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**Kerman Energy Efficiency Upgrade
Program**

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PREFACE

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

The Food Production Investment Program, established in 2018, encourages California food producers to reduce greenhouse gas (GHG) emissions. Funding comes from the [California Climate Investments](#) program, a statewide initiative that uses cap-and-trade dollars to help reduce GHG emissions, strengthen the economy, and improve public health and the environment.

The food processing industry is one of the largest energy users in California. It is also a large producer of GHG emissions.

The Food Production Investment Program will help producers replace high-energy-consuming equipment and systems with market-ready and advanced technologies and equipment. The program will also accelerate the adoption of state-of-the-art energy technologies that can substantially reduce energy use and costs and associated GHG emissions.

Kerman Energy Efficiency Upgrade Program is the final report for the project FPI-18-013 conducted by Baker Commodities, Inc. The information from this project contributes to the Energy Research and Development Division's FPIP Program.

For more information about the Energy Research and Development Division, please visit the [CEC's research website](http://www.energy.ca.gov/research/) (www.energy.ca.gov/research/) or contact the CEC at ERDD@energy.ca.gov.

ABSTRACT

Baker Commodities, Inc. implemented the Kerman Energy Efficiency Upgrade Program to reduce costs, increase quality and efficiency, and lower polluting emissions. Baker upgraded its Kerman, California rendering and meat byproduct processing facility by replacing outdated, inefficient equipment with drop-in ready, commercially available technologies from California vendors. These energy-efficient upgrades, which included installing a high-efficiency boiler and a new metering hopper, were designed to reduce energy costs and improve the quality and consistency of production. Post-installation verification confirmed that the project achieved annual reductions of 2,891 metric tons of carbon dioxide equivalent, more than double the original projection. The new boiler increased efficiency and reliability, while the metering hopper improved process control, stabilized throughput, and reduced energy demand. Together, these improvements reduced the facility's reliance on fossil fuels, strengthened resilience, and helped sustain local employment. Importantly, the project—located in a low-income, disadvantaged community with a pollution burden in the 91st percentile—also delivered environmental and public health benefits by cutting criteria air pollutants and toxic air contaminants. Beyond the direct gains at the Kerman facility, Baker has shared lessons learned across its 20 United States locations and through national industry associations, encouraging broader adoption of energy-efficient technologies within the food processing sector. The project demonstrates how targeted investments can simultaneously advance decarbonization, improve industrial competitiveness, and bring meaningful benefits to California communities.

Keywords: Energy efficiency, rendering, facility upgrades, boiler, hopper, food production

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Executive Summary

Introduction

Baker Commodities, Inc. (Baker) provides a wide range of rendering, plumbing, and grease management services nationwide. Baker has been family-owned since 1937 and is currently operated by three generations of the Andreoli family. At the Kerman location, a variety of process equipment collectively convert meat scraps, trap grease, and used cooking oil from restaurants into two types of nutrient-dense animal feed — meat and bone meal and feeding fats — as well as other products such as renewable diesel. Baker's 20 facilities help to alleviate the nation's problem of over-burdened landfills by recycling millions of pounds of animal by-product and used cooking oil that would otherwise be disposed of as waste. The Kerman division processes at least 5.5 million pounds per week of these materials.

Meat and bone meal is used by nutritionists as a protein and energy supplement in poultry and swine feed and is also used as an ingredient in the manufacturing of pet food. It is a high-protein meal that boosts the feed rations of livestock and cannot be obtained by crop feeds such as corn. Feeding fats are blends of recycled used cooking oil and animal fats produced by rendering mammal and poultry tissue. Fats have the highest caloric value available for animal nutrition. The animal feed and ingredient industries are the largest consumers of these rendered fats and oils.

Project Purpose

Baker implemented the Kerman Energy Efficiency Upgrade Program to reduce costs, increase quality and efficiency, and lower polluting emissions by replacing inefficient equipment with commercially available, drop-in ready, high-efficiency equipment. The Food Production Investment Program grant reduced the financial risks associated with plant shutdowns, enabling Baker to install new, more efficient equipment and significantly reduce greenhouse gas emissions and operational costs.

The margins in food production are tight. As a result, producers often operate plants continuously for long periods, shutting down only on rare occasions for maintenance or vital repairs. Upgrading existing and functional equipment to more energy-efficient versions is often not a high priority for food production plant operators and typically does not occur until the equipment reaches the end of its useful lifetime or fails completely. For these reasons, Baker had not yet upgraded most of its Kerman, California facility equipment in more than 10 years.

Baker conducted outreach to community organizations and residents and received letters in support of the project from the City of Kerman Public Works Department, H&J Chevrolet, and R.O.C., Inc., a small family-owned transportation company.

Project Approach

Baker was the principal stakeholder who undertook all purchasing and engineering. Momentum was hired as a subcontractor for grant management and measurement and

verification work. Initially, the project proposed a longer list of upgrades, including replacing six inefficient drive motors and pumps, installing new automated control systems, a new metering system, installing a new high-efficiency boiler, insulating two holding tanks, and replacing an old compressor. After additional analysis, the project team, which included Baker engineers and Momentum, decided to move forward with a revised and streamlined list of improvements that would still achieve the expected greenhouse gas reductions. The team focused on funding these items:

1. Installing a new metering hopper, which regulates the flow of material into the cookers, also known simply as a “hopper”
2. Installing a new high-efficiency boiler to replace an existing, oversized system

The final upgrades improved the efficiency of key components for the facility. Prior to these changes, the cookers were experiencing larger energy swings when they were fed too quickly or too slowly. These speed fluctuations would often lower the temperature of the cookers, requiring the boiler to run at higher speeds and increasing natural gas use. The improved feed control of the metering hopper now provides more consistent temperature within the cookers, which equates to a better regulated and consistent demand on the new Hurst boiler.

Project Results

Baker estimated the total annual greenhouse gas reductions for this project would be 1,388 metric tons of carbon dioxide equivalent (MTCO₂e). The total actual measured annual greenhouse gas reductions were 2,891 MTCO₂e, more than double the estimate.

A majority of energy savings comes from the consistency of the boiler firing, which prevents high peaks of energy demand. Although the new raw material feed metering hopper is not a low-energy unit with any measurable energy savings, it allows the cookers to operate efficiently, and the boiler to use less energy, ultimately increasing facility throughput.

The expected therm savings from the implemented upgrades are shown in Table ES-1. When the expected therm values are compared to the final measured therm values, the results are a 14 percent improvement over expected reductions.

Table ES-1: California Air Resources Board Measured Reductions and Savings

Item	Units	Baseline	Estimated Upgrade	Estimated Reduction	Measured Upgrade	Measured Reduction
Annual Equipment Natural Gas Usage	therms/year	4,016,171**	3,767,150	249,020**	3,201,307**	814,864**
Equipment Greenhouse Gas Emissions	MTCO ₂ e/year	22,549*	21,161*	1,388*	19658**	2891**

* Based on original proposal that was reduced in scope. This estimate was not updated for the reduced scope.

** Based on reduced scope assuming the metering hopper savings were not double counted, so boiler savings only.

Source: Baker Commodities Inc.

Technology/Knowledge Transfer/Market Adoption

Baker has provided training and workshops to other Baker locations, sharing its experiences. As a private rendering company, Baker continually strives to improve rendering operations, which equate to lowering the cost of processing. Efficiency findings are then reviewed by Baker engineering and corporate staff on how to use the information to make other Baker divisions more efficient, lower the greenhouse gas footprint, and lower the carbon intensity score for the fat and oil products being used in renewable fuels. Baker has 20 locations and more than 900 employees with an annual revenue of more than \$350 million.

Baker shares knowledge learned through this project to help other food processing companies improve their operations and reduce their environmental impact and in its role as an active member of the Pacific Coast Renderers Association and the North American Renderers Association. Baker also works closely with other associated industry organizations to stay current on compliance and regulation issues, trends, and technology. Across these organizations and especially across Baker's other locations, this knowledge is shared extensively through presentations, internal meetings, and one-to-one correspondence at association meetings.

CHAPTER 1:

Project Purpose

Project Overview

The Kerman Energy Efficiency Upgrade Program (KEE-UP) project is a \$1.3-million energy efficiency and operational upgrade project that replaced old, inefficient equipment at the Baker Commodities, Inc. (Baker) Kerman, California facility shown in Figure 1. The facility uses several types of process equipment to produce nutrient-dense animal feed and other products from a variety of feedstocks. The KEE-UP project replaced inefficient equipment with commercially available, drop-in ready, high-efficiency equipment to reduce costs, increase quality and efficiency, and lower polluting emissions.

