₂e MJ-1

The Aemetis Biogas pathway meets all the requirements of a typical Tier 1 dairy manure biogas to RNG pathway, except that:

- Project biogas production is lower than baseline emissions
- The model needs to be revised to reflect correct weighted average CH₄% calculation

Aemetis Biogas produces pipeline quality RNG from biogas generated from anaerobic digestion using dairy manure as a feedstock and injects it into a natural gas pipeline. The injected

renewable natural gas is taken out in CA by downstream dispensing entities and used as a transportation fuel in the form of CNG via “book and claim accounting.”

Raw biogas from the digesters at each farm is piped to the Upgrading Facility in Keyes and upgraded to pipeline quality specifications. The upgraded biomethane is injected into the pipeline at the onsite injection point. Biogas produced/collected at local dairies is transmitted to the Aemetis Biogas upgrading facility through a network of private biogas gathering lines. Biogas entering the upgrading facility at 65 PSIG is increased to 215 PSIG with a biogas feed compressor. From the biogas feed compressor, the biogas is transmitted to an Air Liquide CO₂ Membrane Separation System, where the CO₂ and CH₄ are separated. CO₂ is vented to the atmosphere; the CH₄ (RNG) is transmitted to the product gas compressor, where the pressure is increased to 245 PSIG. RNG from the product gas compressor is measured and metered before being sent to the Pacific Gas and Electric (PGE) Company interconnection point. RNG injected into the PGE pipeline is distributed to Trillium and other dispensing stations in California.

Under USEPA’s RFS program, the Aemetis Biogas RNG facility can produce: Renewable Compressed Natural Gas (Fuel Category Code 190) and Renewable Liquified Natural Gas (Fuel Category Code 200) under a D code of 3 utilizing Biogas from agricultural digesters (Feedstock Code 333) using a Renewable CNG/LNG Production Process (Process Code 851)

By building the facility, the Biogas Upgrading Facility aligns directly with the Low Carbon Fuel Production Program’s funding initiatives and meets SB 1383 comprehensive strategy to reduce emissions of short-lived climate pollutants to achieve a reduction in methane by 40% below the 2013 by 2030.

Figure 2:Top View of Aemetis Upgrading Facility



Source: Aemetis Biogas, LLC

Figure 3: Aemetis Advanced Fuels Keyes Facility with Biogas Upgrading Facility Completed Under Overhang



Source: Aemetis Biogas, LLC

Chapter 1: Introduction

1.1 LCF-19-001: Aemetis Biogas Upgrading Facility Summary

The Recipient, in cooperation with a project team consisting of Aemetis Biogas, LLC, and Momentum, sought to build a biogas cleanup plant at the existing Aemetis Ethanol Facility in the first phase of the project. The project team expanded upon the existing Facility to install new equipment that can produce RNG from dairy biogas from cow manure. When fully operational (50+ dairies), this new biogas cleanup facility will produce 7.2M DGE per year of carbon negative RNG. Carbon Intensity (CI) scores of -300 gCO₂e/MJ is the expected average on most dairies depending on their waste management. The current structure works for the nine (9) operational sites and additional personnel are expected to join the team in Q3'2024 as new sites come online.

Additionally, it is important to note that the Biogas Operations team experienced less than three days of unscheduled downtime in all of 2023 and have experienced zero (0) unscheduled downtime in 2024. In fact, since the project initiated 24/7 operations in April 2023 we have had only 11 days of downtime, including scheduled downtime for GUS/PGE maintenance. We are very proud of the Operations Teams' success. The CI scores based on available data collection and confirmed by California Air Resource Board (CARB). This life-cycle carbon intensity (CI) analysis was performed to support a California LCFS Tier 2 pathway application for the compressed natural gas (CNG) produced by Aemetis Biogas, LLC at the Aemetis Biogas LLC renewable natural gas (RNG, or biomethane) facility (referred to as Aemetis Biogas hereafter). Currently we have seven pathways which cover the CNG produced from the biogas generated from digesters at seven different farms. Based on the life-cycle modeling using a modified Tier 1 Simplified CI Calculator for Biomethane from Anaerobic Digestion of Dairy and Swine Manure [1], and the operational data from November 2022 to September 2023, the CIs of the RNG for these pathways are:

- i. Ackerman Dairy -323.13 g CO₂e MJ-1
- ii. A C Machado (Ahlem) Dairy -366.91 g CO₂e MJ-1
- iii. Double D Dairy -369.02 g CO₂e MJ-1
- iv. Pinnacle (KR Blount) Dairy -368.06 g CO₂e MJ-1
- v. S&S Dairy -359.55 g CO₂e MJ-1
- vi. Trinkler Dairy -322.15 g CO₂e MJ-1
- vii. Albert Mendes Dairy -321.08 g CO₂e MJ-1

The Aemetis Biogas pathway meets all the requirements of a typical Tier 1 dairy manure biogas to RNG pathway, except that:

- Project biogas production is lower than baseline emissions

- The model needs to be revised to reflect correct weighted average CH₄% calculation

Aemetis Biogas produces pipeline quality RNG from biogas generated from anaerobic digestion using dairy manure as a feedstock and injects it into a natural gas pipeline. The injected renewable natural gas is taken out in CA by downstream dispensing entities and used as a transportation fuel in the form of CNG via “Book and Claim Accounting.”

Raw biogas from the digesters at each farm is piped to the Upgrading Facility in Keyes and upgraded to pipeline quality specifications. The upgraded biomethane is injected into the pipeline at the onsite injection point. Biogas produced/collected at local dairies is transmitted to the Aemetis Biogas upgrading facility through a network of private biogas gathering lines. Biogas entering the upgrading facility at 65 PSIG is increased to 215 PSIG with a biogas feed compressor. From the biogas feed compressor, the biogas is transmitted to an Air Liquide CO₂ Membrane Separation System, where the CO₂ and CH₄ are separated. CO₂ is vented to the atmosphere; the CH₄ (RNG) is transmitted to the product gas compressor, where the pressure is increased to 245 PSIG. RNG from the product gas compressor is measured and metered before being sent to the Pacific Gas and Electric (PGE) Company interconnection point. RNG injected into the PGE pipeline is distributed to Trillium and other dispensing stations in California.

Under USEPA’s RFS program, the Aemetis Biogas RNG facility can produce: Renewable Compressed Natural Gas (Fuel Category Code 190) and Renewable Liquified Natural Gas (Fuel Category Code 200) under a D code of 3 utilizing Biogas from agricultural digesters (Feedstock Code 333) using a Renewable CNG/LNG Production Process (Process Code 851)

By building the facility, the Biogas Upgrading Facility aligns directly with the Low Carbon Fuel Production Program’s funding initiatives and meets SB 1383 comprehensive strategy to reduce emissions of short-lived climate pollutants to achieve a reduction in methane by 40% below the 2013 by 2030.

