ENERGY RESEARCH AND DEVELOPMENT DIVISION

FOOD PRODUCTION INVESTMENT PROGRAM

FINAL PROJECT REPORT

Demonstrating an Optimized Compressed Air Energy System at the Sun-Maid Kingsburg Facility

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PREFACE

The California Energy Commission's (CEC) Energy Research and Development Division supports and invests in energy research, development, demonstration, and deployment programs to spur innovation in energy efficiency, renewable energy, advanced clean generation, energy-related environmental protection, energy transmission, distribution, and transportation.

The Food Production Investment Program (FPIP), established in 2018, encourages California food producers to reduce greenhouse gas (GHG) emissions. Funding for this program comes from the California Climate Investments (CCI), a statewide program that puts billions of Cap-and-Invest, formerly known as Cap-and-Trade, dollars to work reducing GHG emissions, strengthening the economy, and improving public health and the environment – particularly in priority population communities. The CCI's Cap-and-Invest program creates a financial incentive for industries to invest in clean technologies and develop innovative ways to reduce pollution.

FPIP will help producers replace high-energy-consuming and aging equipment and systems with market-ready and advanced technologies. The program is committed to investing and accelerating the adoption of new advanced technologies and equipment that provide significant benefits to the electrical grid, maximize the reduction of GHG emissions, and reduce air pollution in priority population communities.

As one of the state's top energy consumers, the food processing industry is a major source of GHG emissions. In response, FPIP is committed to:

- Helping California food processors work towards a low-carbon future;
- Demonstrating the reliability and effectiveness of advanced energy and decarbonization technologies and strategies;
- Enhancing and benefiting the electrical grid, especially during net peak periods; and
- Benefiting or improving public health and the environment, particularly in priority populations.

For more information about the California Climate Investment program, please visit the Cap-and-Invest Dollars at Work website at https://www.caclimateinvestments.ca.gov/ or contact the CCI at info@caclimateinvestments.ca.gov.

For more information about the Food Production Investment Program, please visit the program's website at https://www.energy.ca.gov/programs-and-topics/programs/food-production-program.

ABSTRACT

Sun-Maid Growers of California replaced its aging, energy-inefficient compressed air system at its raisin production facility in Kingsburg, California, with energy-efficient, drop-in-ready technologies from California-based vendors. The upgraded and optimized compressed air system included a fully integrated suite of advanced oil-free centrifugal compressors, heat-of-compression regenerative dryers, high-capacity air receivers, and intelligent control automation. The system resulted in annual reductions of approximately 1,012 metric tons of carbon dioxide equivalent in greenhouse gas emissions and approximately 4,441,086 kilowatt-hours in total facility electrical energy consumption, while maintaining production quality and throughput. The system also delivers stable, lower-pressure compressed air that is essential for facility operations and enables future heat-recovery integration. The deployment of the upgraded compressed air system has also reduced emissions of on-site criteria air pollutants and toxic air contaminants by directly lowering on-site fossil fuel consumption. Notably, the project is located in a low-income, disadvantaged community characterized by a pollution burden in the 94th percentile. Beyond the energy and environmental benefits, the project demonstrates that investing in large-scale efficiency upgrades to compressed air systems can deliver substantial, reliable savings. The project demonstrates a replicable and scalable model that other food processors and industrial facilities can adopt. By demonstrating the technical feasibility and the economic value of advanced compressed air technologies, this project supports California's broader clean energy objectives and advances efforts to modernize industrial infrastructure, enhance competitiveness, and reduce emissions across the manufacturing sector.

Keywords: food processing, industrial decarbonization, compressed air systems, greenhouse gas emissions, energy efficiency, electricity

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Project Purpose and Approach

Sun-Maid Growers of California (Sun-Maid) has made a significant impact on California's agricultural economy as the world's largest producer and processor of raisins. Sun-Maid operates as a cooperative; it is owned by an extensive network of California grape growers. It acts as a key driver of the local economy by providing employment, a stable product market, and support for production practices through shared education and technical support. Sun-Maid is determined to lead the food processing industry in the successful deployment of advanced technologies while maximizing efficiency and minimizing environmental impact. To reflect this, Sun-Maid crafted its company roadmap, an Energy Master Plan, detailing how to successfully deploy and implement several energy-conscious strategies and technologies across all its facilities. This roadmap echoes creative approaches to addressing on-site sustainability and energy issues while meeting the unique needs of the food processing sector.

This project installed and demonstrated an upgraded and optimized compressed air system at Sun-Maid's raisin production facility in Kingsburg, California. Compressed air is essential to many food processing operations and represents one of the facility's largest single energy loads. The existing system, consisting of five air compressors and two dryers, was replaced with a more efficient configuration of four air compressors and three dryers. The upgraded system incorporates a high-performance trim screw compressor, heat-of-compression regenerative dryers, and a centralized programmable logic controller for system-level optimization. The upgraded compressed air system showcases state-of-the-art oil-free compressor technology that aligns with the Department of Energy's Compressed Air Challenge Best Practices for engineering and design. As a result, the project demonstrates significant reductions in operating costs, energy consumption, and greenhouse gas emissions while improving compressed air quality in the facility.

The project team included contributors from Sun-Maid's engineering, maintenance, and sustainability management staff, energy and sustainability consultants from DC Energy Services (dba Imperion), and project designers from Process Air Solutions. These contributors supported all phases of the project, including development, design, procurement, installation, commissioning, and reporting. The project team addressed several technical challenges common across California's food processing sector, including oversized and inefficient legacy systems, limited pressure-control capabilities, reliance on industry-standard equipment rather than the best-available technologies, and a lack of data-driven controls. Some impactful project challenges occurred during the installation phase, including COVID-19-related disruptions, scheduling constraints, and adjustments to the timing of the project's heat recovery integration. These challenges were effectively managed, resulting in a successful, on-time system demonstration.

The project followed a structured approach: pre-installation inspection and baseline data collection; equipment design and procurement; site preparation; installation and commissioning; and post-installation measurement and verification. During implementation, additional energy-efficiency opportunities were identified for the facility's steam and hot water systems supplied by the central boiler. As a result, the heat recovery system tie-in was deferred.

Key Results

To confirm the system's benefits and performance, energy savings were quantified using a retrofit isolation measurement and verification protocol based on direct measurements of key electrical and system parameters, such as compressor demand, pressure, and airflow rate. This measurement and verification protocol was applied over three months of pre-installation energy data collection and twelve months of post-installation data collection. Pre- and post-installation energy data were collected using calibrated meters, true-power loggers, and the facility's internal monitoring systems. Extensive post-installation evaluation of the system showed that electrical energy savings exceeded initial estimates by more than 100 percent (Table ES-1), while maintaining reliable, consistent airflow, quality, and pressure to end-use equipment.

Table ES-1: Comparison of Estimated Energy Savings and Actual Energy Savings

Energy Savings	Electricity Reductions (kWh/Yr)	GHG Emissions Reductions ($MTCO_2e$/Yr)
Estimated Savings	2,038,276	1,139
Actual Savings	4,441,086	1,012

kWh=kilowatt-hours; $MTCO_2e$=metric tons of carbon dioxide equivalent
Source: DC Energy Service (dba Imperion)

These energy reductions translate into substantial operating cost savings. With a project cost of approximately $2,000,000, Sun-Maid’s investment in upgrading its compressed air system is expected to pay back within two years, accounting for utility incentives, the Food Production Investment Program grant, and annual energy cost savings. Beyond energy and emission reductions, the project also provided qualitative operational benefits, including more stable system pressures, improved compressed air quality, reduced maintenance requirements, and improved performance.