Figure 1: Overview of the Baker Commodities, Inc. Facility

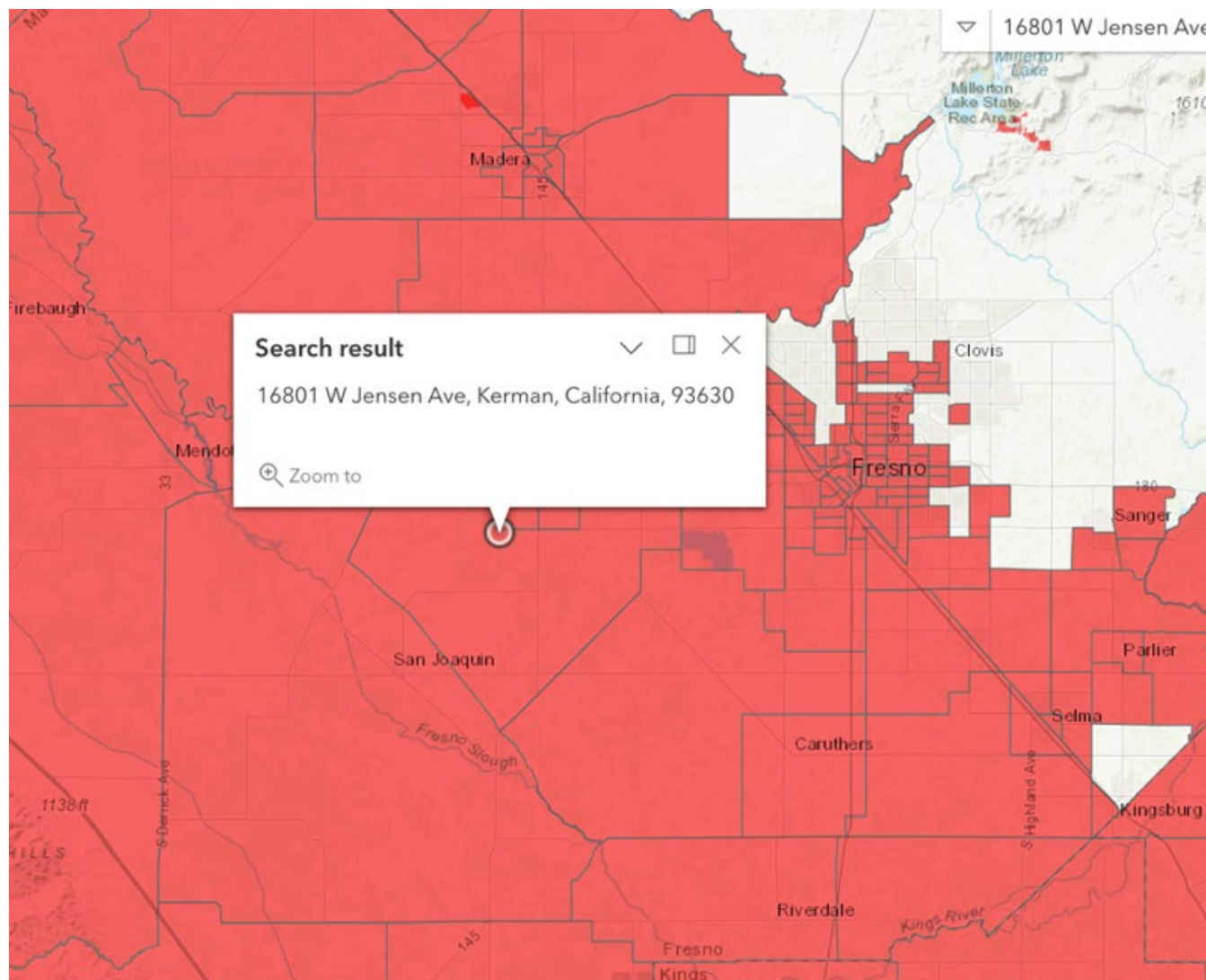


Source: Baker Commodities Inc.

The facility produces two types of nutrient-dense animal feed — meat and bone meal and feeding fats — and other products. The plant and land application areas include the 41-acre plant property and 537 acres of land application areas, which are at an elevation of approximately 200 feet. The climate is arid, with hot summers and mild winters. The rainy season generally extends from November through March.

The Kerman site is located in and provides direct benefits to the local community that, according to CalEnviroScreen 4.0, is classified as a Senate Bill (SB) 535 Disadvantaged Community with a CalEnviroScreen 4.0 percentile range of 70 to 80 percent and is surrounded by more severe pollution burden scores (see Figure 2). At the time of the project application in 2018, the CalEnviroScreen 3.0 percentile range of pollution was in the 91st percentile.

Figure 2: SB 353 Disadvantaged Community Designation



Source: Baker Commodities Inc.

The facility encompasses a variety of process equipment, which collectively convert meat scraps, trap grease, and used cooking oil from restaurants into two types of nutrient-dense animal feed — meat and bone meal and feeding fats — and other products. Baker proposed this project to replace a variety of old, inefficient equipment at its Kerman, California food production facility with new, drop-in ready, commercially available technologies purchased from California vendors.

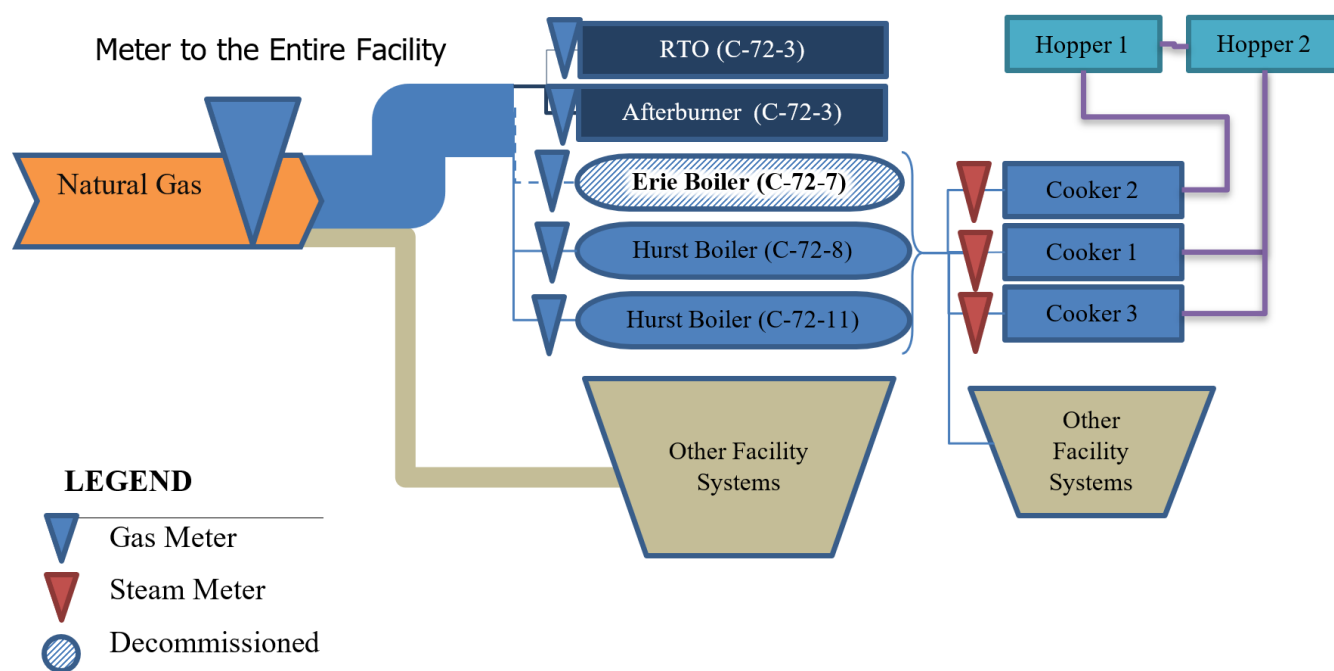
The new equipment was intended to help cut operating costs, maintain or improve product quality and quantity, and reduce the greenhouse gas (GHG) emissions associated with food production by approximately 1,388 metric tons of carbon dioxide equivalent (MTCO_{2e}) per year. While much of the original plan was not included in the final project, the largest pieces of equipment, a hopper and a boiler, were installed. Despite the changes, the project resulted in more than double the original estimated reductions, saving a total of 2,891 MTCO_{2e}.