Figure 4: Top View of Aemetis Facility

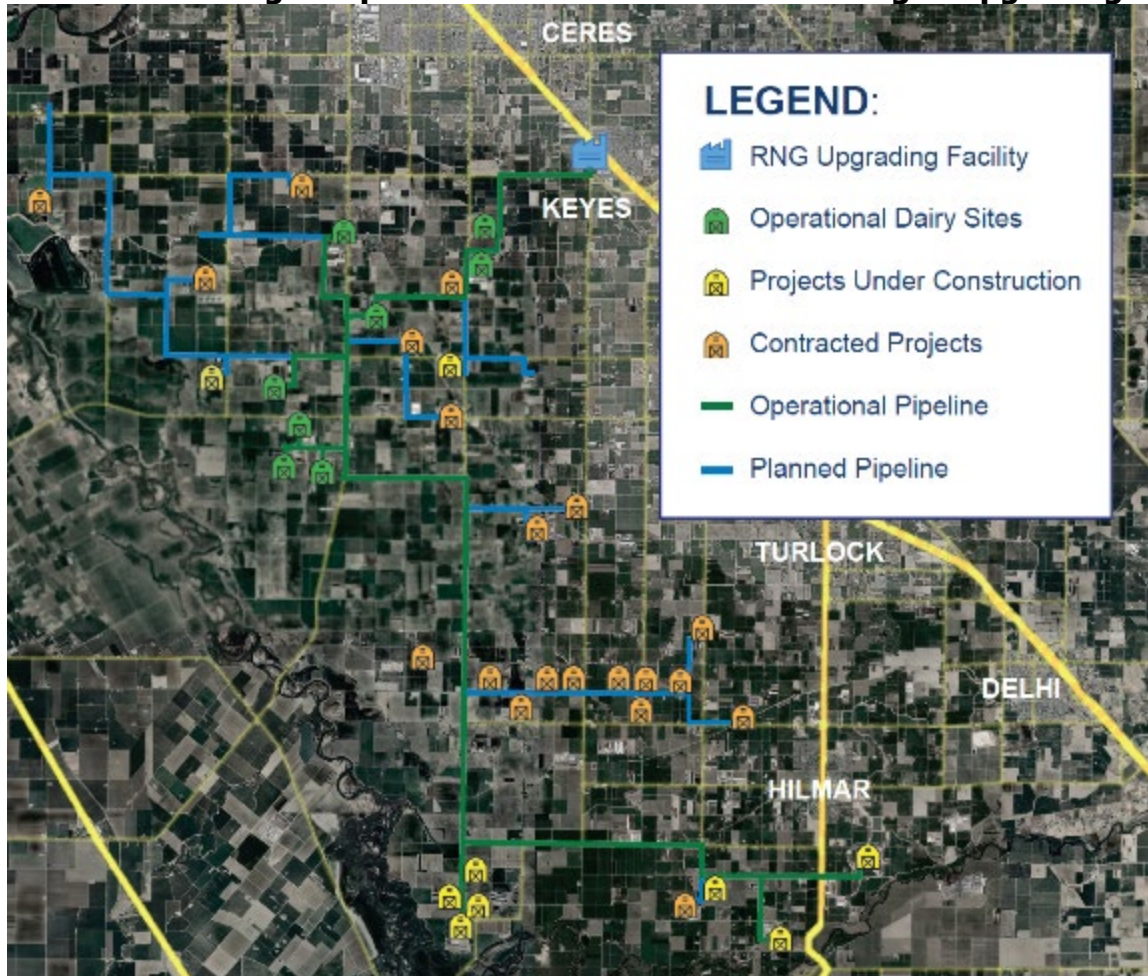


Source: Aemetis Biogas, LLC

1.2 PROJECT OVERVIEW

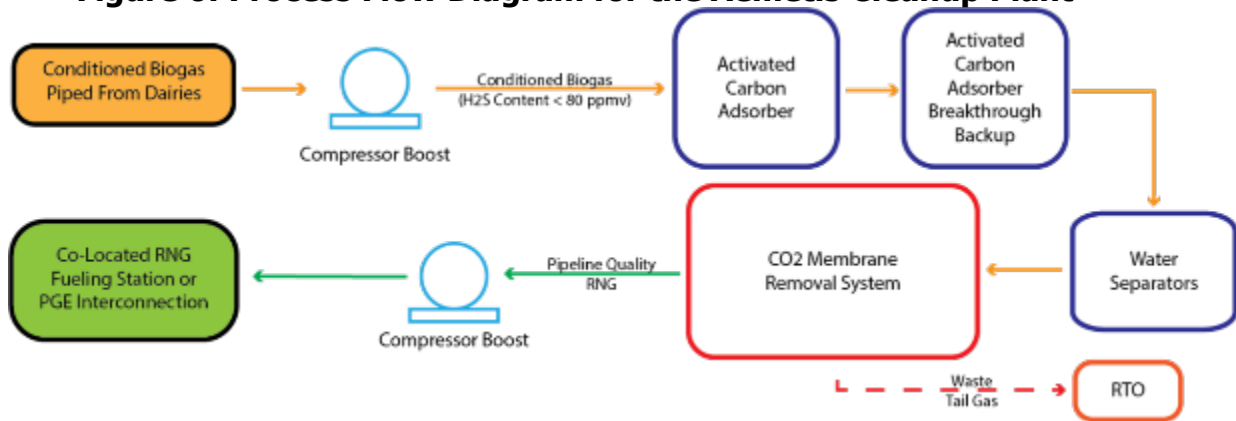
The Recipient, in cooperation with a project team consisting of Aemetis Biogas, LLC, and Momentum, sought to build the Aemetis Biogas Upgrading Facility located at 4209 Jessup Road, Ceres CA 95307. The Aemetis Biogas Upgrading Facility is considered in the city of Ceres at the existing Keyes Ethanol facility.

Figure 5: Aemetis Biogas Pipeline Connection to Aemetis Biogas Upgrading Facility



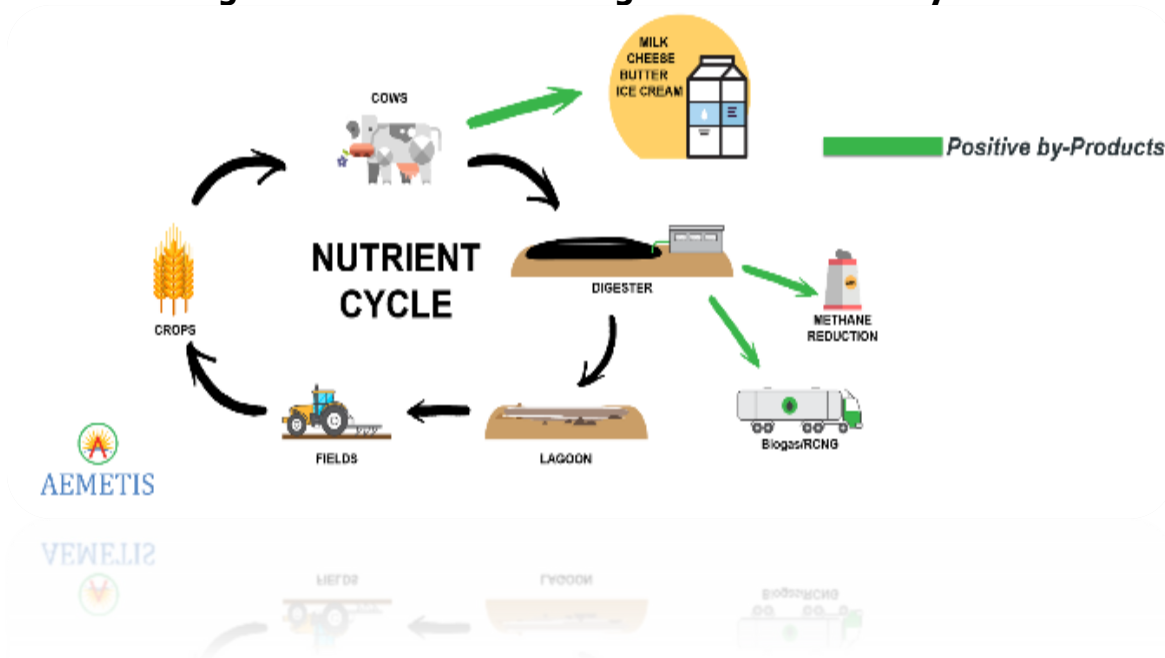
Source: Google Maps

Figure 6: Process Flow Diagram for the Aemetis Cleanup Plant



Source: Aemetis Biogas, LLC

Figure 7: Process Flow Diagram for Nutrient Cycle



Source: Aemetis Biogas, LLC

1.3 Project Goals

At full capacity, Aemetis anticipates that the Aemetis Biogas Upgrading facility will produce over 1.0 million MMBTU/year of RNG with an estimated carbon intensity (CI) below -400 grams of carbon-dioxide equivalents per megajoule of RNG (gCO₂e/MJ) on most project sites. This CI is approximately 530 percent below the California Air Resources Board (ARB) Low Carbon Fuel Standard (LCFS) 2020 reference benchmark of 92.92 gCO₂e/MJ for diesel and 91.98 gCO₂e/MJ for gasoline.

Since commencing operations on October 25th, 2022, the Aemetis Biogas Upgrading Facility has processed 340,057 MMBTU of biogas to date. As we continue to bring more dairies online and

increase biogas processing, we are progressing towards our target of 1.0 million MMBTU per year. However, reaching this goal will take additional time and effort. 340,057 MMBTU is approximately 2,647,591 diesel gallon equivalents (DGE).

1.4 Ability to Meet Deadlines and Milestones

The project team demonstrated experience in meeting project deadlines and achieving critical milestones, both on past and current privately funded ultra-low-carbon fuels projects and on those funded through a combination of public and private funds.

Table 4: Goals and Objectives

Goal (G) or Objective (O)	Suitability Discussion	Achievement
(G) Strengthen the economic viability and competitiveness of California's ultra-low-carbon fuels marketplace	The technologies and their innovative arrangement to treat conditioned dairy biogas from anaerobic digesters provide the opportunity to begin producing large quantities of negative-CI RNG for direct, on-site injection into the state's natural gas pipeline infrastructure or sale to local CNG fleets—reducing fuel production costs and enabling greater distribution of ultra-low-carbon fuels throughout California.	Dairy biogas from anaerobic digesters have successfully begun producing large quantities of negative CI RNG. This RNG is now being directly injected into the PG&E's pipeline and being sold to local CNG fleets. As a result, fuel production costs have been reduced, and the distribution of ultra-low carbon fuels throughout California has increased.
(G) Advance the emissions reduction goals of AB 32 and SB 32	This project targets emissions reductions in both agriculture and transportation, two of California's largest emissions sources. The project will capture emissions generated by manure from 66,000 cows at 30+ dairies, which will be converted to ultra-low-carbon RNG for use as carbon-negative transportation fuel. Aemetis had 30 dairies committed to the ACDDC by Q4 2022 and 50 dairies by 2025.	So far, Aemetis has captured emissions from 15,490 cows at nine (9) dairies.
(G) Expand the availability of ultra-low-carbon fuels in California	The project will produce over 1 million MMBTU per year of ultra-low-carbon RNG, equivalent to 6.88 million gallons of diesel. The RNG will be made available to fleets via an on-site fueling station as well as	NA

	via the State's natural gas pipeline infrastructure.	
(G) Reduce air pollution.	The project will significantly reduce emissions at dairies and from tailpipes of vehicles utilizing the produced ultra-low-carbon RNG. This will result in lifecycle emissions reductions of CO, CO ₂ , H ₂ S, NOX, SOX, DPM, PM ₁₀ , PM _{2.5} , reactive organic gases, and greenhouse gases, among many other air pollutants that significantly impact health and the environment.	The project has significantly reduced emissions at the current nine (9) local operating digester dairies. This has resulted in lifecycle emissions reductions of CO, CO ₂ , H ₂ S, NOX, SOX, DPM, PM ₁₀ , PM _{2.5} , reactive organic gases, and greenhouse gases, among many other air pollutants that significantly impact health and the environment.
(G) Support the transition away from diesel and fossil fuels	Existing market mechanisms, including the LCFS and RFS2, enables Aemetis to utilize the proposed technologies to generate some of the lowest-CI fuels in the world for sale at highly competitive prices. This ability to compete exceptionally well with traditional fossil fuels will support the transition away from diesel and fossil fuels for committed fleet offtake partners.	i. Ackerman Dairy -323.13 g CO₂e MJ-1 ii. A C Machado (Ahlem) Dairy -366.91 g CO₂e MJ-1 iii. Double D Dairy -369.02 g CO₂e MJ-1 iv. Pinnacle (KR Blount) Dairy -368.06 g CO₂e MJ-1 v. S&S Dairy -359.55 g CO₂e MJ-1 vi. Trinkler Dairy -322.15 g CO₂e MJ-1 vii. Albert Mendes Dairy -321.08 g CO₂e MJ-1
(G) Benefit local Priority Populations	The Aemetis Biogas Upgrading Facility Project is located within an AB 1550 and SB 535 populations. All local emissions reductions will generate benefits to the local Priority Populations through reduced GHG emissions. Additionally, the project will include targeted community engagement, the development/administration of a scholarship program for local Priority Populations to pursue STEM fields and trades with relevance to clean energy, transportation, and manufacturing.	All local emissions reductions generated from the nine (9) current operating dairies has benefited the local Priority Populations through reduced GHG emissions.