Knowledge Transfer and Recommendations

The success of this project offers valuable lessons for other food processors and industrial facilities across California. The target audience includes compressed air hardware vendors, project developers, utility account representatives, energy-efficiency professionals, food-processing facility staff, and industrial manufacturing staff. The project team shared project results through various outreach opportunities and efforts, including:

- Multiple utility representative meetings.
- Compressed air vendor presentations.
- Walkthroughs with staff from various food processors and industrial manufacturers.

- Speaking opportunities at conferences, including the California League of Food Producers Food Processing Expo.
- Published documents prepared for public dissemination.
- Nominations for energy project awards.

Compressed air systems with centrifugal compressors equipped with variable-frequency drives have historically been considered high-maintenance options. This project demonstrates that these systems can be designed to achieve energy reductions without increased maintenance, while maintaining or improving the quality of compressed air. In addition to food processing facilities, this project may serve as a case study for similar market sectors across California. There are over 36,000 manufacturing businesses and 512 licensed hospitals in the state. An estimated 75 percent of manufacturing facilities and 90 percent of hospitals have one or more compressed air systems. Assuming a 10-percent penetration rate over five years, more than 3,600 manufacturing and hospital facilities in California could achieve similar emission reductions. This is a conservative estimate, especially given that many corporations operate multiple facilities across the state. The estimate of market potential is based on the project's payback period, demonstrated success in a representative facility, and the reputational value of a large food processor such as Sun-Maid.

Key recommendations from this project include the following.

- Prioritizing system-level optimization — rather than one-to-one equipment replacement — yields greater savings and operational improvements.
- Lowering system pressure is one of the most effective strategies for electrical use and should be prioritized during system redesign.
- Measurement and verification should be incorporated from project inception to support utility incentives or investment decisions and to build confidence among facility managers, technology adopters, and policymakers.

This project serves as a strong model for food processors, manufacturers, agricultural operations, and other facilities with high compressed-air demands. It supports California’s climate and clean-energy goals by demonstrating achievable and cost-effective reductions in electricity use. This demonstration of exceptional performance in a complex, high-throughput environment provides a compelling case for broader adoption of optimized compressed air systems across the state, particularly in communities facing air-quality and economic challenges.

CHAPTER 1: Introduction

Company and Facility Overview

Sun-Maid Growers of California (Sun-Maid) is one of the state's most well-known agricultural cooperatives, representing hundreds of raisin growers and operating as a flagship processing and packaging facility in Kingsburg, California. Since acquiring its first building in 1964, Sun-Maid's Kingsburg facility has been one of the most extensive raisin-processing and packaging facilities in the world, now spanning over 650,000 square feet for processing, packaging, shipping, and storage across 170 acres. This facility operates 24 hours per day, Monday through Saturday, and 12 hours on Sundays, for an estimated 8,112 annual operating hours. Sun-Maid offers a complete line of dried fruit products, including raisins and other dried fruits, chocolate and yogurt-flavored fruits, raisin bread, and baking mixes. Sun-Maid also offers its products in bulk to food manufacturers as ingredients. The facility processes and packages nearly one million pounds of raisins daily.

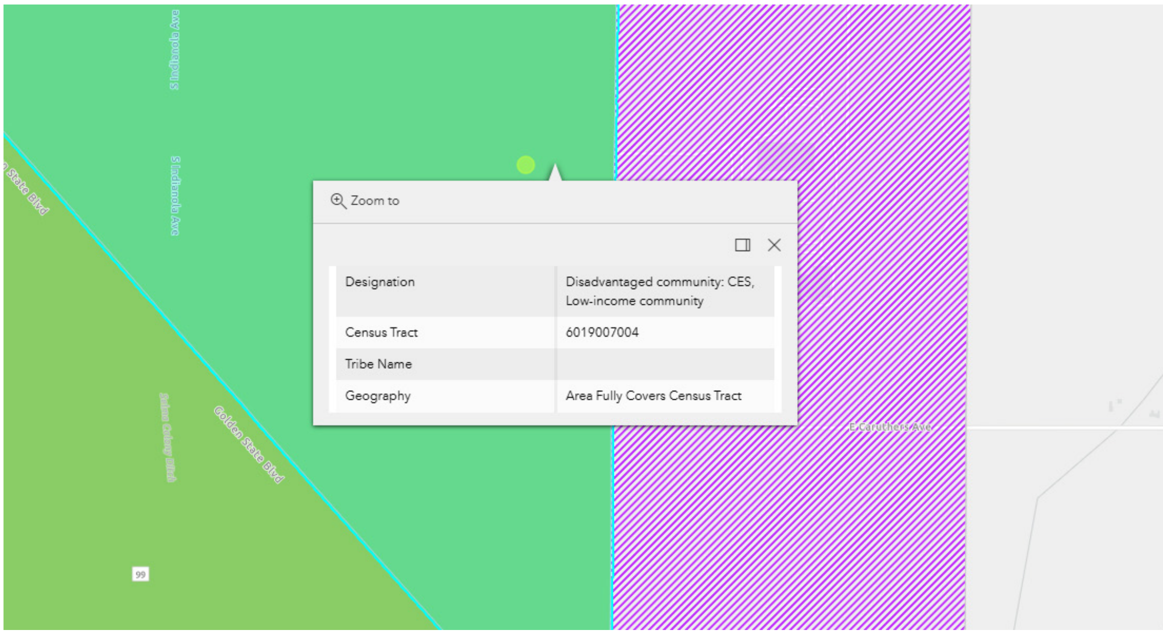
Figure 1: Overview of the Sun-Maid Kingsburg Facility

Source: Sun-Maid Growers of California, 2022

Kingsburg's operations comprise a variety of areas, including 63 acres of wastewater fields, 65 acres of paved and under-roof areas, and 20 acres of vineyard. In 2014, Sun-Maid embarked on calculating the impacts of its emissions and determined that an Energy Master Plan must be developed for the facility to meet future energy needs and achieve overall carbon reductions. Over the last several years, Sun-Maid has begun to develop reduction goals and strategies aligned with the Science-Based Targets Initiative framework. The Science-Based Targets Initiative is a corporate climate action organization that enables companies and financial institutions worldwide to play their part in combating the climate crisis.