Hopper

The hoppers distribute materials to the cookers by using separate screw augers with individual variable frequency drives to individually feed each cooker. Before this project, the existing hoppers were poorly configured, which provided inconsistent feeding of the cookers; one of the cookers was frequently overfed, thus demanding more steam, and the other cooker received too little feedstock, resulting in excess energy use. Replacing one of the existing hoppers and implementing a new configuration enabled the introduction of feedstock to the cookers in a way that facilitates more energy-efficient operations.

Before installing the replacement hopper, the system consisted of the elements shown in Figure 3 (Hoppers 1 and 2).

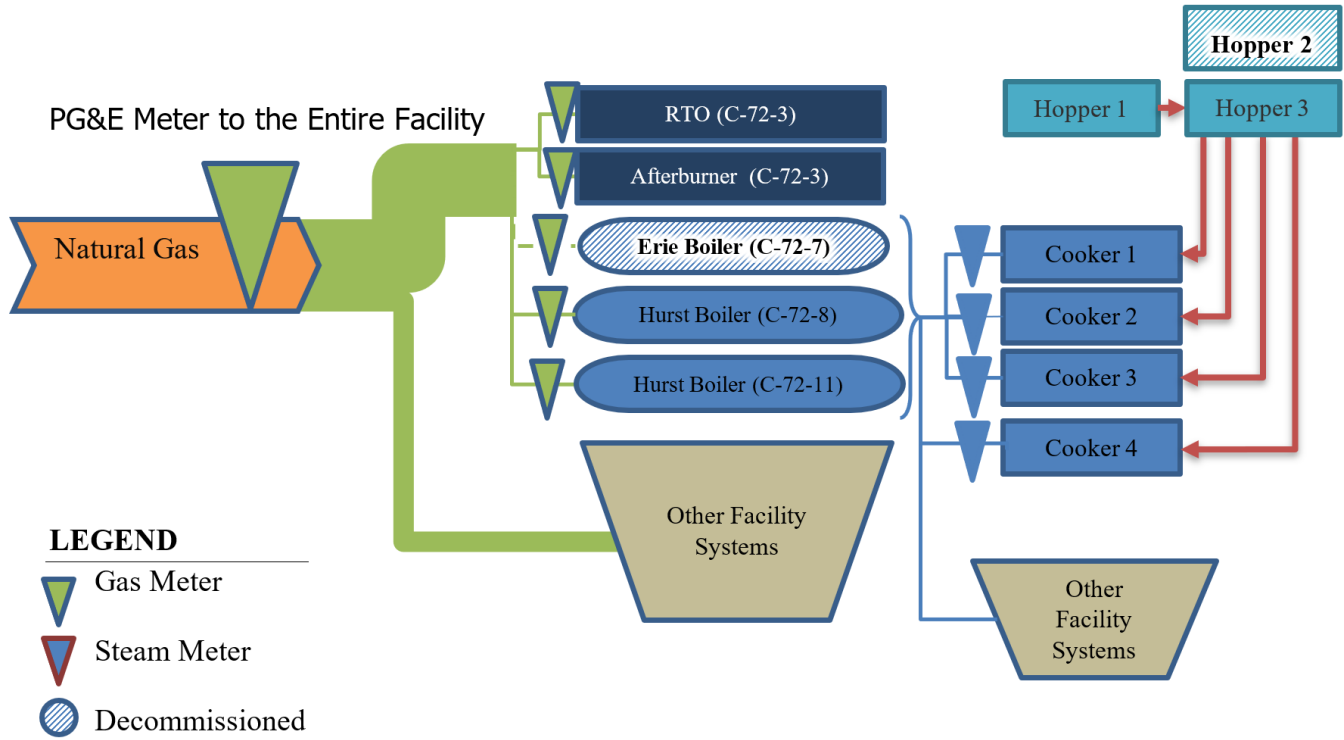
Figure 3: Original Process Flow Diagram



Source: Baker Commodities Inc.

The newly installed configuration is shown in Figure 4 (Hoppers 1 and 3, with Hopper 2 decommissioned). The project included the installation of an automated control system that increased overall process efficiency and reduced waste. The hopper that Baker deployed included an additional meter with current transformers to monitor electricity consumption for the hopper upgrade. Baker also monitored improvements using existing facility-wide natural gas meters.

Figure 4: Newly Installed Hopper Process Flow Diagram



Source: Baker Commodities Inc.

Boiler

A new Hurst boiler was installed to replace the existing Erie boiler. The Erie boiler operated at 900 horsepower and only 65 percent efficiency, while the new boiler operates at 800 horsepower and 90 percent efficiency. This boiler provides heat in the form of steam to the primary cooking unit. At approximately 45 percent of the facility's total natural gas consumption, this boiler is a critical part of the food production process. Table 1 provides the measured natural gas savings from the Boiler Pre-Installation Measurement and Verification (M&V) Report.

Table 1: Less Efficient Erie Boiler Compared to More Efficient Hurst Boiler

Month (2019)	Erie Boiler C-72-7 (therms/day)	Hurst Boiler C-72-8 (therms/day)
Jan	158,931	174,290
Feb	157,518	138,309
Mar	191,337	137,041
Apr	147,450	135,644
May	154,239	138,306
Jun	176,869	136,032
Jul	210,184	140,944

Month (2019)	Erie Boiler C-72-7 (therms/day)	Hurst Boiler C-72-8 (therms/day)
Aug	151,218	150,718
Sep	175,943	146,615
Oct	181,706	144,523
Nov	184,791	139,421
Dec	113,078	160,354
Total	2,003,264	1,742,196

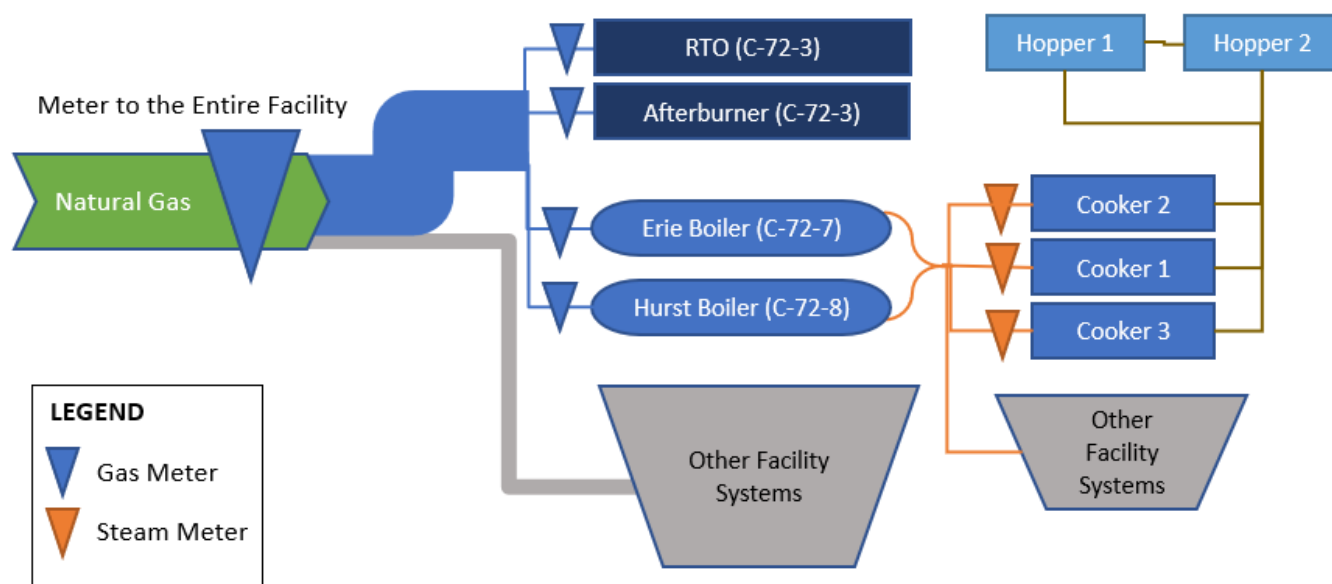
Source: Baker Commodities Inc.

Baker monitored improvements using existing facility-wide natural gas meters.

Input parameters: natural gas flow for the facility overall, with four additional meters for the regenerative thermal oxidizer, afterburner, and two boilers.