(O) Receive 7.2 million scf per day of dairy biogas	The technologies are modular in nature. Thus, the facility was constructed with future scalability in mind. This strategy will enable the facility to be scaled up without modifying the upstream infrastructure or inlet valves.	The facility was constructed with future scalability in mind. It enabled the facility to be scaled up without modifying the upstream infrastructure or inlet valves.
(O) Achieve annual production of 1.0 million MMBTU, approximately 6.88 million diesel gallon equivalents (DGE))	The technologies are commercially deployed and can perform their intended function of producing high-purity RNG from various waste gas feedstocks. In the immediate project, Aemetis will leverage the diverse experience of its project partners to guarantee that the system is properly commissioned to achieve all fuel production targets. The expanding list of committed dairy partners will ensure there is sufficient feedstock to achieve these fuel production targets.	Currently have 45 dairies committed to the Aemetis Biogas Upgrading Facility Project to help achieve annual fuel production targets. So far, 340,057 million MMBTU of production since October 25th, 2022, the official commencing operational date.
(O) Demonstrate RNG with CI as low as -415 gCO ₂ e/MJ	Existing dairy biogas to RNG projects have achieved CI scores as low as -350 gCO ₂ e/MJ on projects that compress, condition, and transport the gas via on-road trucks. In contrast, Aemetis believes that by selling the RNG onsite or injecting it into the nearby PG&E pipeline, it will be able to achieve a similar or better Pathway CI. Provisional pathway applications for seven (7) dairies were submitted to CARB in May 2023 with an average CI score of -352. Subsequent dairy provisional pathway applications are expected to be as low, or lower.	i. Ackerman Dairy -323.13 g CO₂e MJ-1 ii. A C Machado (Ahlem) Dairy -366.91 g CO₂e MJ-1 iii. Double D Dairy -369.02 g CO₂e MJ-1 iv. Pinnacle (KR Blount) Dairy -368.06 g CO₂e MJ-1 v. S&S Dairy -359.55 g CO₂e MJ-1 vi. Trinkler Dairy -322.15 g CO₂e MJ-1 vii. Albert Mendes Dairy -321.08 g CO₂e MJ-1
(O) Reduce GHG emissions by more than 2.6 million MTCO ₂ e/year	Aemetis calculated the emission reduction number using the LCFPP Benefits Calculator Tool. With a high uptime guarantee, the project will achieve its fuel production goals to ensure the emissions reductions	340,057 MMBTU of RNG with a carbon intensity of -400 gCO ₂ e/MJ would correspond to approximately -143,523 metric tons of CO ₂ equivalent. This negative value indicates a net reduction in CO ₂ emissions due to the

	of the project and the resultant negative-CI RNG.	use of RNG compared to conventional fuels.
--	---	--

Source: Aemetis Biogas, LLC

1.5 Project Objectives

By building a new RNG production system that converts high-polluting dairy manure effluent into biogas and, ultimately, ultra-low-carbon RNG, the project aligns directly with the Clean Transportation Program's (CTP) major funding initiatives, including AB 32, SB 32, SB 535, AB 1550, and California's 2017 Climate Change Scoping Plan.

The Aemetis Biogas Upgrading Facility has created over ten permanent, full-time positions with an average annual salary of \$55,000 plus full benefits, as well as support approximately 150+ temporary, full-time positions during project construction, installation, and commissioning—all in an area suffering from extremely high unemployment (98th percentile) and poverty (83rd percentile). Other benefits to residents in the nearby low-income and disadvantaged communities include preferential hiring, significant reductions in emissions of toxic air contaminants, provision of RNG to Monterey Park Tract—one of the state's most severely impacted disadvantaged communities—and a new annual scholarship program that will provide \$50,000 to local students from those communities studying STEM fields or trade crafts with direct application in renewable energy, waste management, sustainable agriculture, or clean transportation.

The primary objective of this agreement was successfully established through the construction and commissioning of the Aemetis Biogas Upgrading Facility. The pictures below show before and after pictures of the facility, which was built as a standalone processing facility at Aemetis' existing ethanol production facility in Keyes.

Chapter 2: Project Context

2.1 Project Team

Aemetis Biogas, LLC

The project team’s qualifications—including relevant expertise, experience, and skill sets were able to enable the successful execution of the Aemetis Central Dairy Digester Cluster Biogas Cleanup Project.

Table 5: Aemetis Background

Project	Annual Outputs	Location	Milestones
Aemetis Advanced Fuels Keyes	68.5M Gallons Ethanol. 400,000 tons of Distiller’s Grain; 1.8M lbs. Distiller’s Corn Oil; and, Condensed Distiller’s Solids.	Keyes, CA	Upgraded and operational in 2011 Expanded in 2018
Aemetis Kakinada Integrated Chemical and Fuels Facility	50MM Gallons Biodiesel. Glycerin; and Edible Oils.	Kakinada, India	Operational in 2008 Expanded in 2018, 2019

Source: Aemetis Biogas, LLC

Project Team Members

The project team members’ qualifications, skills, abilities, and relevant technical and business experience aligned with the needs of the project and its successful completion. For the past several years, Aemetis, the Applicant and project lead, has focused on rapidly deploying advanced renewable fuel production technologies utilizing waste feedstocks, with the goal of producing ultra-low-carbon-intensity transportation fuels at commercial scale. SCS Energy is a national leader in the design, engineering, procurement, construction, and operation of landfill and digester gas-to-energy facilities, with more than 78 projects completed or currently underway. SCS Energy provided engineering and construction support and pipeline interconnection services leveraging their many collective decades of experience. Air Liquide provided design, manufacturing, and installation oversight services for its industry leading Biogaz™ and Air Liquide Digester RemovAL™ Systems. Momentum provided support on project management, reporting, and securing additional funds to continue reducing the CI of the produced RNG. Velocity 7 developed a new annual scholarship program that will, over the next three years, provide \$50,000 to local students from those communities studying STEM fields or trades with direct application in clean energy, waste management, or clean transportation.

Aemetis Biogas LLC

Collectively, the Aemetis team has 200+ years and nearly \$3 billion of project execution experience. The team has completed numerous large projects, including a recent \$10-million renovation of its ethanol production systems, a \$5-million liquid CO₂ project with Linde Gas (now Messer), the construction of a \$25-million biodiesel facility, and a \$5-million waste-to-ethanol

facility. Importantly, Aemetis and its project team has designed, constructed, and/or operated more industrial low-carbon fuel production projects than any other development team—from 30+ Central Valley dairy digesters to the state’s largest ethanol production facility. No other project team has a similar track record or is as well capitalized. Aemetis also has an exceptional track record of safe operations, a history of environmental compliance, and long-term, 20-year commitments with its upgraded dairy biogas feedstock providers. Key personnel include:

Table 6: Team Members

Name	Title	Project Role	Key Qualifications
Eric McAfee	Founder, Chairman	Oversight, QA/QC	Key Business and Finance Experience
Andy Foster	EVP and COO	Lead Administrator	Operations Management Experience
Todd Waltz	EVP and CFO	Accounting	Business and Finance Experience
Jyothi Tammineni	Director, Accounting	Accounting	Finance and Reporting Experience
Robbie Macias	Biogas Project Manager	Project Manager	Business and Operations Management Experience
Lynzee Corvelo	Controller	Accounting	Finance and Reporting Experience
Roy Dowd	Operations Manager	Operations	Chemical/Process and Operations Management Experience
Juan Linarez	E & M Manager	Project Manager	Chemical/Process Engineering and Design Experience
Goutham Vemuri	VP, Development	Project Support	Biological Engineering and Scale-up Experience

Source: Aemetis Biogas, LLC

SCS Energy

Founded in 2001, SCS Energy, a division of SCS Engineers, performs landfill gas-to-energy (LFGE) and digester gas-to-energy (DGE) projects as a design, design/construct, or operation/maintenance services contractor. SCS has designed, constructed, and operated more LFGE and DGE facilities than any other engineering firm in the United States. Jeffrey L. Pierce, P.E. serves as Senior VP at SCS Energy. On the project, he performed project development, design, and engineering activities.

Air Liquide

Air Liquide is the worldwide leader in the supply and manufacturing of large biogas upgrading systems. To date, Air Liquide has provided 50+ similar systems in the USA and over 80 worldwide, some of which have been in operation for more than 10 years. Air Liquide’s largest system to date is 12,000 scf per minute (scfm). The company has deployed numerous systems of a scope and scale like the proposed project. Joseph P. Bushinsky serves as the Senior Director of Sales and Marketing at Air Liquide. On the project, he performed system design consultation, procurement, and construction oversight.

Momentum

Momentum inspires, manages, and executes campaigns for forward-thinking organizations around the globe. Its clients are the visionaries working to research, develop, and commercialize advanced energy, water, transportation, and manufacturing technologies. Since 2005, the company's team members have helped approximately 300 high-profile public and private clients plan, develop, and finance more than \$4 billion in transformative advanced technology projects. Momentum staff helped manage publicly funded projects with a total value of approximately \$200 million.