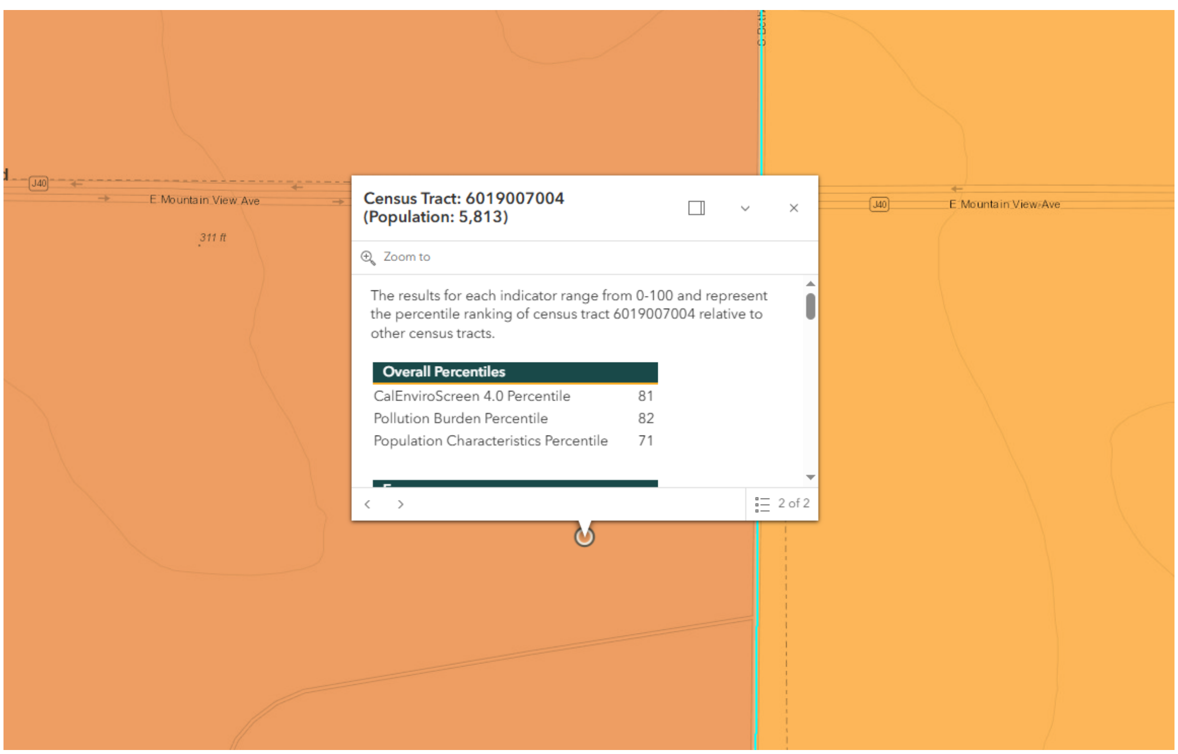
According to the California Climate Investments Priority Population Mapping Tool 4.0, the Kingsburg site is located in a priority population area, which includes residents of: (1) census tracts identified as disadvantaged by the California Environmental Protection Agency per Senate Bill 535; (2) census tracts identified as low-income per Assembly Bill 1550; and (3) a low-income household per Assembly Bill 1550. According to the CalEnviroScreen 4.0 tool, the site is in the 81st percentile for pollution and is surrounded by higher pollution burden scores.

Figure 2: California Climate Investments Priority Populations



Source: California Climate Investments Priority Populations Mapping Tool 4.0

Figure 3: CalEnviroScreen



Source: CalEnviroScreen 4.0

Issue

Industrial food processing facilities in California are major consumers of both electricity and fossil fuels. These facilities typically operate continuously and require reliable, safe, and high-quality energy resources. Because operations are generally nondiscretionary (mandatory), there are limited opportunities to curtail activities or otherwise reduce demand and usage. These types of facilities rely heavily on energy-intensive equipment, and compressed air systems are among the most demanding loads. This facility's major energy users include vacuums, compressed air, hydraulics, chilled water, heating, ventilation, and air conditioning (HVAC), boilers, facility lighting, and processing equipment. The compressed air system is essential to nearly every production stage — from sorting and conveying to packaging and quality control. Before this project, the existing compressed air system depended on outdated centrifugal and rotary screw compressors, deteriorating air dryers, and decentralized controls. It operated at high pressure levels, leading to significant inefficiencies, particularly under variable loading conditions. Similar challenges, including reliance on legacy systems, are common across food processing facilities.

Several factors drove the need to modernize the compressed air system. From an equipment standpoint, the technology landscape has advanced dramatically in recent years. Aging compressors operate at lower isentropic efficiency, exhibit poor turndown performance, and suffer from control instability, leading to pressure fluctuations and wasteful blow-off. Air dryers that depend on desiccant regeneration through external heat sources or uncontrolled purge cycles further increase electrical and thermal energy consumption. Legacy control systems limit the ability to optimize compressor sequencing, synchronize equipment behavior, and maintain stable header pressure using real-time facility demand data. From an operational perspective, the existing compressed air configuration at the Kingsburg facility had reached its efficiency limit. The system required high pressure to maintain reliable performance, and the mix of compressors often resulted in inefficient part-load operation and unnecessary energy use.

Environmentally, in regions like the San Joaquin Valley, which experiences some of the worst air quality in the state and where the project site is located, reducing stationary-source emissions provides local benefits by lowering pollutants that contribute to poor air quality. Under a regulatory and policy lens, California's climate and clean energy goals set strong ambition for industrial facilities to reduce their electricity use, fossil fuel consumption, and associated greenhouse gas (GHG) emissions. The state's targets for 2030 and 2045 require significant efforts across the industrial sector, and compressed air — often accounting for 10 to 30 percent of total site electricity use — represents a key opportunity for reductions. California's energy policy and building code have recently set standards for new compressed air systems, but typically hinder utility incentives to replace or revise existing systems. These policies and codes also set common baselines for vendors and designers, often leading to standard-practice installations rather than best-practice installations. This is mainly due to the use of first cost versus total cost of ownership when evaluating project economics. Historically, the view that the economics of continued operation of inefficient systems is superior to investment in new infrastructure with longer-term returns on investment has been a standard misperception. In a market context, although more advanced technologies are commercially available, adoption has been limited by high upfront costs, limited demonstration projects, and uncertainty about system integration and performance in demanding production environments.

Project Solution

To address these issues and align with California's continually evolving energy goals, Sun-Maid set out to upgrade and optimize its existing compressed air system, which accounted for a significant share of the facility’s energy and fossil fuel consumption.

Modern centrifugal compressors with integrated variable-speed drives, high-performance air dryers, and intelligent control platforms now offer substantial improvements over traditional rotary screw units, which are still widely used across the industry. The new system includes multiple high-efficiency centrifugal compressors equipped with variable-speed drives, an oil-free screw compressor for trim capacity, heat-of-compression (HOC) regenerative dryers (which use heat generated by the compressors rather than external electric or fossil fuel energy sources), and a centralized programmable logic controller that optimizes equipment sequencing, pressure control, and part-load behavior. Emerging and novel compressors are also significantly quieter, which increases worker safety, as the most common internal injuries are caused by hearing loss. The new system was estimated to reduce GHG emissions and energy consumption by at least 10 percent.

The project’s goals focused on site preparation, procurement and installation of equipment, measurement and verification (M&V) of energy benefits, and the establishment of a technically sound example to inform adoption at similar facilities. Objectives included: improving operational performance; enhancing system reliability; quantifying the reductions in electricity consumption, fossil fuel use, GHG emissions, and criteria pollutants; and validating results through a rigorous M&V process. This demonstration has value to numerous industrial sectors that rely heavily on compressed air, including dairy processing, beverage production, fruit and nut handling, cold storage, and general manufacturing. Facilities with continuous or semi-continuous operations, high compressor horsepower requirements, and aging infrastructure are especially well positioned to replicate the system. Factors supporting broader adoption include strong energy savings, reduced maintenance requirements, predictable performance, and ease of integration with existing distribution systems. By undertaking this project, Sun-Maid provides a real-world case study showing how high-efficiency systems can perform under continuous, high-volume operating conditions. The project demonstrates how targeted upgrades to essential production systems can advance the clean energy economy, reduce environmental impacts, and support resilient, competitive food production in the state.

CHAPTER 2: Project Approach

Project Description

In early 2019, Sun-Maid was awarded $805,584 by the California Energy Commission's (CEC) Food Production Investment Program (FPIP) for the Demonstrating an Optimized Compressed Air Energy System at the Sun-Maid Kingsburg Facility project. The project removed the legacy energy-intensive compressed air system and replaced it with an integrated suite of advanced oil-free centrifugal compressors, HOC regenerative dryers, a high-capacity air receiver system, and a programmable logic controller (PLC)-based central control architecture.

The project was implemented in three phases.

1. The preparation and procurement phase involved identifying the needs, conceptual design, and equipment vendors.
2. The installation and commission phase involved installing the equipment, verifying the functionality, and commissioning the system to meet the facility's needs.
3. The operational phase involved the operation of the system in the facility, including M&V, quality control, and maintenance.