Output metrics: natural gas consumption (therms); consumption rate normalized to production. The previous system, presented in Figure 5 shows the boiler system prior to upgrades. The new configuration, presented in Figure 6, shows the 900 horsepower Erie boiler has been replaced by a new 800 horsepower Hurst boiler. Each boiler in the new configuration also has inline gas meters.

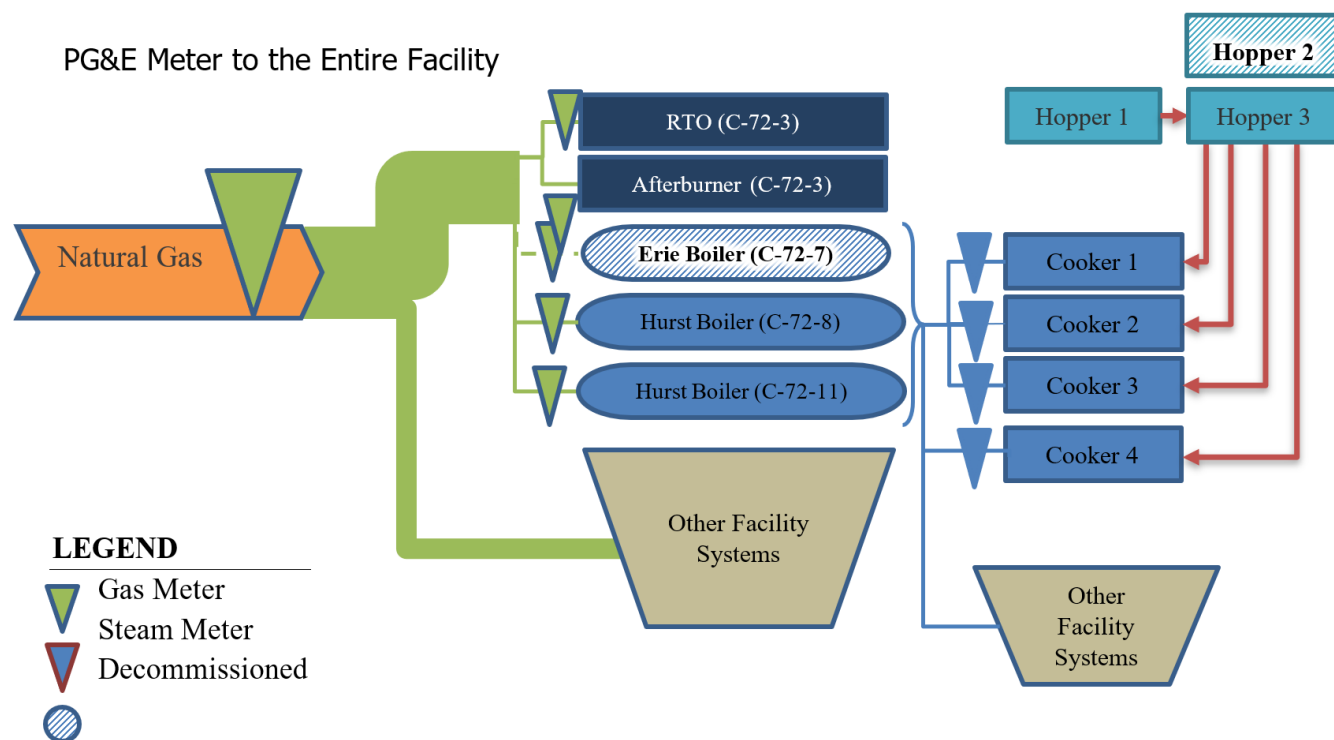
Figure 5: Pre-Installation Process Flow Diagram



Source: Baker Commodities Inc.

These meters feed only to the boiler (no other natural gas equipment on site) and act as dedicated meters. Therefore, no new monitoring equipment was installed.

Figure 6: Post-Installation Process Flow Diagram



Source: Baker Commodities Inc.

CHAPTER 2:

Project Approach

Project Description

The project was originally scheduled to begin in March 2019 and end in April 2022 (37 months), but the impacts of COVID and supply chain disruptions caused delays, and the project was extended to 2023. Because supply chains were heavily impacted, many of the planned meters and pumps were removed from the scope of the project. However, the project was still able to install the principal pieces of equipment (a hopper and a boiler) to replace older, inefficient counterpart equipment.

This project was implemented in four phases:

1. **Planning:** Identifying the needs of the business, developing a conceptual design, and preparing detailed plans and specifications for the equipment upgrades.
2. **Construction:** Removal of the existing equipment, excavation, concrete work, steel erection, mechanical and electrical installation, and equipment installation.
3. **Commissioning:** Testing and adjusting the equipment and training the equipment operators.
4. **Operational:** M&V, production, quality control, and maintenance.

Project Team

The Baker project team of experienced professionals included Doug Smith, Assistant Vice President, Research and Development and Quality Assurance, and David Rocha, Plant Manager of the Kerman Division. This core team managed:

- **Equipment manufacturers:** Provided support for the installation of equipment, including training, documentation, and warranty support.
- **Construction contractors:** In-house contractors handled the physical installation of equipment, including demolition, excavation, and civil work.
 - **In-house electrical contractors:** Electrical contractors installed and maintained electrical systems.
 - **In-house safety consultants:** Safety consultants from the Environmental Health and Safety team provided guidance on safety and risk management issues related to the installation of equipment.
- **Momentum:** Subcontractor provided grant administration and M&V support.

Measurement and Verification Plan

The M&V Plan initially included a wider array of equipment but was updated when the scope of the project was narrowed to the boiler and the metering hopper.

The boiler replacement was proposed to substantially increase natural gas efficiency by deploying a smaller boiler more adequately sized to handle on-site loads and operate with substantially higher efficiency than the existing system. Control updates were implemented to improve boiler efficiency, thereby reducing the facility's natural gas compared to previous operations. Baker monitored improvements using existing facility-wide natural gas meters that were already in place and acted as dedicated meters. No new monitoring equipment was needed for the boiler.

The new Hurst boiler was installed in December 2019. Pre-installation data on natural gas consumption and feedstock throughput were collected daily from January 1, 2019, through December 31, 2019. Post-installation data on natural gas consumption was collected daily from January 1, 2020, through December 31, 2020; post-installation feedstock data was collected daily from January 1, 2020, through December 5, 2020.

Pre-installation data for the new metering hopper was collected from January to June 2020, and the hopper was installed in December 2020. However, due to the installation of a new cooker (which was not part of this project) and other adjustments made to processing operations, post-installation M&V data collection began June 1, 2021, and concluded May 31, 2022.

Data used for this analysis included natural gas consumption by the existing boiler system, steam use by the cookers, and raw material feedstock throughput. Energy use associated with the hoppers was indirectly measured through improved energy efficiency and reduced therms required to run the boiler. To estimate energy savings associated with the hopper system, cooker steam consumption was normalized to feedstock throughput. Baker management recorded readings for this data daily from internal submeters at the facility.

Site Preparation and Equipment Procurement

Hopper

Installing the new metering hopper required a complete plant shutdown, dismantling and removal of decommissioned equipment, and temporary deconstruction of facility roofing to enable installation (Figure 7).

Decommissioning of the old hopper began with removing the motor and gearbox for Cooker 3 and chains and sprockets, as well as an additional screw conveyor for Cooker 2. Welds and supports for the old hopper were torch cut, and the components were manually lowered using chain hoists. After the old hopper was removed, the screw conveyors and down chutes for the existing three cookers were removed.

Figure 7: Dismantling the Old Hopper



Source: Baker Commodities Inc.

On December 4, 2020, Baker shut down all Kerman plant operations for the installation of the new metering hopper. During this time, the facility diverted raw material loads to another Baker facility in Vernon, California for processing and held other loads at the Hanford, California plant.

Prior to moving the new metering hopper into the plant for installation, modifications were made to the hopper to accommodate the screw conveyor that would supply material to the new hopper. Other changes included modifications to the troughs for each of the screws and extending the screw conveyor and trough dedicated to the new cooker (Cooker 4).

The new hopper was moved into the plant and raised into position via crane. To accomplish this, several panels from the roof were temporarily removed, and water and electrical lines were relocated. The hopper had to be manipulated and maneuvered to fit into position. After the hopper was in position, the frame and supports were welded to suspend the metering hopper in place. After the unit was secured, the cables and shackles for the crane were disconnected.