Velocity 7

Velocity 7 is a non-profit that supports residents and businesses from low-income and disadvantaged communities in more fully participating in the growing green energy economy and sustainable transportation ecosystem. Janet Cohen serves as the Executive Director for Velocity 7. Janet is an experienced non-profit director with many years running and advising environmental non-profits.

Eco Engineers

Eco Engineers is a leading renewable energy consulting firm working to build a clean energy economy. It is focused on low-carbon fuels—such as biodiesel, ethanol, biogas, renewable electricity—and advanced fuels that include renewable biodiesel, RNG, and cellulosic ethanol, as well as low-carbon fuels produced from municipal solid waste, pyrolysis oil, and other cellulosic feedstocks. Eco Engineers is a CARB-approved and accredited 3rd-party verifier within the Low Carbon Fuel Standard.

2.2 Business Plan: Marketing Plan

Markets

According to the US Energy Information Administration, California is the second-largest consumer of natural gas in the nation (2.14 trillion cubic feet in 2018).¹ However, in-state production of ultra-low- and negative-carbon natural gas remains quite low; some 90% of the state's demand for natural gas is satisfied by out-of-state imports.² The proposed ultra-low-carbon RNG production project is designed to maximize the fuel's ability to compete in various transportation fuel markets throughout California, while providing benefits to diverse populations as the market for low-carbon fuels continues to grow. To meet this demand, RNG produced by the Aemetis Biogas Upgrading Facility. will be preferentially routed to the on-site RNG refueling station for local sale to trucking fleets utilizing RNG, with the remainder injected into PG&E's transmission and distribution pipeline for sale to fleets throughout California. Additionally, this ultra-low-carbon RNG can be utilized as feedstock for hydrogen fuel cell vehicles such as with the off-take agreements in progress with Toyota and Messer. This diversity of sale and distribution channels will enable the produced RNG to be competitively and cost-effectively dispensed throughout the state.

Chief among potential markets is the growing demand for natural gas as a transportation fuel, which has recently expanded due to the inclusion of natural gas engines in the California Air Resources Board's (CARB) Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project (HVIP) program. Recent advances in Low NO_x engine technologies and their inclusion in the HVIP program have created a strong

¹ U.S. Energy Information Administration (EIA). "Frequently Asked Questions". Accessed online on 11/19/19 at: <https://www.eia.gov/tools/faqs/faq.php?id=46&t=8>.

² U.S. Energy Information Administration (EIA). "California State Profile and Energy Estimates". Accessed online on 11/19/19 at: <https://www.eia.gov/state/analysis.php?sid=CA>.

demand for natural gas as a transportation fuel in California. To date, 1,115 Low NO_x trucks and buses fueled by natural gas have received funding through the HVIP program, and another 2,052 are currently on the waitlist for funding, signaling a strong continuing demand for natural gas and RNG.³ Indeed, CARB has deemed the success of the HVIP program’s Low NO_x Vouchers to be so significant that they have removed most Low NO_x natural gas engines from voucher eligibility due to their ability to commercially compete directly with traditional diesel engines. The remaining 11.9L Low NO_x natural gas engines eligible for voucher funding will require using in-state produced RNG, which will further drive market demand for Aemetis’ ultra-low-carbon RNG.

While there is some debate over the future of the CARB Truck and Bus Regulation and its potential impact on emissions reductions, Low NO_x natural gas engines are not expected to be phased out of compliance for at least the coming decade. This is largely due to their ability to achieve significant emissions reductions over their diesel engine equivalents. The comparatively high cost of zero-emission vehicles and their nascent refueling or recharging infrastructure, particularly in longer haul operations and disadvantaged communities, will continue to demonstrate that Low NO_x trucks fueled with ultra-low-carbon RNG are the most cost-effective means of significantly reducing lifecycle transportation emissions for the immediate future, and in advance of the 2023 and 2031 National Ambient Air Quality Standards targets. Accordingly, the Aemetis Project’s ability to produce 6.88 million DGE of negative-CI RNG annually will play an important role in shaping the future of California’s transportation industry, while achieving significant lifecycle emissions reductions to support the state’s environmental goals and those of the Intergovernmental Panel on Climate Change (IPCC).

Relevance

Aemetis has built upon lessons learned in the successful execution of previous and existing contracts with the Energy Commission—one of which was successfully completed in 2018 and now has seven (7) operating total so far. The first four pathway applications were Double D Dairy, Ackerman Dairy, AC Machado Dairy, and Pinnacle Dairy. Their operational data from November 2022 to January 2023 was recorded and submitted to obtain the Carbon Intensity scores of the Compressed Natural Gas for the pathways. The scores are shown below in Table 7.

Table 7: 2022-2023 Carbon Intensity Scores		
Dairy Name	CI Score	Data Period
DD	413.85 g CO ₂ e MJ	November 2022 – January 2023
Ackerman	415.88 g CO ₂ e MJ	November 2022 – January 2023
AC Machado	411.30 g CO ₂ e MJ	November 2022 – January 2023
Pinnacle	415.38 g CO ₂ e MJ	November 2022 – January 2023

Source: Aemetis Biogas, LLC

From these 4 initial dairies, we have produced pipeline quality Renewable Natural Gas from biogas generated from anaerobic digestion using dairy manure as a feedstock. Since then,

³ CALSTART. “Deployed Vehicle Mapping Tool”. Accessed online on 11/19/2019 at: <https://www.californiahvip.org/tools-results/#program-numbers>.

another three projects have gone online, and their carbon intensity scores are shown below in Table 8.

Table 8: 2023-2024 Carbon Intensity Scores

Dairy Name	CI Score	Data Period
S&S Dairy	359.55 g CO ₂ e MJ	January 2023-February 2024
Trinkler Dairy	322.15 g CO ₂ e MJ	January 2023-February 2024
Albert Mendes Dairy	321.08 g CO ₂ e MJ	January 2023-February 2024

Source: Aemetis Biogas, LLC

Wickstrom was commissioned the in March 2024 and the temporary pathway application is currently in progress. Additionally Alamo Dairy was commissioned in April 2024 and the temporary pathway application is currently in progress. These are our 8th and 9th dairies that are processing biogas and in que to obtain a CI Score. Our latest gas production summary for the month of April 2024 is seen below in Table 9.

Table 9: Production Summary May 2024

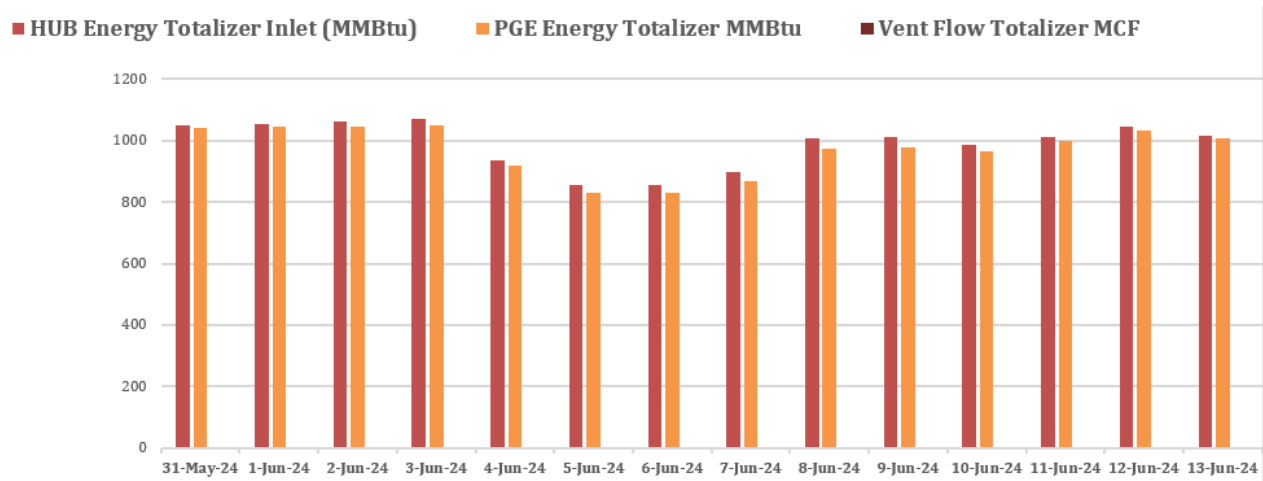
Gas Day	Ackerman Production	Ahlem Production	Blount Production	Double D Production	S&S Production
5/1/2024	112.59	103.07	74.33	170.50	74.25
5/2/2024	116.23	100.51	69.76	152.67	77.62
5/3/2024	105.19	96.91	62.84	138.48	77.47
5/4/2024	101.80	105.00	67.16	149.47	80.37
5/5/2024	58.59	107.87	73.81	103.92	44.97
5/6/2024	129.10	101.57	70.70	162.66	0.39
5/7/2024	96.70	102.85	70.50	125.63	86.03
5/8/2024	119.67	105.52	70.34	159.54	91.44

Source: Aemetis Biogas, LLC

Another seven projects of are undergoing construction and on schedule to be completed end of 2023 up until mid-2024. Once these projects are completed, they will follow the same process of recording operational data for a year and generating a carbon intensity score. We plan to

continue building projects until our max capacity is reached, which is estimated at 50 dairies at the Aemetis Biogas Upgrading facility. See details below in Figure 8.

Figure 8: Aemetis Biogas Upgrading Facility 14-Day Run Data



Source: Aemetis Biogas, LLC

Role of Dairy Partners

Our current project partners and project supporters that will help ensure the continued success of the project and the large-scale utilization of the produced ultra-low-carbon RNG. All the dairies listed below in Table 10 are in queue for construction and have committed to getting this project completed. The dairies will all get their biogas transported to the main upgrading facility where their gas will get scrubbed to inject into PG&Es interconnection.