The project was originally scheduled for 27 months but, due to the impacts of COVID and supply chain delays, it was extended to 57 months.

Permitting Requirements

This project did not require new federal, state, or local environmental permits. All work occurred inside the existing compressor building and adjacent paved yard. The work involved removing existing compressors, replacing them with higher-efficiency units, and upgrading internal infrastructure within the bounds of an existing industrial facility. The replacement of compressors, piping, air dryers, and receivers did not introduce new emissions sources or increase system capacity in a manner that would trigger permit review. Licensed contractors performed electrical work in accordance with local code requirements for panel upgrades, conduit installation, and wiring. No separate electrical permit was required because the work fell within the scope of ongoing facility maintenance and equipment replacement. Mechanical work, including piping and slab extensions, also conformed to typical maintenance and equipment swap-out activities. No interface with municipal water, sewer, stormwater, or other public infrastructure was required.

California Environmental Quality Act (CEQA)

The project qualified for an exemption from CEQA review because the scope of work involved retrofitting the existing system with functionally similar, more efficient equipment within the same footprint, without expanding operations or altering land use, and required little to no reconstruction of the existing facility. The work did not involve new construction, capacity expansion, or environmental disturbance.

The CEC confirmed the exemption based on CEQA Guidelines:

- Class 1 (Existing Facilities) — Replacement or reconstruction of existing structures and mechanical systems.
- Class 2 (Replacement or Reconstruction) — Replacement of facilities on the same site with substantially similar utility and purpose.

No ground disturbance occurred beyond the extension of an existing concrete slab to accommodate additional air receivers. This minor modification did not change the nature of the facility's operations or environmental impacts. Based on this, no additional environmental analysis or mitigation steps were required.

Project Team

The project was executed by a coordinated team of facility staff, engineers, consultants, and equipment vendors supporting design, procurement, installation, commissioning, and reporting. Joshua O'Bannon, Engineering Department Manager, led capital planning and overall project execution, drawing on experience with industrial and food-processing facility projects. Alex Suniga, Director of Finance-Operations, provided financial oversight, including budgeting, forecasting, and cost analysis. M&V activities were led by Jack DiGiacomo, President, and Thomas Cochran, Vice President, of DC Energy Services, who brought experience in industrial energy systems, refrigeration, and utility efficiency programs. Equipment vendors, including Michael Bakalyar of Bakalyar Enterprises and Ed Ball of Process Air Solutions, contributed technical expertise in compressed air system design, performance optimization, and system reliability. The project also received significant internal support from Sun-Maid's board members and its engineering, maintenance, and sustainability teams. In addition, it received strong external support from California State University, Fresno; Lockheed Martin Energy; the City of Kingsburg Economic Development Division; and the Association of Energy Engineers. This broad base of stakeholder support contributed to the project's viability and helped justify its implementation. The successful execution of the project relied on a coordinated, skilled team of technical experts, facility staff, engineers, contractors, and third-party consultants. These individuals were instrumental in project development, design, procurement, installation, commissioning, and reporting.

Food Facility Team

Joshua O'Bannon has 6 years of experience as the Engineering Department Manager for Sun-Maid. His responsibilities include capital planning and oversight of all capital and expense projects. O'Bannon is experienced in the engineering, design, and management of industrial/food processing, private works, public works, and school construction and alteration projects.

Alex Suniga is the Director of Finance-Operations for Sun-Maid. Suniga has 14 years of extensive accounting experience within the consumer packaged goods arena, having worked for Foster Farms poultry ($3.5 billion), Ruiz Foods ($900 million), and now Sun-Maid. Suniga brings an array of financial experience, including forecasting, financial analysis, operations, and cost accounting.

M&V Team

Jack DiGiacomo has over 10 years of experience in management, construction, consulting, energy engineering, and utility incentive programs. His experience spans building design, wastewater management, compressed air, vacuum, industrial refrigeration, HVAC, process cooling, fluid handling, lighting, and process improvements. While his main focus has been on demand-side management solutions with utility incentive programs, he has been working on business development opportunities with the distributed energy solutions team for energy storage projects and participating in utility program proposals nationally. He is currently the President and Co-Founder of DC Energy Services and oversees the company's multidisciplinary operations.

Thomas Cochran has 7 years of experience in the industrial/commercial energy-efficiency market and 6 years in industrial refrigeration. He earned his Bachelor of Science in mechanical engineering with an emphasis in thermal fluids and alternative energy. Cochran worked for Lockheed Martin as a Project Engineer for over 3 years, assisting with the implementation of Southern California Edison's Industrial Energy Efficiency Program. Cochran is Vice President and Co-Founder of DC Energy Services, an engineering and consulting firm that specializes in industrial systems, energy engineering, and project management.

Equipment Vendors

Michael Bakalyar is President of Bakalyar Enterprises, LLC, and a consultant for Process Air Solutions. During his 40+ years in the compressed air industry, Bakalyar has served in management and officer roles for two major distributors and a major manufacturer, developing and directing technical sales and service teams specializing in system evaluation and problem-solving. He has worked with his teams to develop tools and processes that accurately profile demand and power, providing a valid basis for modeling solutions and ensuring that project implementation delivers the modeled (promised) results. He has served in an advisory capacity for major compressor and air treatment manufacturers, promoting the importance of best-practice performance and reliability in real operating environments. He has also served as a subject-matter expert for the Compressed Air and Gas Institute System Assessment Section, tasked with developing an American National Standards Institute-accredited exam for the certification of "Compressed Air Specialist".

Ed Ball is a consultant for Process Air Solutions. Ball has 7 years of experience in the technical application of compressed air and gas compression and drying equipment. Mr. Ball also has 20 years of experience as a compressor and blower distributor in Wyoming and Montana, where ambient conditions make it difficult to provide clean, dry compressed air during extreme cold conditions. He served on the Project Development Committee of the Compressed Air Challenge for 6 years as clean dry air technical representative.

Local Support

This project received significant internal support from Sun-Maid's board members, engineering, maintenance, and sustainability management. In addition, the project received applause and support from: California State University, Fresno; Lockheed Martin Energy; the City of Kingsburg Economic Development Division; and the Association of Energy Engineers.

The expression of support from so many stakeholders helped influence the project's viability and justify commitment to it.

Figure 4: DC Energy Services (dba Imperion) and CEC Project Team

Source: California Energy Commission

Site Preparation and Equipment Procurement

During this phase, the project focused on site preparation, including removing the old system and preparing the slab, piping, and electrical connections for the new system. The project also procured the necessary equipment and materials for the upgraded compressed air system. Sun-Maid completed the following tasks.

- Removal of Equipment to Be Replaced — The team extracted the glycol from the existing cold-water cooling system and the five compressors; removed the five compressors, existing dryers, filters, and associated piping (air, water, and condensate); and disconnected the electrical circuits and control wiring from all equipment.
- Prepping and Cleaning the Concrete Slab — The team saw cut and removed a small area of asphalt next to the existing compressor slab, and it formed and poured a slab extension for the additional air storage tanks.

While prepping the site, the project team began concurrently determining the specific equipment to procure. The project developed performance specifications for the existing and new equipment. Sun-Maid’s pre-existing compressed air system consisted of one 500-horsepower (hp) 3-stage centrifugal, three 400-hp 2-stage rotary screws, oil-free compressors, and one 100-hp single-stage rotary screw, variable frequency drive (VFD)-equipped compressor. The equipment supplied two 2,350-gallon wet air receivers, which then supplied two 2100-cubic feet per minute (CFM) heatless desiccant air dryers. The compressors were staged via a PLC-based control system that rotates the trim compressors in and out in a normal rotation to maintain even runtimes. The existing equipment specifications are listed in tables 1–3 below.