Installation included reinstalling and welding in the screw conveyors and drop chutes. The new hopper was then attached to the supply screw conveyor, and new bearings, sprockets, and chains were installed. New electrical work was also installed for the augers coming from the new metering hopper. The gearbox and motor that had been removed were replaced, as well as the drive for the supply screw conveyor. After all hopper equipment and related systems were on line, Baker staff installed two new in-line steam meters on the boiler outflow lines.

On December 7, 2020, the installation of the new unit was completed, and three of the four cookers resumed operation, with the fourth going on line on December 8, 2020, after a new drop chute was fabricated.

To complete the installation of the new system, new in-line steam meters were installed on May 5, 2021. Two meters were installed on the steam outputs from both boilers; these meters helped Baker determine how effective the metering hoppers are at providing feedstock to the cookers in a more efficient manner, reducing natural gas consumption associated with underused cookers.

Boiler

Installing the Hurst boiler required building a new foundation pad and enclosure complete with ducting for ventilation, electrical infrastructure, and a low-nitrogen oxide (NOx) burner (Figure 8).

Figure 8: Boiler Installation



Source: Baker Commodities Inc

Baker completed the foundation pad, placed the new boiler on the pad, and constructed the enclosure and supporting infrastructure around the boiler unit.

A selective catalytic reduction (SCR) system was installed in conjunction with the burner to further reduce NOx emissions. The SCR unit installation required additional foundation pad, framework, and metal structure to support the equipment. Ammonia tanks used for urea injection as part of the SCR system were installed on top of a concrete pad and within an enclosure separate from the boiler.

Project Modifications

The Baker Kerman facility was impacted by the COVID-19 pandemic in a number of significant ways. The pandemic led to reduced demand for products due to disrupted supply chains, economic downturn, and changing consumer priorities. Supply chain interruptions delayed raw material availability and increased production costs. An economic recession prompted budget constraints, impacting rendering services and non-essential products. Meanwhile, the pandemic increased the cost of labor and materials. Safety measures, labor shortages, and

inflation raised labor expenses (many of the employees were impacted, including one death from COVID-related respiratory issues). Material scarcity, driven by supply chain disruptions, intensified competition and raised material costs. The company implemented a number of safety measures to protect its employees from the virus, such as social distancing, mask wearing, and increased sanitation. The company also implemented numerous work-from-home policies to reduce the number of people on site.

In addition, the food processing industry is subject to drastic shifts in food consumption, restaurant closures, and changing behaviors. This can make it difficult to accommodate unexpected changes, such as those caused by the pandemic. The company also faced funding limitations, as the pandemic made it difficult to obtain loans and other forms of financing. The company worked with its customers to ensure that it could meet their demand for products. The company also implemented numerous flexibility measures, such as overtime and temporary staffing, to accommodate unexpected changes in demand.

Despite these challenges, Baker was able to successfully complete this project. The company addressed the challenges, including:

- Reducing costs: The company worked to reduce costs by negotiating lower prices with suppliers and contractors.
- Increasing efficiency: The company implemented efficiency measures, such as streamlining production processes and improving inventory management. These measures helped the company to reduce costs and improve profitability.
- Obtaining funding: The company worked to improve its credit rating, which made it easier to obtain financing.

Moreover, the additional permitting process nearly came to a standstill due to governing agencies facing office closures and staff shortages. Upon reviewing all project constraints, Baker assessed where the most significant return on investment could be achieved. It was determined that the GHG and energy savings of a new boiler system and raw material feed hopper, streamlining energy input to the cookers, far exceeded the electrical savings from updated motors. Consequently, the focus shifted to the feed hopper and the new Hurst boiler.

The facility also had to pivot due to the impact on feedstock. Initially, the effect of the COVID pandemic on dead livestock from dairies was not substantial, but supply decreased by as much as 30 percent for approximately four months. As the consequences of COVID extended into 2021, demand from restaurant suppliers plummeted by approximately 50 percent due to restaurant closures. Consequently, there was a corresponding 50 percent decline in material from slaughter operations. While restaurant grease initially dropped, there was a subsequent increase in demand from grocery stores due to in-home meal preparations.

By the end of 2021, as restaurants began to reopen, used oil collections saw a 30 percent increase, slaughterhouse material rebounded to at least 10 percent above pre-COVID levels, and deadstock returned to pre-COVID levels with a 10 percent gain. The changes in feedstock introduced inconsistencies across equipment use, making it more challenging to compare pre-

and post-installation results. Equipment-specific issues are detailed in the following paragraphs.

Hopper

No major barriers were encountered during the installation of the hopper. The steam meter procurement was delayed because the software could not be properly integrated at the time of start-up; as of the installation on May 10, 2021, Baker was able to complete the system upgrades and began collecting M&V data. While data collection was delayed, the full 12 months of M&V data was eventually procured and analyzed.

Boiler

Besides the COVID-19 related issues of labor shortages and supply chain difficulties, the major impediment to the installation occurred with the change required by the San Joaquin Valley Air Pollution Control District (Air District) to modify the design from a standalone low-NOx burner to a low-NOx burner with an SCR unit with ammonia injection.

Prior to completing installation, Baker was informed by the Air District that the low-NOx burner planned for installation was no longer considered Best Available Control Technology. Instead, the Air District required Baker to install an SCR system in conjunction with the burner to further reduce NOx emissions. To overcome this barrier, Baker modified its design and obtained a cost estimate for the new equipment. Baker constructed support structures, a concrete foundation, and ammonia tanks. After these modifications, the boiler and the SCR unit were installed without further complication.

CHAPTER 3:

Project Results

Pre-Installation Measurement & Verification Findings

Before this grant, the cookers were experiencing larger energy swings when they were fed too quickly or too slowly. These speed fluctuations often lowered or spiked the temperature of the cookers, therefore requiring the boiler to run less efficiently. The new hopper controls the inputs to the four cookers. This control provides more consistent temperature within the cookers, which prevents high energy peaks by allowing the boiler to fire more consistently. The new raw material feed hopper is not in itself a low-energy unit that has any measurable energy savings; rather, the raw material hopper allows the cookers to operate more efficiently and thus allows the boiler to run at a lower energy usage, ultimately increasing facility throughput. To vet the calculations, Baker compared its natural gas readings from all its submeters against the Pacific Gas and Electric (PG&E) meter used for the entire facility (and billing). Over the time used for these calculations, Baker's calculation method resulted in an overestimate of natural gas use by 0.15 percent from the PG&E meter.

Table 2: Pre-Installation Estimated Reductions

Item	Units	Baseline	Upgraded	Reduction
Equipment GHG Emissions	MTCO ₂ e/year	22,549	21,161	1,388
Equipment Natural Gas Usage	therms/year	4,016,170	3,767,150	249,020
Annual Energy Costs	\$/year	\$2,400,000	\$2,255,000	\$145,000

Source: Baker Commodities Inc.

Hopper

To obtain pre-installation M&V results for the hopper, the method used for estimating benchmark energy consumption, focusing specifically on the system's cookers, follows.

Relevant existing data included:

- Daily steam use for individual cooker units.
- Daily natural gas consumption and pressure for the entire facility (total therms billed by PG&E).
- Daily natural gas consumption and pressure for individual boiler units, plus regenerative thermal oxidizer and afterburner.
- Daily material throughput.

All measurements were recorded daily by an operator and management, and these readings were used to calculate the energy use at the facility.

Data used for this analysis includes natural gas consumption by the existing boiler system, steam use by the cookers, and raw material feedstock throughput.

Energy use associated with the hoppers was not directly measured. For this analysis, an approach to estimate energy savings associated with the hopper system used cooker steam consumption normalized to feedstock throughput. Baker operators recorded readings for this data daily from internal submeters at the facility. The 14-day trendlines were created to show the averages and smooth the data fluctuations of a six-day per week operating schedule.

Boiler

To obtain pre-installation M&V results, the method for estimating benchmark energy consumption by the Erie boiler included:

- Daily natural gas consumption and pressure for the entire facility (total therms billed by PG&E)
- Daily natural gas consumption and pressure for individual boiler units, plus regenerative thermal oxidizer and afterburner
- Daily material throughput

PG&E measurements were collected continuously and based on the utility bill. Daily natural gas consumption and pressure for individual units were recorded daily by an operator and management, and these readings were used to calculate energy use at the facility. Feedstock data was collected on an as-received basis.

Post-Installation M&V Findings

Hopper

Hopper 1 is now exclusively used to feed Hopper 3. Hopper 3 has four separate screw augers with individual variable frequency drives to feed each cooker. This new configuration appropriately introduces feedstock to the cookers to allow for more efficient operations.