Table 10: Role of Partners and Customers

Dairy	Role	Means of Ensuring Project Success
Joe O. Rocha Dairy	Feedstock Provider	Local dairy biogas feedstock partner with 2,700 head of cattle
Ackerman Dairy	Feedstock Provider	Local dairy biogas feedstock partner with 2,700 head of cattle
Ahlem Farms Jerseys	Feedstock Provider	Local dairy biogas feedstock partner with 3,350 head of cattle
AJ Borba Farms	Feedstock Provider	Local dairy biogas feedstock partner with 3,900 head of cattle
Alamo Dairy Farms	Feedstock Provider	Local dairy biogas feedstock partner with 2,600 head of cattle
Albert Mendes Dairy	Feedstock Provider	Local dairy biogas feedstock partner with 2,225 head of cattle
Borba Dairy Farms	Feedstock Provider	Local dairy biogas feedstock partner with 5,150 head of cattle

Dairy Central	Feedstock Provider	Local dairy biogas feedstock partner with 2,380 head of cattle
Double D Dairy	Feedstock Provider	Local dairy biogas feedstock partner with 5,300 head of cattle
Hilmar Holsteins	Feedstock Provider	Local dairy biogas feedstock partner with 4,400 head of cattle
K&R Blount Dairy	Feedstock Provider	Local dairy biogas feedstock partner with 1,810 head of cattle
Martins Brothers Dairy	Feedstock Provider	Local dairy biogas feedstock partner with 4,200 head of cattle
Morris Family Enterprises	Feedstock Provider	Local dairy biogas feedstock partner with 1,025 head of cattle
Oliveira Dairy	Feedstock Provider	Local dairy biogas feedstock partner with 2,770 head of cattle
S&S Dairy, Inc.	Feedstock Provider	Local dairy biogas feedstock partner with 2,900 head of cattle
Trinkler Dairy	Feedstock Provider	Local dairy biogas feedstock partner with 2,900 head of cattle
Wickstrom Jersey Farms	Feedstock Provider	Local dairy biogas feedstock partner with 3,130 head of cattle
Peterson Dairy	Feedstock Provider	Local dairy biogas feedstock partner with 1,200 head of cattle
Soares Dairy	Feedstock Provider	Local dairy biogas feedstock partner with 1,200 head of cattle
Silva's Holstein Dairy	Feedstock Provider	Local dairy biogas feedstock partner with 1,300 head of cattle
Machado Dairy	Feedstock Provider	Local dairy biogas feedstock partner with 1,100 head of cattle
Lumar Dairy	Feedstock Provider	Local dairy biogas feedstock partner with 1,900 head of cattle
Edelweiss Dairy	Feedstock Provider	Local dairy biogas feedstock partner with 1,400 head of cattle
Gioletti & Sons Dairy	Feedstock Provider	Local dairy biogas feedstock partner with 3,200 head of cattle
El Katrina Dairy	Feedstock Provider	Local dairy biogas feedstock partner with 1,400 head of cattle

Double D Holsteins	Feedstock Provider	Local dairy biogas feedstock partner with 1,500 head of cattle
B6 Dairy	Feedstock Provider	Local dairy biogas feedstock partner with 2,500 head of cattle
Zylstra Dairy	Feedstock Provider	Local dairy biogas feedstock partner with 1,500 head of cattle
MB Lucky Lady	Feedstock Provider	Local dairy biogas feedstock partner with 1,200 head of cattle
Jordao Dairy	Feedstock Provider	Local dairy biogas feedstock partner with 1,400 head of cattle
GJ Silva Dairy	Feedstock Provider	Local dairy biogas feedstock partner with 3,500 head of cattle
Silveira Holsteins	Feedstock Provider	Local dairy biogas feedstock partner with 1,000 head of cattle
Gomes Dairy	Feedstock Provider	Local dairy biogas feedstock partner with 1,100 head of cattle
Sam Kooistra Dairy	Feedstock Provider	Local dairy biogas feedstock partner with 1,200 head of cattle
D5 Farms	Feedstock Provider	Local dairy biogas feedstock partner with 1,200 head of cattle
N&C Silveira Dairy	Feedstock Provider	Local dairy biogas feedstock partner with 1,400 head of cattle
KVF #1 Dairy	Feedstock Provider	Local dairy biogas feedstock partner with 400 head of cattle
KVF #2 Dairy	Feedstock Provider	Local dairy biogas feedstock partner with 600 head of cattle
Alamo #2 Dairy	Feedstock Provider	Local dairy biogas feedstock partner with 2,500 head of cattle
Azevedo Dairy	Feedstock Provider	Local dairy biogas feedstock partner with 800 head of cattle
Joe Meirinho Dairy	Feedstock Provider	Local dairy biogas feedstock partner with 1,200 head of cattle
GJC Dairy, Inc.	Feedstock Provider	Local dairy biogas feedstock partner with 1,000 head of cattle
Garcia Dairy	Feedstock Provider	Local dairy biogas feedstock partner with 1,500 head of cattle

Veldhuis North Dairy	Feedstock Provider	Local dairy biogas feedstock partner with 4,000 head of cattle
----------------------	--------------------	--

Source: Aemetis Biogas, LLC

Verifiable Low-Carbon Fuels Production Experience

Aemetis is a global leader in the production of low-carbon fuels, having created and proven a strong track record for renewable ethanol and biodiesel. Aemetis' most recent undertakings will leverage its vast experience in the production of low-carbon fuels to begin producing ultra-low-carbon RNG.

Feedstock Cost and Quality

Aemetis is strategically positioned to take advantage of the vast amounts of methane generated at dairies in Stanislaus and Merced Counties due to its early efforts to enter into long-term feedstock agreements, thus guaranteeing stable feedstock pricing and supply. Dairy manure is a waste product which has held little economic value and been the source of significant negative environmental impacts to date. Under the ACDDC Project, Aemetis installs dairy biogas treatment systems at each member dairy to remove large amounts of H₂S found in manure biogas prior to the conditioned biogas being injected into the private ACDDC pipeline. Aemetis Biogas LLC has entered into long-term agreements with feedstock providers, offtake partners, technology partners, logistics companies, and fleet operators to ensure the long-term economic sustainability of the project. Copies of these offtake and feedstock supplier agreements are included in the Confidential Volume. Importantly, Applicant provides a fixed rate fee to each member dairy over the 25-year contract, ensuring uninterrupted access to feedstocks.

Co-Products and Other Revenue Streams

The project will not require ongoing financial support from the generation of co-products. However, the project helps generate additional direct revenue for dairy operators by reducing the footprint and air quality impacts of manure storage, enabling each dairy to maximize operational efficiencies, and, thus, increasing biogas generation. This support for dairy operators will act as an incentive for participating in the ACDDC Project and becoming a critical feedstock provider-partner. Importantly, the economic viability of the Aemetis Biogas Upgrading Facility. Project is in no way reliant upon alternative revenue streams, the generation and marketing of any potential co-products, and avoided tipping fees.

LCFS, RFS2, and Cap and Trade Credits

The project has generated revenue through sales of ultra-low-carbon RNG and, delivering most of the project revenue, LCFS credits and RFS2 credits—RINs. The system does not rely upon revenue from sales of co-products for financial viability; the system generates a profit based solely on RNG sales and residual cap and trade incentives. Aemetis utilizes the revenues from selling generated RINs and LCFS credits to reinvest into the ACDDC project and continue expanding its production capacities for a range of low- and ultra-low-carbon fuels

Site Control, Safety, Maintenance, and Training

Applicant has in place a range of in-depth health, safety, maintenance, and training procedures to support the continued operation of the facility while minimizing risks of hazards. In addition to thorough multi-day new-hire training and education of all new employees, Aemetis requires

each of its employees to undergo annual safety and operational training. Importantly, Aemetis works closely with the technology providers and equipment vendors to update its safety, maintenance, and training procedures to account for potential issues that could arise during the production of the conditioned dairy biogas and the ultra-low-carbon RNG. Aemetis has developed extensive standard operating procedures (SOP) for all operations at the Keyes facility. SOPs were developed and implemented for the Aemetis Biogas Upgrading Facility. in consultation with equipment manufacturers, engineering consultants, and the plant's operations, maintenance, and Environmental, Health, and Safety (EHS) team.

Chapter 3 Project Results

3.1 Operations

The construction of the Aemetis Biogas Upgrading Facility involved meticulous planning, site preparation, and the installation of advanced technology to convert dairy biogas into renewable natural gas (RNG). Initial phases focused on design, securing permits, and preparing the site. Anaerobic digesters were installed at multiple dairy farms to capture biogas, which was then transported via pipelines to the central upgrading facility. The core facility was equipped with gas separation membranes, compression systems, and biogas upgrading skids to ensure high-efficiency purification and low carbon intensity.

A key component of the project was establishing a robust interconnection with PG&E's pipeline network, involving the installation of essential metering and safety equipment. Following rigorous testing and commissioning, the facility began operations, integrating additional dairy farms and scaling up biogas processing capacity. The collaboration with stakeholders ensured the project's success, making the Aemetis Biogas Upgrading Facility a model for sustainable biogas projects.