Table 1: Specifications for Existing Air Compressors

Details	Compressor #1	Compressor #2	Compressor #3	Compressor #4	Compressor #5
Manufacturer	Elliot	Kobelco	Kobelco	Kobelco	Ingersoll Rand
Model	PAP-Plus-500	KNW 400-125	KNW 400-125	KNW 400-125	IRN100H
Type	3-Stage Centrifugal	2-Stage Rotary Screw	2-Stage Rotary Screw	2-Stage Rotary Screw	2-Stage Rotary Screw
HP	500	400	400	400	100
Stages	3	2	2	2	2
Lubricant	Oil-Free	Oil-Free	Oil-Free	Oil-Free	Synthetic
Cooling	Water	Water	Water	Water	Air
Controls	Inlet Guide Vane With Blow-off	Load Unload	Load Unload	Load Unload	VFD
Full Load Flow (ACFM)	2642@115 psig	1975@125 psig	1975@125 psig	1975@125 psig	467@125 psig
Full Load (kW)	365	332	332	332	85
Unloaded (kW)	N/A	39.2	39.2	39.2	2017
kW/ACFM	7.238	5.949	5.949	5.949	5.494
Voltage (V)	4160	460	460	460	460
Year Built	1996	1996	1996	1996	2011

Key: ACFM=actual cubic feet per minute; psig=pounds per square inch; Kw=kilowatt
Source: DC Energy (dba Imperion)

Table 2: Specifications for Existing Air Dryers

Details	Dryer #1	Dryer #2
Manufacturer	Pneumatech	Pneumatech
Model	EH-2100	EH-2100
Type	Heatless Dessicant	Heatless Dessicant
Rated Flow	2100	2100

Details	Dryer #1	Dryer #2
Pressure Dew Point	-60	-60
Year Installed	1997	1997

Source: DC Energy (dba Imperion)

Table 3: Specifications for Existing Air Receivers

Details	Receiver #1	Receiver #2
Manufacturer	Hanson	Hanson
Serial	37324	37324
Type	Wet	Dry
Number of Gallons	2100	2350
Year Built	1997	1997

Source: DC Energy (dba Imperion)

Sun-Maid procured all major equipment in accordance with engineering specifications. Sizing and selection of equipment were based on the facility's current air requirements, energy-efficiency benefits, and cost savings. Equipment vendors provided performance specifications. The new system included three Gardner Denver Quantima Q52 400-hp 2-stage centrifugal compressors with integrated VFD motor controls, one Gardner Denver Ultima U160 215-hp 2-stage VFD screw compressor, three Sahara Henderson SP-8500 and SP-1500 HOC regenerative dryers, one PSC-2000 flow pressure controller, and the addition of a new PLC automation system with interface controls for the new compressors. The new centrifugal compressors provide the total facility compressed-air load, while the new VFD screw compressor enables trim control and load shaping as needed.

The new PLC was programmed to maximize the overall system efficiency while maintaining the facility at a reduced system pressure. The PLC continuously analyzes the total system flow and the flow from each compressor. It controls the system by balancing the load as efficiently as possible, using pressure algorithms in the main header. The baseline system operated the compressors at 125 pounds per square inch gauge (psig) setpoints to maintain an average engine room header pressure of approximately 103 psig. In contrast, the installed system operates the baseload centrifugal compressors at a 95-psig setpoint and the load-shaping screw compressor at 130 psig. The new PLC and flow controller intelligently discharge the 130-psig load shaping system to maintain an average engine room header pressure of approximately 95 psig. The specifications for the grant-funded installed equipment are listed in tables 4–6.

Table 4: Specifications for Proposed Air Compressors

Details	Compressor #1	Compressor #2	Compressor #3	Compressor #4	Compressor #5
Manufacturer	Gardner Denver	Gardner Denver	Gardner Denver	Kobelco	Gardner Denver

Details	Compressor #1	Compressor #2	Compressor #3	Compressor #4	Compressor #5
Model	Quantima Q52	Quantima Q52	Quantima Q52	KNW 400-125	Ultima I160
Type	2-Stage Centrifugal	2-Stage Centrifugal	2-Stage Centrifugal	2-Stage Rotary Screw	2-Stage Rotary Screw
HP	400	400	400	400	215
Stages	2	2	2	2	2
Lubricant	Oil-Free	Oil-Free	Oil-Free	Oil-Free	Synthetic
Cooling	Water	Water	Water	Water	Air
Controls	VFD	VFD	VFD	Load Unload	VFD
Full Load Flow (ACFM)	1762@100 psig	1762@100 psig	1762@100 psig	1975@125 psig	842@125 psig
Full Load (kW)	300	300	300	332	160
Unloaded (kW)	7.5	7.5	7.5	39.2	4

Source: DC Energy (dba Imperion)

Table 5: Specifications for Proposed Air Dryers

Details	Dryer #1	Dryer #2	Dryer #3
Manufacturer	Sahara	Sahara	Sahara
Model	HAF-9000	HAF-9000	HAF-2400
Type	HOC	HOC	HOC
Rated Flow	9000	9000	2400
Pressure Dew Point	-60	-60	-60

Source: DC Energy (dba Imperion)

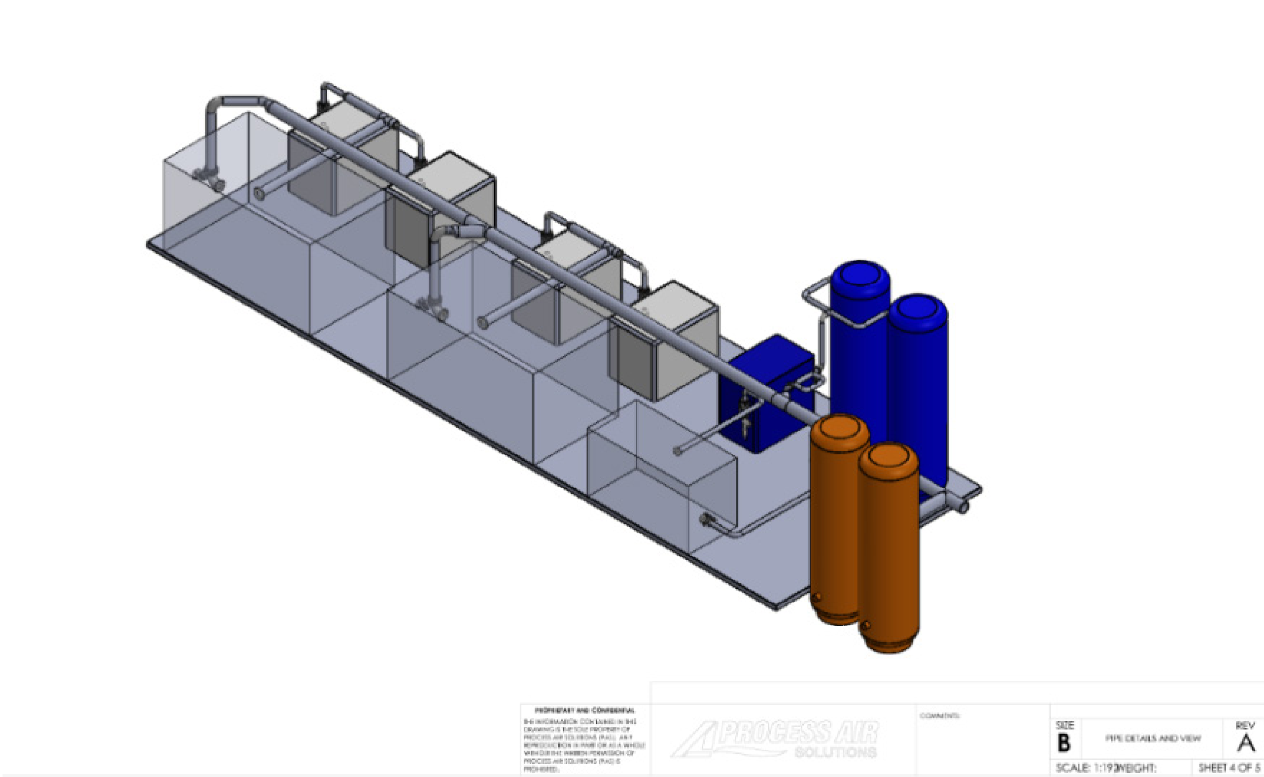
Table 6: Specifications for Proposed Air Receivers