Baseline values in Table 3 were extrapolated from pre-installation data collected January through June 2020. Post-installation values were collected from June 2021 through May 2022. The post-installation M&V assessment concluded that the energy consumption by Baker's cooking process had decreased when comparing baseline data projected to an annual level and 12 months of post-installation data collected during the M&V period.

Table 3: GHG and Criteria Emissions Comparing Pre- and Post-Hopper Installation

Months	Natural Gas Equivalent (therms/year)	GHG (MT/year)	NOx (lb/year)	VOC (lb/year)	SOx (lb/year)	PM (lb/year)
Baseline (Projected Annual)	2,675,304	14,214	2,942	1,124	762	2,034
Post-Install Annual	2,336,532	12,414	2,570	981	666	1,776
Annual Change	338,772	1,800	372	143	96	258

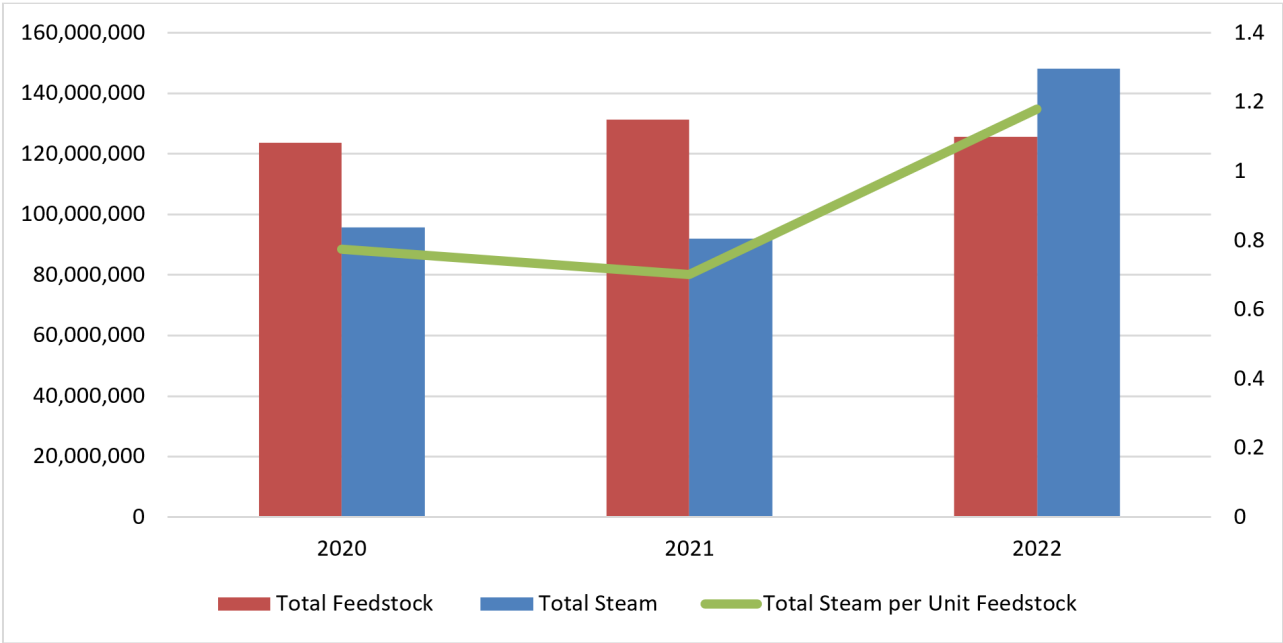
lb/year = pounds per year; MT/year = metric tons per year; PM = particulate matter; SOx = sulfur oxides; VOC = volatile organic compounds

Source: Baker Commodities Inc.

While energy consumption associated with steam use decreased between the evaluation periods, these gross values do not account for production levels. Throughput of feedstock materials is the key variable that drives energy use.

Figure 9 presents cooking process operations for the period of January through May of the years 2020, 2021, and 2022. Comparing Baker’s historical feedstock throughput and steam use for the feedstock cooking process shows the relative energy use has increased in 2022.

Figure 9: Feedstock Processed, Steam Used and Steam Per Unit Feedstock



Source: Baker Commodities Inc.

This indicates a drop-in energy efficiency that is due to the decision to run the fourth cooker at a high input load. The decision was made due to a sudden influx of raw materials, coinciding with a temporary plant shutdown at a nearby rendering facility. At the time, using three cookers was not able to keep up, so the fourth cooker was brought online at full capacity to process the increased tonnage with greater throughput. The increase in energy use in 2022 is seen as an anomaly. During this project, a second Food Production Investment Program (FPIP) grant project (FPI-19-027) was awarded and is expected to resolve this situation by increasing the efficiency and steam production of the boiler system, allowing the cookers to access more steam and process feedstock more efficiently. The existing boiler (which will be replaced in FPIP project FPI-19-027) is aging, inefficient, and undersized. The new boiler under FPI-19-027 has the capacity to efficiently work up to 1200 horsepower versus 800 horsepower previously and the additional capacity can handle the fourth cooker. Baker attributes the causes of this decrease in efficiency anomaly to the following:

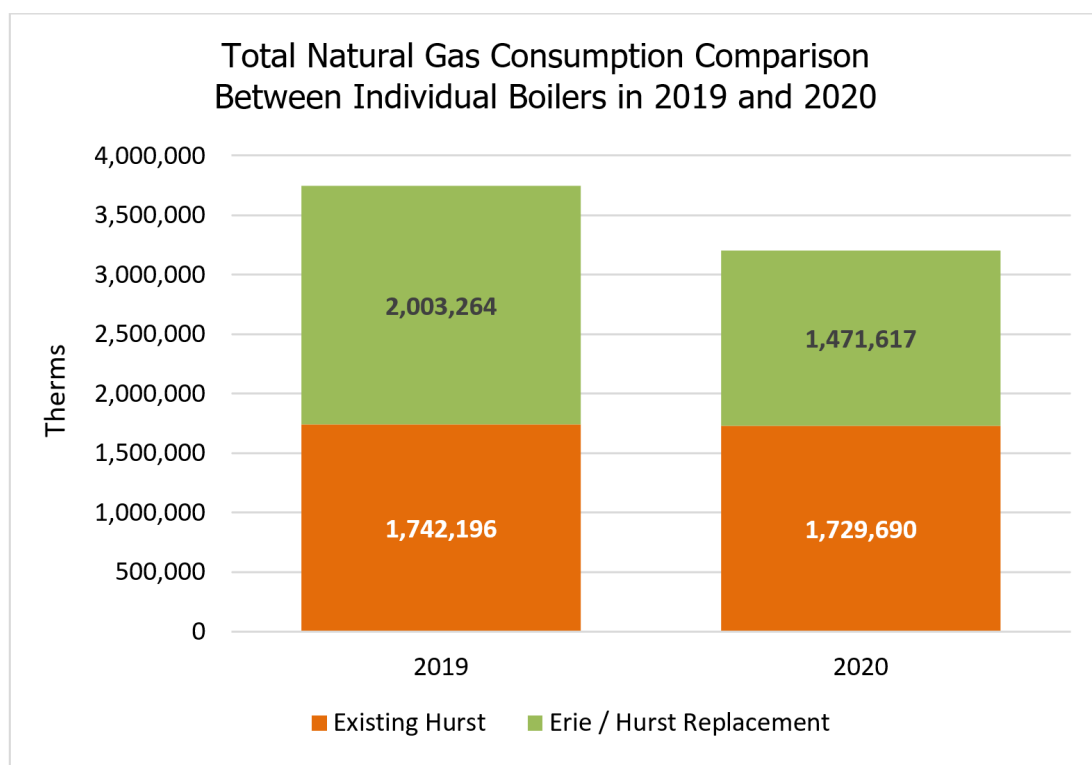
- The additional operation of Cooker 4 at a full capacity, rather than at a moderated rate.
- The smaller boiler (pre-FPI-19-027) system is unable to provide sufficient steam to operate all four cookers to their optimal capacity. This project (FPI-18-013) was designed for the three original cookers with the new boiler.

As a result, the production volume and processing speed (feedstock material throughput) have not increased in proportion to the steam used for cooking. Baker's second phase work (under FPI-19-027) is expected to resolve this situation, allowing the cookers to access more steam and process feedstock more efficiently.