Figure 9: Aemetis Biogas Upgrading Facility Foundation



Source: Aemetis Biogas, LLC

Figure 10: Aemetis Biogas Upgrading Facility Foundation



Source: Aemetis Biogas, LLC

Figure 11: Aemetis Biogas Upgrading Facility under construction



Source: Aemetis Biogas, LLC

Figure 12: Aemetis Setting Equipment



Source: Aemetis Biogas, LLC

Figure 13: Equipment Overview



Source: Aemetis Biogas, LLC

Figure 14: Overview of Aemetis Biogas Upgrading Facility



Source: Aemetis Biogas, LLC

Table 11: Production Daily Average of Current Operational Dairies

Double D	146 MMBtu
Ackerman	115 MMBtu
S&S	86MMBtu
Trinkler	204MMBtu
Mendes	125 MMBtu
Blount	60MMBtu
Machado	111MMBtu
Wickstrom	193MMBtu

Figure 15: Dairy that transports biogas via pipeline to the Aemetis Biogas Upgrading Facility



Source: Aemetis Biogas, LLC

3.2 Biogas Upgrading Facility Operational Status Review

The biogas upgrading facility has demonstrated strong operational availability. In January 2024, the Aemetis Biogas Upgrading Facility maintained a 98.25% availability rate. However, in February 2024, the availability rate slightly decreased to 93%. This decline was primarily due to the minimal downtime required for preventive maintenance, including checking and cleaning flow meter orifices, and two chiller trip issues caused by computer programming errors.

Production Metrics

As of April 2024, the Aemetis Biogas Upgrading Facility has successfully produced 14,747 Dekatherms of biogas that have been injected into the pipeline. On April 15th, 2024, we hit our first 1000 dekatherm day at 1044 Dekatherm. April 16th was at 1054 Dekatherm.

3.3 Total Greenhouse Gas Emissions

Utilizing the LCFPP Benefits Calculator Tool, Aemetis has quantified the environmental impact of the project in terms of greenhouse gas emissions. The total annual reduction in CO₂ equivalent (CO₂e) emissions achieved by the project is estimated at 2,632,149 metric tons (MT), assuming an average carbon intensity of -415 gCO₂e/MJ. Over a 25-year period, this reduction translates to a total of 65.8 million MT of CO₂e displaced.

3.4 Economic Benefits

Business Opportunities

The plant will expand in-state RNG production by increasing the annual volume that Aemetis produces from zero MMBTU in 2019 to a total of 1.0 million MMBTU per year by 2030, depending on how many projects go online. With this high-volume production increase, several expanded business opportunities have arisen for California-based businesses, including suppliers, project participants, and distributors. First, the production increase so far has resulted in a roughly 70% percent increase in annual revenue for Aemetis. With 10 new direct jobs, more than 132 supported indirect jobs in short term construction and maintenance work, and a new revenue stream for local dairies, the project has quickly become an economic force in the region. Of the approximately \$7.6 million in annual expenses that will be incurred for feedstock supply and plant operations for the new RNG production, 100 percent of this will be spent in California (based on the assumption that 100% of the raw feedstock materials will be supplied in-state). In addition, 100 percent of the plant's RNG output will be sold within California, typically delivered to local fleets and major CNG retailers, as described above at Section 3.3. Based on 2019 year-to-date sales, Aemetis estimates in any given month 75% of the RNG output from the new project will be consumed in the San Joaquin Valley air basin, where dairy biogas RNG can have disproportionately greater positive impacts on disadvantaged communities that suffer from air pollution stemming from high volumes of heavy-duty truck traffic and off-road diesel fuel equipment utilization in the agricultural sector. Additionally, there are significant avoided health care costs stemming from the use of 1.0 million MMBTU of negative-CI RNG to annually displace 6.88 million DGE. Further, with a demonstrated success, this project could reduce the technical and financial risks associated with subsequent similar projects and accelerate this type of business opportunity throughout the State.

Jobs Creation

Ultra-low-carbon RNG production facilities have tremendous potential for economic benefit to the local economy. Currently, the existing Aemetis ethanol plant has 47 full-time employees. The average annual 2023 compensation per person employed at the plant—not including management positions, is approximately \$55,000. In many cases, several current plant employees began working at the ethanol plant *without* the full range of experience and skills required to properly execute the responsibilities of their jobs. As a result, Aemetis invested heavily in employee training and continues to invest in ongoing training. Aemetis Biogas LLC will continue this approach to employee compensation and training at the facility, which has hired seven (7) additional full-time, permanent California employees and long-term contractors in operational and maintenance positions, at an average per-person compensation of \$55,000 plus medical, dental, and vision plans, 401(k) and other benefits. Thus, the new plant has generated approximately \$385,000 in annual wages, most of which the employees will spend locally. During design and construction, the project employed up to 132 temporary workers in engineering, design, and construction, generating approximately \$2,975,000 in wages during the engineering and construction portions of the project and supporting their companies. Since completion, the expanded production facility has generated approximately \$8,927,782 in annual economic activity—or approximately \$223.2 million over the projected 25-year lifetime of the facility, with approximately 100 percent being spent annually within the surrounding area and most of the balance within a 30-mile radius of Keyes, CA, an economically distressed

and high unemployment area within California. Wages and taxes are direct benefits. Aemetis estimates that indirect benefits will be substantial. In direct and indirect spending, the plant's workers, both during construction and operations, has patronized local hotels, restaurants, and other businesses, helping to support local jobs in those industries. Over the lifetime of the project and based on the direct experience of the Aemetis ethanol plant, Aemetis Biogas LLC estimates they will spend tens of millions of dollars within the nearby communities.

Taxes

Now fully operational, the new plant will produce approximately 1.0 million MMBTU of ultra-low-carbon RNG and generate 10 permanent full-time jobs.

All sales of natural gas, including renewable natural gas, are subject to one state tax: the California Use Fuel Tax. According to the California Department of Tax and Fee Administration, the compressed natural gas (and RNG) Use Fuel Tax is \$0.0887/gasoline gallon equivalent (GGE) (126.67 cubic feet or 5.66 pounds). In total, this tax would generate \$808,978.25 in state and local taxes each year—a total of \$20,224,456.26 over 25 years of full capacity production.

Through the addition of 10 full-time workers with an average annual income of \$55,000, Aemetis Biogas LLC will pay an additional \$385,000 per year in wages and generate approximately \$1,214,750 in additional annual state and local—or \$30,368,750 over the 25-year plant lifetime.

Sustainability

The project will help preserve and enhance the use of natural resources in the State by increasing the volume of ultra-low-carbon RNG available within California's transportation fuel mix, achieve significant emissions reductions within California's fuel marketplace, and reduce methane emissions and water consumption at local dairies partnering in the ACDDC Project. This will all be achieved by the utilization of waste dairy manure as the primary feedstock and be maximized using a private pipeline to eliminate transportation emissions associated with transporting the dairy biogas feedstock to the Aemetis Biogas Upgrading Facility.

The facility uses dairy manure biogas as its feedstock, thus avoiding the need to land-apply or send the manure to open-air lagoons. Each of the dairies will have a new covered manure lagoon constructed, enabling the manure to be collected with recycled water inputs and capturing fugitive methane, CO, H₂S, CO₂, and other toxic air pollutants generated by decomposing manure.

The plant will not utilize any feedstocks that come from forest clearing but will rely exclusively on dairy manure biogas. As a result, the project has no negative impact on the use of land for food, feed, or fiber production and eliminates the plant's direct and indirect land use impacts on California's agricultural economies. Importantly, the introduction of dairy manure lagoons will improve the living condition of the herd through reduced bacteria counts in the wash water, enabling dairies to improve the efficiency of their operations, and resulting in greater in-state production and consumption of local dairy products.

Additionally, the project has reduced consumption of the State's petroleum resources. Negative-CI RNG produced in California means less California petroleum used to make transportation fuels that would be used in lieu of RNG, extending the life of California's petroleum reserves.

According to ARB, RNG from dairies is the lowest-CI fuel available on a full fuel-cycle basis (production to end use).⁴ When used in trucks with near-zero natural gas engines, it can result in transportation fuels with extremely low carbon intensities, particularly when produced from dairy biogas. Such near-zero engines also produce almost no nitrogen oxides (NOx), a primary component of smog, or black carbon. By on-site sales or direct injection into the state's natural gas infrastructure, the Aemetis Biogas Upgrading Facility. immediately benefits the low-income, predominantly minority communities that suffer the most from exposure to diesel exhaust. The health effects these communities face is severe: premature death; decreased lung function in children; increased respiratory symptoms; and hospitalizations and emergency department visits for aggravated chronic heart and lung conditions, including asthma.⁵

⁴ <https://www.act-news.com/news/rng-cleaner-air-reducing-emissions/>

⁵ Ibid.

Chapter 4: Outreach and Education

4.1 Outreach

Aemetis has conducted outreach to the Keyes Fire Protection District and undertaken a variety of efforts to educate the surrounding community, workforce, and local educational institutions about the project's environmental benefits and impacts. Aemetis has been in regular communication with the Keyes Fire Protection District and will be compliant with all applicable fire safety codes in the project. Additionally, Aemetis has collaborated with the CPUC, PG&E, the VOLT Institute, Opportunity Stanislaus, the Merced and Stanislaus Farm Bureaus, and Monterey Park Tract to ensure ongoing community engagement and support throughout the design and execution of the project. The Aemetis team has also met with Congressman Josh Harder, Assemblymember Adam Gray, Merced and Stanislaus County Supervisors.

Educational Outreach at Chatom Elementary School

On March 23, 2023, Danny Hermosillo, Construction Supervisor, and Jessica Cardoso, Project Manager, visited Chatom Elementary School as part of their annual Ag Day event. This outreach effort aimed to enlighten students from third to sixth grade about the significance of digesters and their environmental contributions. During their visit, they conducted presentations for six different classes, introducing the concept of digesters and elucidating their functionality. The students were receptive and enthusiastic, already having some familiarity with dairy farms due to personal connections. The presentation not only educated the students but also inspired them to share their newfound knowledge with their peers, potentially fostering a future interest in operating digesters themselves.