Details	Receiver #1	Receiver #2	Receiver #3	Receiver #4
Manufacturer	Hanson	Hanson	SPV	SPV
Serial	37324	37324	-	-
Type	Dry	Dry	Dry	Dry
Number of Gallons	2350	2350	2350	2350

Source: DC Energy (dba Imperion)

The project team developed the piping layout for the compressed air system using the equipment specifications in the tables above; see Figure 5.

Figure 5: New Compressed Air System Piping Layout



Source: Sun-Maid Growers of California

Equipment Installation and Commissioning

In this phase, the team executed all tasks required to install and commission the new system. The equipment installation requirements for the project were complex. Sun-Maid completed the following tasks.

- It properly scheduled the installation of the new system during the facility's nine-day window of downtime for its annual inventory, making the installation complex and requiring a vertical startup. In an installation process, a "vertical startup" is a rapid, efficient approach to achieving full production capacity, aiming for a quick ramp-up with minimal disruptions.
- It coordinated the installation of all the equipment for the new system by setting and anchoring the larger equipment, including four compressors, three air dryers, four air receivers, and one heat exchanger. It fabricated and installed the stainless-steel air headers, compressor drops, crossover piping to dryers, pressure control piping, and inter-receiver connections. It installed the glycol cooling lines for both compressors and dryers, then filled the system with a glycol-demineralized water mixture. It installed two new 480-V electrical panels, adding and modifying conduit runs, connecting control and communication wiring, and integrating the new PLC.

- It commissioned equipment with factory technical support and adjusted it as needed to meet stated performance specifications. The new system had no issues during startup or commissioning and successfully delivered dry, clean compressed air to the facility before the end of the downtime. Sun-Maid verified the integrity and functionality of the installed equipment. It continuously adjusted the system until it reached its best-efficiency point and its lowest dynamic efficiency, based on the facility load profile. A crew of approximately 16 worked 12- to 14-hour days to address any issues during the installation process.

All equipment met or exceeded performance expectations. The system achieved operational status 10 hours before production resumed. One of the compressors was maintained as a reserve source but it has been electrically disconnected to prevent regular operation; see Figure 6.

Figure 6: Overall Installed System

Source: California Energy Commission

Project Changes and Challenges

Like most large-scale industrial retrofits, the project encountered challenges. The project was formally given a year-and-a-half no-cost time extension to the schedule. The most prominent project challenges were as follows.

- COVID-19 — Requirements resulting from COVID-19 impacted the project with several time-consuming limitations. Staff (including project team members) were unable to continue working; shipments of equipment under warranty were delayed; on-site social distancing protocols were implemented; and a mix of in-person and virtual meetings was held to finalize the project.
- Timeline — Food processing scheduling would typically prohibit the removal and replacement of a utility system like compressed air during normal operating conditions. All work had to occur within a rigid nine-day window. The short timetable required significant preplanning, prefabrication, pre-staging of materials, scheduling of additional labor capacity, and arrangements for extended service hours with local suppliers.
- Complex Electrical Work — The project required new electrical panels, which required facility-wide coordination for temporary shutdowns.
- Heat Recovery Delay — The heat recovery system tie-in was not completed due to additional energy-efficiency opportunities identified surrounding the steam and hot water systems supplied by the facility’s main boiler.

CHAPTER 3: Results

M&V Plan

DC Energy (dba Imperion) conducted all M&V activities for the project, including developing an M&V plan, monitoring and collecting pre- and post-installation data, and analyzing and generating M&V finding reports. The M&V protocol used was the International Performance Measurement and Verification Protocol, Option B (Retrofit Isolation: All Parameter Measurement). This option was selected because it allows for direct measurement of energy use attributable to the compressed air system while isolating savings from other facility processes. There were two time periods for energy data collection: 3 months of pre-installation data and 12 months of post-installation data. The pre-installation dataset established a baseline representative of typical operating conditions, while the post-installation dataset captured system performance across seasonal changes and production variations.

A comprehensive suite of monitoring equipment and instrumentation was selected and installed to capture all critical input and output parameters influencing the performance of the compressed air system. The monitoring system included true-power electrical meters installed on each compressor to accurately measure energy consumption and demand, pressure transducers located at critical points within the compressed-air header to track system pressure, and flow meters to quantify the total compressed air delivered. Temperature sensors were also installed on compressor discharge lines and dryer circuits to evaluate thermal performance and operating conditions. All sensors were connected to data loggers capable of recording data at 15-minute intervals. Instrumentation was installed before equipment replacement to establish a measured baseline and to ensure consistency and comparability of data collected before and after the system was implemented.

The monitoring system measured a set of key input parameters to evaluate system performance (Table 7). Measured input parameters included electrical energy consumption in kilowatt-hours (kWh), electrical demand in kilowatts (kW), system pressure in psig, compressed air flow in standard cubic feet per minute, and the compressor operating hours. These measured inputs were used to calculate a range of output metrics required for project evaluation and reporting. Output metrics calculated from these parameters included annual electricity use and reductions, peak electricity demand reductions, GHG emission reductions in metric tons of carbon dioxide equivalent ($MTCO_2e$), and reductions in criteria air pollutants.

Table 7: Key Parameters

Objective	Measurement Parameter	Interval	Duration	Equipment	Equipment Accuracy
Estimate Pre-Installation Energy Usage	CFM	1 hr	3 mons	EMS	+/- 2.5 %

Objective	Measurement Parameter	Interval	Duration	Equipment	Equipment Accuracy
Estimate Pre-Installation Energy Usage	Amperage	15 sec	3 wks	Current Data Logger	+/- 2.1 %
Estimate Pre-Installation Energy Usage	psig	1 hr	3 mons	EMS	+/- 2.0 %
Estimate Post-Installation Energy Usage	CFM	1 hr	12 mons	EMS	+/- 3.0 %
Estimate Post-Installation Energy Usage	Amperage	1 min	12 mons	EMS	+/- 3.0 %
Estimate Post-Installation Energy Usage	psig	1 hr	12 mons	EMS	+/- 3.0 %

EMS=energy management system
Source: DC Energy (dba Imperion)

The M&V plan and approach were prepared assuming that:

- The facility planned no major building projects, such as building additions or equipment additions, which would significantly alter the air flow demand.
- The facility would continue to run as a yearly facility.
- The operating and production schedule would not be altered, to allow consistency.
- The current operation was consistent with the previously collected power data utilized in the approved Pacific Gas and Electric (PG&E) protocol. Flow and pressure data would be collected and correlated with previous power monitoring data, and any baseline adjustments could be made based on this updated flow data, as flow and power are directly correlated.