Boiler

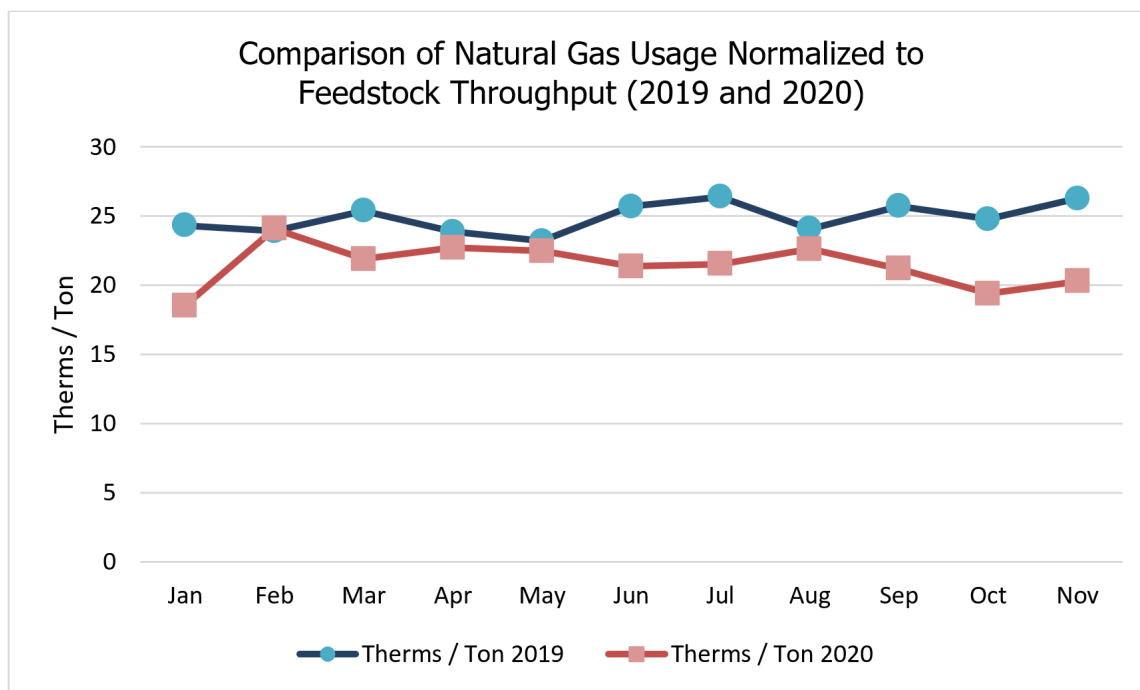
To further demonstrate the efficiencies gained through the boiler replacement, natural gas use was aggregated for each individual boiler during the M&V period from January 1, 2020, to December 31, 2020. Figure 10 shows that nearly all the natural gas reductions from 2019 to 2020 was due to replacing the Erie boiler with a more efficient Hurst boiler. Usage for the existing Hurst boiler, which was not replaced, remained nearly equal between the two years.

**Figure 10: Total Natural Gas Consumption Comparison
Between Boilers in 2019 and 2020**



Source: Baker Commodities Inc.

Figure 11: Comparison of Monthly Total Natural Gas Consumption (therms) to Monthly Total Feedstock Processed (tons) January-November, 2019 and 2020



Source: Baker Commodities Inc.

The upgraded boiler system has resulted in a 14.2 percent increase in efficiency, demonstrated by reduced natural gas consumption normalized to feedstock throughput.

Table 4 shows the results of this project. Natural gas usage was reduced by 543,688 therms/year and GHG emissions were reduced by 2,901 MTCO₂e/year.

Table 4: GHG and Criteria Emissions Comparing Pre- and Post-Boiler Install

Months	Natural Gas Equivalent (therms/year)	GHG (MT/year)	NOx (lb/year)	VOC (lb/year)	SOx (lb/year)	PM (lb/year)
Baseline (Projected Annual)	3,745,460	19,900	4,120	1,573	1,067	2,847
Post-Install Annual	3,201,307	16,999	3,521	1,345	912	2,433
Annual Change	543,688	2,901	599	228	155	414

Source: Baker Commodities Inc.

The boiler replacement substantially increased natural gas usage efficiency by deploying a smaller boiler that is adequately sized to handle on-site loads, and that operates with substantially higher efficiency than the previously existing system. Controls updates also supported improved boiler efficiency. Therefore, the project directly reduced the amount of natural gas consumed by the facility, in comparison to previous conditions, by reducing natural gas consumption required to produce necessary process heat.

CHAPTER 4:

Knowledge Sharing/Project Support/Benefits/Achievements

Knowledge Sharing

Baker has shared knowledge learned from the industrial upgrade project in several ways, including:

- Attending conferences and events: Baker has attended a number of conferences and events to share its knowledge with other industry professionals.
- Providing training and workshops: Baker has provided training and workshops to help other Baker locations learn from its experiences. Baker has 20 locations and more than 900 employees with an annual revenue of more than \$350 million. Lessons learned about the optimal use of boilers, hoppers, and other key rendering equipment are shared companywide.

Project Support

Baker's management team is actively engaged in environmental leadership. Baker serves on numerous committees and boards of directors, donating time and money in support of organizations that are vital to the continued success of the rendering industry, including the Pacific Coast Renderers Association and the North American Renderers Association since their inception. Baker also works closely with other associated industry organizations to stay current on compliance and regulation issues, trends, and technology.

Baker conducted outreach to community organizations and residents and received letters of support from the City of Kerman Public Works Department, H&J Chevrolet, and R.O.C., Inc., a small family-owned transportation company. Baker will make this final report and presentation available to these organizations.

Benefits

Baker is committed to sharing knowledge and promoting innovation in the food processing industry. The company believes that by sharing its knowledge, it can help the industry to become more efficient, sustainable, and competitive.

The Baker industrial upgrade project has provided several benefits to California, including:

- Increased employment stability: If equipment breaks down, operators are left with less work while equipment is fixed. In this case, the new equipment has led to fewer days or hours off line. In addition, corporations like Baker that operate on thin margins can ensure employment stability by achieving greater operational efficiency. The project has solidified current jobs in California. These jobs provide a source of income for

Californians and help to stimulate the economy. While no new full-time positions were created, the entire facility has operated more consistently.

- Reduced environmental impact: The project has reduced the environmental impact of Baker's operations by increasing efficiency and therefore decreasing natural gas demands.
- Increased innovation: The project has helped to promote innovation in the food processing industry. While the drop-in ready, commercially available equipment is not new, the process design has led to the development of new applications of current technologies for consistency and greater efficiency.
- Increased competitiveness: The project has helped Baker to become more competitive in the global marketplace. This has benefited the State of California by increasing the economic activity and job stabilization associated with the company's operations. With increased throughput, Baker is considering further expansions.

The knowledge shared by Baker has been beneficial to numerous stakeholders, including:

- The knowledge to improve rendering processes is most relevant for other renderers. Baker continues to share its learnings across numerous organizations and committees, ideally reducing the industry's environmental impact.
- Baker has met with government agencies such as the California Department of Food and Agriculture, the United States Department of Agriculture, and the Food and Drug Administration to share industry knowledge, contributing to the development of regulations and policies that support the food processing industry. Baker works diligently with state and local legislators and lawmakers in protecting the integrity of the industry, further ensuring a viable future for rendering.
- Baker's knowledge has helped the general public to understand the food processing industry and its impact on the environment. The North American Renderers Association at Clemson University's Animal Co-Products Research & Education Center developed the *Carbon Footprint Calculator for Rendering Operation*, a method of calculating the carbon footprint of a rendering facility. This calculator provided the rendering industry with a method to measure the benefits of the rendering recycling process and industry.

CHAPTER 5:

Conclusions/Recommendations

Conclusions

The Baker industrial upgrade project was a success. The project was able to achieve its goals and objectives, including:

- Increased efficiency, lower operating costs, and improved profitability, including a reduced environmental impact:
 - When measured as a stand-alone fix, the hopper upgrade resulted in a GHG reduction of 1,800 MTCO₂e. As described, the 1,800 MTCO₂e/year is included in 2,891 MTCO₂e/year from the boiler.
 - When measured at the boiler, the boiler upgrades resulted in an annual reduction of GHG emissions equal to 2,891 MTCO₂e, or an average of 242 MTCO₂e per month. This represents a 14 percent reduction in annual GHG emissions and exceeds the original reduction estimates by 1,513 MTCO₂e/year.
- The impact of the first CEC grant allowed Baker to achieve an efficiency that the equipment that was on site prior to the grant would never have allowed. The new efficient boiler, coupled with the raw material feed screw hopper installed, allowed Baker to use less natural gas per ton of raw material processed.