The impact of our visit extended beyond the day itself. One classroom displayed their appreciation through heartfelt thank you notes, a testament to the impression that was left behind. The following day, these notes of gratitude served as a reminder of the importance of our outreach efforts. The fact that the students took the time to express their appreciation underscores the success of our endeavor and the resonance it found among these young minds.

Collaboration Outreach with Modesto Junior College

Aemetis took another step-in community engagement by hosting a site visit for a Modesto Junior College class focused on biomass research. On August 2nd, 2023, a group of 14 researchers from the college visited our facilities. The day began with an informative presentation that highlighted the challenges and opportunities within the biogas industry. This was followed by a comprehensive tour of one of our operational digesters, providing the students with a firsthand look at the technology in action. The site visit culminated at our biogas upgrading clean-up facility, showcasing the intricate process of interconnecting with PG&E.

Interviews and Knowledge Exchange

After the presentation and site visits, the students were divided into groups for a more personalized experience. Three groups interviewed a total of four Aemetis employees: Juan Linarez (Project Engineer), Roy Dowd (Operations Manager), Robbie Macias (Vice President), and Jessica Cardoso (Project Manager). This interactive session allowed for an in-depth exchange of knowledge and insights between our experts and aspiring researchers. The employees shared their experiences, expertise, and perspectives on various aspects of the biogas industry, fostering a meaningful connection between academia and real-world applications.

Aemetis remains dedicated to fostering a strong bond between our projects and the communities we serve. The educational outreach at Chatom Elementary School and collaboration with Modesto Junior College exemplify our commitment to sharing knowledge and promoting the environmental benefits of our endeavors. By engaging with students, researchers, and local stakeholders, we are confident in creating a more sustainable and informed future.

To explain the project to the public, Aemetis Biogas LLC has after NOPA, published a notice in the local newspaper and issued a press release via its online marketing channels. Working with Opportunity Stanislaus, Aemetis has conducted targeted community meetings to explain the local health benefits, as well as specific job opportunities made available by the project. Additionally, Aemetis will continue their outreach campaign efforts to local high schools, community colleges, and universities to share knowledge about the benefits and opportunities for biogas projects in California's Central Valley. This will be supplemented by a five-year, \$50,000 scholarship program for students from the local Priority Population Communities pursuing degrees in STEM, construction trades, or other degrees with relevance to the renewable fuels or sustainable agriculture industries. This breadth of outreach has measurably contributed to the success of the project by Aemetis and advance interest and engagement in these innovative projects and their ability to achieve significant environmental and community health benefits, and job opportunities. For 2024, three (3) students from Ceres High School were chosen to be awarded scholarships in the dollar amount of \$1,500.00 each. The criteria that were established for the scholarship are students going into any of the following fields of study be pulled for review and consideration for the Aemetis scholarship.

- Renewable Energy
- Environmental Science
- STEM
- Science
- Math

In addition, when the recipient comes in to collect funding, they are required to bring in proof of college enrollment for at least 12 units. It has also been requested the scholarship funds be cut to the student's college of choice rather than directly to the student ensuring it is being appropriately disbursed.

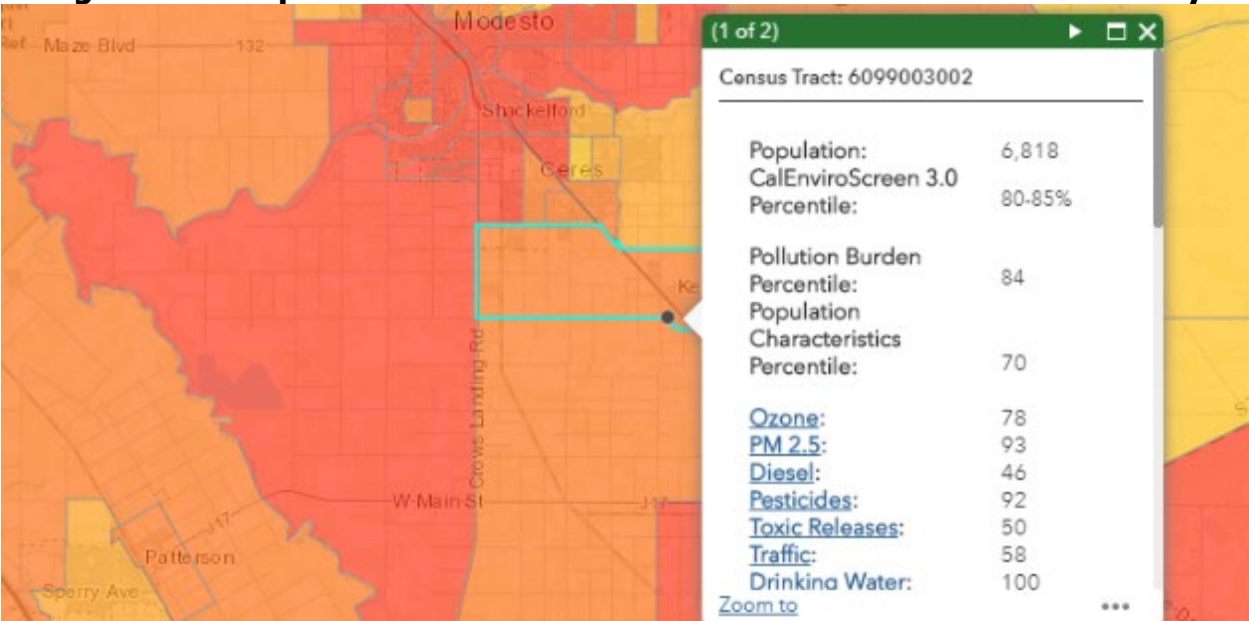
4.2 Project Location and Disadvantaged Communities

The project benefits priority populations, both locally and across California, in numerous ways. Since operational, the Aemetis Biogas Upgrading Facility. and ACDDC has delivered direct, meaningful and assured benefits to those populations and addressed important community needs, including odor and pollution control, supporting targeted education programs, job creation, and increased economic opportunities. The priority population most affected by the proposed project includes residents of the area directly surrounding the facility. The ACDDC Biogas Cleanup Plant is located at 4209 Jessup Road, Keyes, CA 95307. This address is in census tract 6099003002, an area scoring in the 84th percentile for pollution burden according to CalEnviroScreen 3.0. According to CalEnviroScreen 3.0, the population of this census tract is 6,818.

This area is characterized by the following high burdens: Ozone (78%), PM2.5 (93%), Pesticides (92%), Drinking Water (100%), Cardiovascular Health (79%), Education (78%), Poverty (83%), Unemployment (98%), and Housing Burden (73%). In addition to these high environmental and socioeconomic burdens, the surrounding community is designated as a low-income community. The

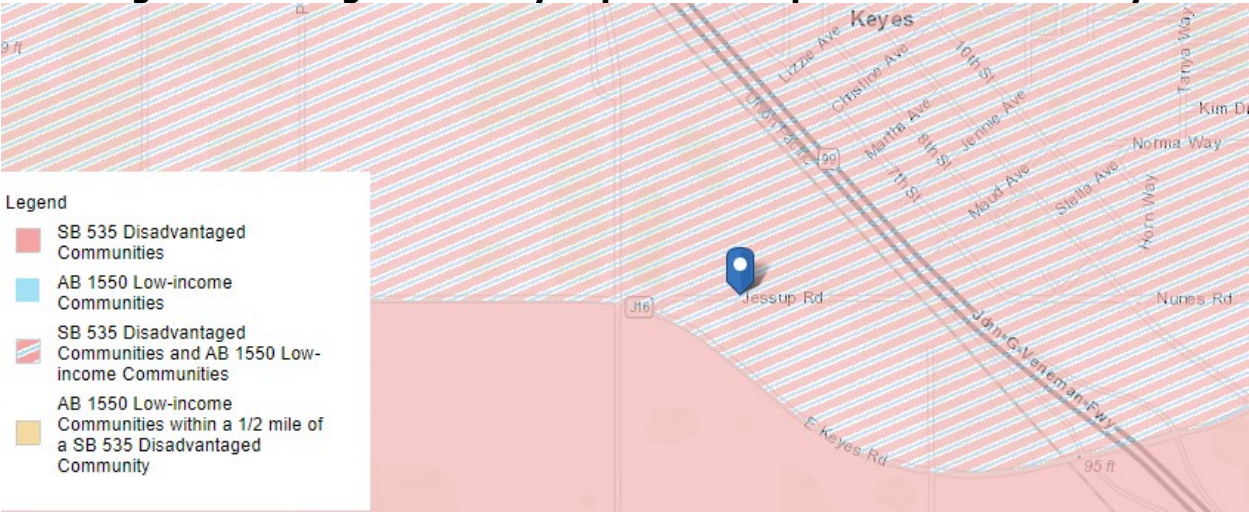
surrounding communities are all Priority Populations deserving of equitable investment by the state to reduce emissions, improve public health, and generate economic opportunities.

Figure 16: Snapshot of CalEnviroScreen 3.0 Results for the AAFK Facility



Source: CalEnviro 3.0 Screenshot

Figure 17: Image of Priority Population Map for the AAFK Facility



Source: CalEnviro 3.0 Screenshot

As mentioned, the project has meaningfully addressed important community and household needs for nearby, identified priority populations. These needs include those identified during outreach by Aemetis, as well as those identified by CalEnviroScreen 3.0 and the LCFPP Benefits Calculator Tool. Between January 24, 2019, and August 31, 2019, Aemetis performed a series of outreach activities, with the goals of informing the local community about the project, identifying the needs of the residents, and incorporating those needs into the design of the project. Outreach performed included public meetings with the Merced County Farm Bureau (MCFB), Stanislaus County Farm Bureau, and the community of Monterey Park Tract.