Analytical methods included systematic data validation and cleaning to remove anomalies, normalization to account for production variability where applicable, and annualization of pre-installation data to allow direct comparison with post-installation performance. Emissions and environmental benefits were calculated using emission factors consistent with the FPIP quantification methodology. All assumptions applied in the analysis are documented in subsequent sections.

Estimated Benefits

The projected benefits for the project were developed using the FPIP Benefits Calculator Tool and were based on the above assumptions. Data was collected at the facility from mid-March to mid-April 2016 (one month) at 15-second intervals. The projected benefits from the submitted proposal were reductions in: electricity consumption due to compressor efficiency gains, GHG emissions associated with reduced energy consumption, and criteria air pollutant emissions (Table 8). Because the facility is located in a priority population, projected benefits also included improved air quality and support for local economic stability.

Table 8: Estimated Savings

Savings	Electricity Use (kWh/Yr)	GHG Emissions Emitted ($MTCO_2e/Yr$)	Electricity Reduction (kWh/Yr)	GHG Emissions Reduction ($MTCO_2e/Yr$)
Estimated	5,527,511	9,106	2,034,276	580.22

Source: DC Energy (dba Imperion)

Pre- and Post-Installation M&V Findings

Pre-Installation M&V Findings

Pre-installation data were collected over three months prior to the equipment removal. During pre-installation data collection, a pre-installation inspection was conducted, and the existing equipment model numbers, capacities, and operating parameters were verified to be consistent with those previously submitted. Pre-installation monitoring of the compressed air system air demand and pressure was conducted from April to July 2019 (3 months) at 1-minute intervals. This monitoring was accomplished using existing flow and pressure meters and an energy management system at Sun-Maid. Minor disruptions occurred due to routine maintenance and brief facility outages, but these events were documented and, where necessary, excluded from baseline calculations. No major changes to the M&V plan were required during the pre-installation period.

Pre-installation data were annualized using operating-hour records and production schedules (Table 9). Adjustments were made to account for seasonal variations and downtime periods. Annualization assumed that measured conditions were representative of typical facility operations.

Table 9: Annualized Pre-Installation Measurements

Savings Summary	Pre-Installation Energy Use (kWh/Yr)	Pre-Installation Emissions Emitted ($MTCO_2e/Yr$)	Estimated Energy Reduction (kWh/Yr)	Estimated Emissions Reduction ($MTCO_2e/Yr$)
On-Peak Production	4,075,599	929	973,422	222
Off-Peak Production	2,587,212	590	703,866	160
Total	6,662,811	1,518	1,677,288	382

Source: DC Energy (dba Imperion)

To determine the pre-installation annual electricity usage of the compressed air system, power and pressure measurements were collected over several weeks. Since the compressor system's operating profile changed regularly, it was necessary to split the data into two distinct operating-day types. The two distinct operating types are referenced as on-peak and off-peak hours. The two different profile types were then assigned their annualized hours of operation.

Based on the data:

- During on-peak hours, the facility operated for a total of 4,680 hours per year:
    - 18 hours per day, 5 days per week, 52 weeks per year.
- During off-peak hours, the facility operated for a total of 3,432 hours per year:
    - 6 hours per day, 5 days per week (24 hours per day on Saturdays and 12 hours per day on Sundays), 52 weeks per year.

The total combined hours of operation were thus 8,112 hours per year. Using the annual baseline electrical energy consumption values for the compressed air system, GHG emissions associated with the pre-existing equipment were calculated using the California Air Resources Board's FPIP Calculator tool. The results are described below.

Post-Installation M&V Findings

Post-installation data were collected continuously for 12 months following commissioning (Table 10). During post-installation data collection, an inspection was conducted to verify that the installed system met expectations. Post-installation monitoring of compressed air system air demand and pressure was conducted from February 2021 to February 2022 (12 months) at 1-minute intervals. This monitoring was conducted using flow, current, and pressure meters, as well as the energy management system at Sun-Maid. The data was downloaded monthly, validated, and stored. This period captured variations in production levels, ambient temperatures, and operating schedules. Data quality was high, with only minor gaps due to temporary communication outages, which were resolved via interpolation. No changes to the M&V protocol were required during the post-installation period.

Table 10: Post-Installation Measurements

Savings Summary	Post-Installation Energy Use (kWh/Yr)	Post-Installation Emissions Emitted ($MTCO_2e$/Yr)	Actual Energy Reduction (kWh/Yr)	Actual Emissions Reduction ($MTCO_2e$/Yr)
On-Peak Production	1,787,581	407	2,288,017	521
Off-Peak Production	434,143	99	2,153,069	491
Total	2,221,725	506	4,441,086	1,012

Source: DC Energy (dba Imperion)

Excel pivot tables were utilized to organize, group, and summarize the data. During data review, it was observed that the system operating profile was consistent with the pre-installation operation, and it was necessary to split the data into two operating profiles.

- The On-Peak Production profiles included operations Monday through Friday from 4 am to 11 pm.
- The Off-Peak Production profile included operations Monday through Friday from 11 pm to 4 am and Saturday and Sunday from 12 am to 12 am.

Using the annual baseline electrical energy consumption values for the compressed air system, GHG emissions associated with the post-installation equipment were calculated using the California Air Resources Board's FPIP Calculator tool. The system's energy operation modeling was accomplished using custom spreadsheet-based calculation models developed by DC Energy (dba Imperion) based on system requirements, throughputs, and operating hours.

All data analysis and additional calculations were utilized in custom-developed Excel spreadsheets.

Project Findings

Upon completing the analyses, the collected pre- and post-installation M&V results were compared with the estimated savings used to develop the project application, as shown in Table 11.

Table 11: Actual Project Savings

Savings	Electricity Reduction (kWh/Yr)	GHG Emissions Reduction ($MTCO_2e$/Yr)	Air Demand Reduction (CFM)
Estimated Savings	2,038,276	1,139	630
Actual Savings	4,441,086	1,012	1,446
Difference	118%	-11%	130%

Source: DC Energy (dba Imperion)

As a result of the delayed tie-in of the heat recovery system to the end use, the overall emissions savings decreased by 11 percent from the originally estimated level. However, the project's performance has exceeded expectations, with CFM and electricity savings far higher than originally anticipated when the project application was developed.

The new compressed air system is currently saving approximately 4,441,086 kWh of electricity and 1,012 $MTCO_2e$ in GHG emissions annually. In addition to the savings, sufficient compressed air capacity and improved air quality are contributing factors to the project's overall success. Sun-Maid's Engineering Manager has been extremely satisfied with the project's outcome and the efficiency gains observed thus far. "We have been able to successfully reduce our overall facility air pressure, reduce air waste, and significantly reduce improper uses of air in the facility," he stated. "An additional benefit to the installation of a new compressed air system is the reduction in maintenance costs associated with keeping an inefficient system running. Our highly skilled Stationary Engineers can now focus on more important duties, such as putting raisins in the red box, instead of babysitting the compressors, dryers, and cooling system. Since our compressed air encounters the raisins during the washing and cleaning process, clean, dry, oil-free air is a must, which is what this new compressed air system delivers.”

CHAPTER 4: Conclusion

This demonstration project successfully validated the performance, reliability, and market readiness of a fully optimized compressed-air system in a large-scale food-processing facility operating under real-world production conditions. By replacing aging, inefficient equipment with advanced oil-free compressors, HOC regenerative dryers, expanded air storage, and intelligent system controls, the project achieved substantial and verifiable reductions in electricity consumption and GHG emissions while maintaining production quality and operational continuity. These outcomes confirm that comprehensive optimization of compressed air systems is a high-impact, cost-effective pathway to advance industrial energy efficiency and decarbonization in California. The project directly addressed a core challenge facing California's industrial sector: reducing energy use and emissions without compromising productivity or competitiveness. Measured post-installation results demonstrated annual electricity savings of approximately 4.4 million kWh and annual GHG reductions of approximately 1,012 $MTCO_2e$ using commercially available technologies that can be readily replicated across similar facilities.

From a clean energy policy perspective, the project reinforces the role of industrial efficiency as a cornerstone of California's decarbonization strategy. While renewable energy and electrification remain essential, this demonstration highlights the value of reducing energy demand at the source. By lowering electricity consumption and peak demand, the project supports grid reliability and reduces the need for new generation and transmission infrastructure. These benefits are particularly important as California transitions toward a cleaner but more constrained electricity system.

The implications for commercial markets are significant. Compressed air systems are widely used across food processing, cold storage, beverage manufacturing, pharmaceuticals, electronics, and other industrial sectors. Many of these systems operate with inefficiencies similar to those observed prior to this project, including excessive system pressure, poor load management, and limited control integration. This demonstration provides independently verified evidence that a system-level approach — rather than incremental equipment replacement — can unlock deeper energy savings and improved operational performance. For industry decision-makers, the project reduces perceived technical and financial risk by demonstrating proven performance in a demanding production environment.

The project also offers meaningful benefits to California's economy and priority populations. The host facility operates within a priority population, where reductions in energy demand and associated emissions contribute to improved local air quality and public health outcomes. Additionally, the project supports long-term economic resilience by lowering operating costs for a major food processing facility, helping to preserve jobs and sustain agricultural supply chains critical to California's economy.

From a financial perspective, the demonstrated energy savings translate into a favorable return on investment. Based on measured electricity reductions and prevailing industrial electricity rates, the expected simple payback period falls within a timeframe attractive to commercial and cooperative food processors, particularly when combined with incentives from state and utility programs. The project shows that advanced compressed air systems can deliver both environmental and economic value, strengthening the business case for broader adoption.

Several important lessons emerged from the project that can inform future development and deployment. First, early investment in robust M&V is essential for establishing credible baselines and validating performance. Second, advanced controls and system integration are critical to achieving and sustaining deep energy savings. Third, conservative assumptions during project planning can be exceeded when systems are properly designed, commissioned, and operated. These lessons can help streamline future projects and improve outcomes across similar applications.

To accelerate the adoption of advanced compressed air systems and similar decarbonization strategies, the project team recommends:

- Promoting system-level optimization rather than component-only upgrades in incentive and program design.
- Encouraging early metering and data collection to support accurate baselines and performance verification.
- Expanding technical assistance and training focused on compressed air system design, controls, and maintenance.
- Leveraging demonstration results to reduce perceived risk for first-time adopters in the food processing sector.
- Aligning incentives with peak demand reductions, recognizing the grid benefits of industrial efficiency projects.

The market opportunities for this technology and knowledge are broad. Facilities with continuous compressed air demand, aging equipment, high electricity costs, or sustainability commitments are strong candidates for replication. Beyond food processing, sectors such as cold storage, beverage production, dairy processing, pharmaceuticals, and advanced manufacturing are well-positioned to adopt similar solutions due to comparable operational requirements and compressed air quality standards. Factors contributing to acceptance include proven cost-effectiveness, availability of commercial equipment, ease of integration with existing systems, and manageable maintenance requirements.

Knowledge transfer and outreach were integral components of the project. The project team also engaged and collaborated with technology vendors, engineers, energy-efficiency practitioners, and other industry stakeholders and program administrators to disseminate lessons learned and performance data. Project findings were shared through multiple outlets, including:

- Utility Representative Meetings — The project team participated in multiple PG&E, Southern California Edison, Imperial Irrigation District, and Southern California Gas utility representative meetings in which this project was presented as an example of how utility incentive and grant programs can support energy efficiency in compressed air systems for food processing and industrial manufacturing segments. The objectives of the meetings were to educate utility representatives on the decarbonization opportunities available to their customers through compressed air system retrofits. These activities helped ensure that the benefits of the demonstration extended beyond a single facility and contributed to broader market transformation.

- Compressed Air Vendor Presentations — Currently, many compressed air vendors are no longer pursuing energy-efficiency opportunities with their customers as a result of the 2013 Title 24 standards for compressed air systems. The project team participated in multiple compressed air vendor presentations in which this project was presented as an example of how utility incentive and grant programs can support energy efficiency in compressed air systems for food processing and industrial manufacturing segments. The objectives of the meetings were to educate vendors on the opportunities available to their customers for decarbonization and energy savings through compressed air system retrofits.
- Site Tours — Sun-Maid encouraged project partners to host project walkthroughs with various food processors and industrial manufacturers. To date, the facility has hosted several walkthroughs with outside businesses to showcase the project's success.
- Speaking Opportunities — Project case studies and presentation materials with performance data and project outcomes were shared at various conferences and stakeholder workshops. These include the California League of Food Producers' Food Processing Expo in 2019, 2020, and 2022, and the Food Producers/FPIP & SEM Energy Workshop, held in Downey, California, in 2019. The objectives of the speaking opportunities were to share project results with key decision-makers and other interested stakeholders and thus invigorate the marketplace for similar projects.
- Published Documents — Project case studies were developed by Sun-Maid's third-party M&V consultants to describe the project issues and benefits, and ultimately the results of the project analysis. In addition, the project was featured in the California Climate Investments 2020 Annual Report.[1].
- Energy Project Awards — The project team nominated the project for various project awards and was awarded the Region V Energy Project of the Year Award for 2020 by the Association of Energy Engineers. Through this award, the project's success was shared at the virtual award ceremony with over 18,000 members in more than 100 countries.

In conclusion, this project demonstrates that advanced optimization of compressed air systems is a practical, scalable, and impactful strategy for reducing industrial energy use and emissions in California. The verified results support California's clean energy and climate objectives, strengthen the business case for industrial efficiency, and provide a clear roadmap for

[1] California Climate Investments. 2020. *2020 Annual Report*. http://ww2.arb.ca.gov/sites/default/files/auction-proceeds/2020_cci_annual_report.pdf

replication across multiple sectors. By combining proven technology, rigorous measurement, and effective knowledge transfer, the project offers lasting value to the environment, the economy, and the communities it serves.

List of Terms/Glossary

Term	Definition
California-based vendor(s)	A vendor with equipment manufactured in California or a distribution center in California
CCI	California Climate Investments — a statewide initiative that puts billions of Cap-and-Invest, formerly known as Cap-and-Trade, dollars to work reducing greenhouse gas emissions, strengthening the economy, improving public health and the environment, and providing meaningful benefits to the most disadvantaged communities and low-income communities and households, collectively referred to as priority populations
CEC	California Energy Commission
CEQA	California Environmental Quality Act, California Public Resources Code Section 21000 et seq.
CFM	cubic feet per minute
EMS	energy management system
FPIP	Food Production Investment Program — the administrator of funding for the projects awarded under this solicitation
GHG	greenhouse gas
HOC	heat of compression
hp	horsepower
HVAC	heating, ventilating, and air conditioning
kW	kilowatts of electricity
kWh	kilowatt-hours of electricity
M&V	measurement and verification
$MTCO_2e$	metric tons of carbon dioxide equivalent
PG&E	Pacific Gas and Electric Company
PLC	Programmable logic controller
Priority populations	Residents of (1) census tracts identified as disadvantaged by the California Environmental Protection Agency per Senate Bill 535; (2) census tracts identified as low-income per Assembly Bill 1550; or (3) low-income households per Assembly Bill 1550.
psig	pounds per square inch gauge
V	volt — the standard measure of electricity
Sun-Maid	Sun-Maid Growers of California
VFD	variable frequency drive