Each of these meetings was attended by more than 25 members of the local community, businesses, government, and utilities. As a result of this, Aemetis has expanded its scope to include broader outreach to the local community, local schools and colleges, and local workforce development organizations. Specifically, the proposed project will address the identified needs in the following ways:

Table 12: Identified Needs

Need	Mitigation Strategy
Odor Control	One of the most mentioned needs by residents and the source of many complaints about dairy and dairy biogas operations is the need for odor control. Aemetis will reduce odorous H ₂ S emissions at the 30 member dairies of the ACDDC as well as at the Aemetis Biogas Upgrading Facility. facility by constructing covered manure lagoons and deploying a range of gas cleaning technologies that will remove odorous gas compounds from the dairy biogas feedstock.
Job Creation	The project has directly supported 132 temporary, high-paying jobs during construction of the facility, many of which will result in additional indirect spending locally on food, gas, lodging, and other items. The project also created seven new permanent, full-time positions with an average annual compensation of \$55,000 and a generous benefits package that includes medical, dental, and vision plans, and 401(k) with more to hire as more dairy projects connect to the Aemetis Biogas Upgrading Facility.. Additionally, Aemetis Biogas LLC is a proud member of Opportunity Stanislaus and supporter of the VOLT Institute which offers technical job training and job placement assistance.
Ozone	According to CalEnviroScreen 3.0, the census tract containing the facility scores high (78) for ozone. According to the US EPA, NO _x is a vital precursor to ground-level ozone, a harmful air pollutant, and the main ingredient in "smog." ⁶ The project will significantly reduce NO _x emissions associated with medium- and heavy-duty engines operating around the project area and throughout California.
Poverty	According to CalEnviroScreen 3.0, the census tract containing the facility scores high (83) for poverty. The project will help reduce poverty by 1) supporting 132 temporary, high-paying construction jobs and associated indirect spending locally; 2) creating seven permanent, full-time positions with preference for local hiring; and 3) an increase in local and statewide economic activity totaling approximately \$4 million in the first year and \$8.9 million per year at full operations.

⁶ <https://www.epa.gov/ground-level-ozone-pollution/ground-level-ozone-basics>

Emissions	According to CalEnviroScreen 3.0, the census tract containing the facility scores high (84) for pollution burden. The Aemetis Biogas Upgrading Facility. and ACDDC will achieve significant emissions reductions in the local community, including H ₂ S, CO ₂ , NO _x , NH ₃ , PM _{2.5} , CO, and CH ₄ . These emissions are both hazardous to health and the environment and negatively impact quality of life in the surrounding communities. Reducing the concentrations of these emissions will provide noticeable change in the ambient environment to local communities.
Unemployment	According to CalEnviroScreen 3.0, the census tract containing the facility scores high (98) for unemployment. See Job Creation above for how the project addresses this need.
Education	According to CalEnviroScreen 3.0, the census tract containing the facility scores high (78) for education. The project will provide a variety of benefits meant to improve educational outcomes among members of affected priority populations. Aemetis will inaugurate a five-year scholarship program that will provide four \$2,500 scholarships per year to students from the Priority Populations who reside in nearby disadvantaged or low-income communities. These scholarships will benefit students seeking degrees and certifications that will support a future career in ultra-low-carbon biofuels and related sustainable transportation and agricultural fields.

Source: Aemetis Biogas, LLC

The project provides multiple direct, meaningful benefits to priority populations, both during the project term and beyond. Of the benefits listed in the Solicitation Manual, the project will provide six enumerated benefits to priority populations: high-quality jobs providing high pay and a generous benefits package that includes health, dental, and vision insurance; expand business opportunities for California-based businesses, including dairies and fleet operators; increase state and local tax revenues; and, reduce emissions of GHG, criteria and toxic air pollutants, and short-lived climate pollutants.

Of significant note, the facility itself, including the project, has been designed to have zero negative impact on the surrounding community, avoiding all substantial burdens, including displacement of low income, disadvantaged community residents and businesses or increased exposure to toxics or other health risks. Throughout the project, Aemetis and the project team will continuously expand their outreach efforts to increase the visibility of the project and knowledge of the numerous benefits inherent in these types of manure-to-RNG projects.

Chapter 5: Lessons Learned & Conclusions

5.1 Key Lessons

Schedule

During the project implementation phase, Aemetis identified a greater need for oversight of contractors and temporal coordination than originally anticipated. To address this, Aemetis began distributing weekly progress trackers outlining completed tasks and proposed resource allocations for upcoming activities. Additionally, bi-weekly face-to-face stakeholder meetings were organized to facilitate effective communication and address any issues promptly. Bid sheets were a helpful tool from contractors with estimated timeline to complete each scope of work.

Scope

The initial project scope overlooked several critical components, leading to a financial strain beyond the proposed budget. These omitted components included electrical installation of mixers, instrument communications, concrete backfill, site cleanup, biogas sump installation, Pre-Treatment Skid (PTS) / Digester recycle valve, and miscellaneous lines. Significant cost savings were achieved by purchasing materials in bulk at the project's outset, particularly with the early procurement of PVC and liner materials in the summer of 2020.

Technical Aspects

To enhance clarity during construction, generating a comprehensive single-line diagram inclusive of all dairy equipment was recommended. Additionally, eliminating wastewater pumps on the digesters' inlet proved to be a time and cost-saving measure. Alternative ballast weighing materials could have expedited construction, considering the challenges faced with fly ash availability. Scheduling the power drop early was advised to mitigate the risk of delays due to potential backlogged work with the local utility. Furthermore, optimizing inlet scrubber placement and reconsidering pipe supports and valve types were suggested to improve efficiency and cost-effectiveness. Utilizing point-to-point radio communication for PTS where feasible was proposed to prevent data loss during cellular outages, ensuring accurate data collection critical for LCFS/RIN credit generation.

Contract

Inclusion of supplementary clauses regarding site safety protocols and best management practices was deemed necessary in contractual agreements. Vendors, despite their experience in dairy site operations, exhibited compliance levels below Aemetis' safety benchmarks. Hence, considerable effort was directed towards refining contractual language and ensuring strict enforcement of safety mandates on the project site.

Financial/Budget

To accommodate recent inflation and supply chain issues, a contingency of 20% was recommended to be added to the budget.

5.2 Conclusions

The Aemetis Biogas Upgrading Facility remains the largest PG&E interconnection in California, solidifying Aemetis as a central figure in Dairy Biogas RNG production. The Aemetis Biogas Upgrading Facility, supported by the California Energy Commission (CEC), has served as a model for dairies and agencies nationwide, demonstrating the feasibility and scalability of biogas digester projects.

The funding provided by the CEC was instrumental in making this project more cost-effective and establishing a viable, replicable system. The financial investment in gas interconnection and biogas upgrading skids has proven to be rewarding. State support at the project's inception and intermediary phases showcased the potential of converting dairy biogas from methane to renewable natural gas.

As the Aemetis Biogas Upgrading Facility continues to integrate more dairies, we anticipate significant increases in GHG reductions, improvements in CI scores, and higher RNG production. Given the nature of anaerobic digesters, it will take several years to reach full production capacity. However, the projected RNG output is promising.

The state's investment in this facility has not only attracted traditional private funding but also enabled the expansion necessary to make a larger environmental impact. Beyond the environmental benefits, the project also offers significant economic potential through local job creation. By aligning with the goals of SB 1383, the Aemetis Biogas Upgrading Facility exemplifies how producing RNG from dairy biogas can be an effective and viable solution to help California address the current climate crisis.

GLOSSARY

CALIFORNIA ENERGY COMMISSION (CEC)—The state agency established by the Warren-Alquist State Energy Resources Conservation and Development Act in 1974 (Public Resources Code, Sections 25000 et seq.) responsible for energy policy. The Energy Commission's five major areas of responsibilities are:

1. Forecasting future statewide energy needs
2. Licensing power plants sufficient to meet those needs
3. Promoting energy conservation and efficiency measures
4. Developing renewable and alternative energy resources, including aiding to develop clean transportation fuels
5. Planning for and directing state response to energy emergencies.

COMPRESSED NATURAL GAS (CNG)—Natural gas that has been compressed under high pressure, typically between 2,000 and 3,600 pounds per square inch, held in a container. The gas expands when released for use as a fuel.

RENEWABLE NATURAL GAS (RNG) is a pipeline-quality gas that is fully interchangeable with conventional natural gas and thus can be used in natural gas vehicles. RNG is essentially biogas (the gaseous product of the decomposition of organic matter) that has been processed to purity standards.

CALIFORNIA AIR RESOURCES BOARD (CARB)—CARB is charged with protecting the public from the harmful effects of air pollution and developing programs and actions to fight climate change. From requirements for clean cars and fuels to adopting innovative solutions to reduce greenhouse gas emissions, California has pioneered a range of effective approaches that have set the standard for effective air and climate programs for the nation and the world.

DIESEL GALLON EQUIVALENT (DGE)—The amount of special fuel, or special fuel that is liquefied natural gas or compressed natural gas, that is equivalent in terms of energy content to 1 gallon of diesel fuel, as provided in this subsection. The equivalent amount is the amount of fuel that by volume possesses an energy content of 129,500 British thermal units.

LOW CARBON FUEL STANDARD (LCFS)—Under the AB 32 Scoping Plan, the Board identified the Low Carbon Fuel Standard as one of the nine discrete early-action measures to reduce California's greenhouse gas emissions that cause climate change. The LCFS is a key part of a comprehensive set of programs in California to cut GHG emissions and other smog-forming and toxic air pollutants by improving vehicle technology, reducing fuel consumption, and increasing transportation mobility options. The LCFS is designed to decrease the average carbon intensity of California's transportation fuel and provide an increasing range of low-carbon and renewable alternatives, which reduce petroleum dependency and achieve air quality benefits.