GLOSSARY AND LIST OF ACRONYMS

Term	Definition
Baker	Baker Commodities, Inc.
Best Available Control Technology	The level of air contaminant emission control or reduction required by state law and air district rules for new, modified, relocated, and replacement emission sources.
BTU/yr	British thermal units per year
California Air Resources Board (CARB)	The California state agency 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.
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 responsibility 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 providing assistance to develop clean transportation fuels 5. Planning for and directing state response to energy emergencies
carbon intensity	The ratio of carbon dioxide (CO ₂) emitted per unit of energy. It's a measure of how clean any fuel is, and how many grams of CO ₂ are released to produce that fuel.
current transformers	A type of transformer that is used to reduce or multiply an alternating current. It produces a current in its secondary, which is proportional to the current in its primary.
Disadvantaged Community	A designation for communities specifically targeted for investment of proceeds from the state's Cap-and-Trade Program. These investments are aimed at improving public health, quality of life, and economic opportunity in California's most burdened communities, and at the same time, reducing pollution that causes climate change. The investments are authorized by the California Global Warming Solutions Act of 2006 (Assembly Bill 32, Nunez, 2016).
Food Production Investment Program (FPIP)	A California Energy Commission program aimed at supporting energy-efficient technologies in the food production sector to reduce greenhouse gas emissions.

Term	Definition
greenhouse gas (GHG)	Gases that trap heat in the atmosphere, contributing to global warming and climate change.
hopper	A metering hopper regulates the flow of material into the cookers.
horsepower	The power an engine produces, calculated through the power needed to move 550 pounds one foot in one second or by the power needs to move 33,000 pounds one foot in one minute.
KEE-UP	Kerman Energy Efficiency Upgrade Program
kilowatt-hour (kWh)	A unit of electrical energy over time. A kilowatt-hour is the energy delivered by one kilowatt of power for one hour.
kWh/yr	kilowatt-hours per year
land application areas	The designated area on the property where the greywater from septic spilt systems (an older type of septic system) or the treated wastewater (effluent) from aerated wastewater treatment systems is disposed of. Properties not connected to the town sewer network rely on these to store, treat, and dispose of commercial wastewater (greywater and sewage).
lbs/year	pounds per year
measurement and verification (M&V)	Analysis done to verify the performance and impact of an energy efficiency project.
meat and bone meal	Rendered product from mammalian tissues including bone, but exclusive of blood, hair, hoof, horn, hide trimmings, manure, and stomach and rumen contents.
MT/year	metric tons per year
metric tons of carbon-dioxide equivalents (MTCO ₂ e)	metric tons of carbon-dioxide equivalents
MMBTU/yr	million metric British thermal units per year
nitrogen oxides (NO _x)	A group of highly reactive gases that contribute to air pollution, often produced by the combustion of fuels at high temperatures.
PG&E	Pacific Gas and Electric Company
PM	particulate matter
San Joaquin Valley Air Pollution Control District (Air District)	A local air pollution control district made up of eight counties in California's Central Valley — San Joaquin, Stanislaus, Merced, Madera, Fresno, Kings, Tulare and the San Joaquin Valley Air Basin portion of Kern — to enact federal and state air pollution standards. The Valley Air District is governed by a 15-member Governing Board consisting of representatives from the board of supervisors of all eight counties, one health and science member, appointed by the governor,

Term	Definition
	one physician, appointed by the governor and five Valley city representatives.
SB	Senate Bill
selective catalytic reduction (SCR)	An advanced active emissions control technology system that reduces tailpipe emissions of nitrogen oxides (NOx) down to near-zero levels in newer generation diesel-powered vehicles and equipment.
SOx	sulfur oxides
therms/year	natural gas equivalent
used cooking oil	Oils and fats that have been used for cooking or frying, usually found in the food processing industry such as restaurants and fast foods, as well as in households.
variable frequency drives	A device used to control the speed and torque of electric motors by varying the frequency and voltage of the power supplied to the motor.
VOC	volatile organic compound



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ENERGY RESEARCH AND DEVELOPMENT DIVISION

APPENDIX A: Measurement and Verification Plan

December 2023 | CEC-500-XXXX-XXX



APPENDIX A:

Measurement and Verification Plan

Measurement and Verification Plan

The following Measurement and Verification Plan (Plan) has been prepared to satisfy the scope of work for the Kerman Energy Efficiency Upgrade Program (KEE-UP project). The project has been partially funded by the California Energy Commission (CEC), and this Plan was prepared in accordance with the scope of work for that funding agreement. The Plan provides the following:

- A description of the monitoring equipment and instrumentation that will be used.
- A description of the key input parameters and output metrics which will be measured.
- A description of the M&V protocol and analysis methods to be employed.
- A description of the independent, third-party measurement and verification services to be employed.

Project Background

The KEE-UP project is a 34-month, \$1.3-million energy efficiency and upgrading program that seeks to replace a variety of old, inefficient equipment at the Baker Commodities Inc. (Baker) Kerman, California facility. The project will install new, drop-in, high-efficiency motors and other equipment that, when installed, will help Baker cut operating costs, maintain or improve product quality and quantity, and reduce GHG emissions associated with the facility's existing process. The project—located in a low-income, disadvantaged community—will also reduce on-site criteria air pollutant or toxic air contaminant emissions through a direct reduction in on-site fossil fuel consumption and a reduction in electricity. When complete, the proposed upgrades will improve the competitiveness of the Kerman facility, benefit priority populations, and help jobs associated with food production to remain in California.

The efficiency upgrades are being deployed at Baker's existing facility located at 16801 W Jensen Ave, Kerman, California 93630. The facility encompasses multiple types of process equipment to produce two types of nutrient-dense animal feed—meat and bone meal and feeding fats—and other products from a variety of feedstocks. Initial projections suggest that the proposed efficiency upgrades, when complete, will substantially reduce consumption of grid-produced electricity and natural gas.

Proposed Equipment Upgrades

The following list summarizes the equipment upgrades proposed under the project:

- Installation of a new metering hopper
- Installation of a new high-efficiency boiler to replace an existing, over-sized system

The equipment on site is antiquated and over 50 years in age. As such, make and model numbers are not available. For additional details regarding the existing and proposed equipment, please refer to Appendix A.

Projected Savings Based on Preliminary Calculations

The project team submitted an initial proposed level of energy and GHG emissions savings with the project proposal. This initial estimate was subsequently refined and updated using the Energy Commission's Benefits Calculator Tool for the Food Production Investment Program, combined with recommended quantification tools MEASUR and AirMaster+. Based on these evaluations, the following energy savings are anticipated for the project (Table A-1).

Table A-1: Projected Energy Savings for the Project

Equipment	Annual Natural Gas Reduction (therm/yr)
Replace existing boiler with high-efficiency boiler	421,747
Hopper upgrade	0
Total	421,747

Source: Baker Commodities, Inc.

Description of Proposed Monitoring Equipment and Instrumentation; Input Parameters and Output Metrics

The project team will deploy or use monitoring equipment and instrumentation or both specific to each of the five categories of equipment to be upgraded.

Boiler Replacement

The proposed boiler replacement will substantially increase natural gas usage efficiency by deploying a smaller more efficient boiler that is adequately sized to handle on site loads, and that operates with substantially higher efficiency than the existing system. Controls updates will also support improved boiler efficiency. Therefore, deploying the project will directly reduce the amount of natural gas consumed by the facility, in comparison to existing conditions, by reducing natural gas consumption required to produce necessary process heat. Baker will monitor improvements using existing facility-wide natural gas meters that are already installed at the facility. Note, however, that these meters feed only to the boiler (no other natural gas equipment on site), and therefore act as dedicated meters. Therefore, no new monitoring equipment will be installed.

Input parameters will include: natural gas flow for the facility overall; facility throughput; interval

Output metrics will include: natural gas consumption (therms); consumption rate normalized to production

Measurement and Verification Protocol and Analysis

Project benefits with respect to annual electricity reduction and annual natural gas reduction will be assessed and documented in adherence to International Performance Measurement and Verification Protocol Option A. Herein, the project team will directly measure therm level and natural gas consumption for each project component, before and after equipment replacement. The project team will use the facility's existing natural gas meter to collect data for the project.

The project team will review and assemble data as follows:

The proposed system will collect and log data on an ongoing basis, automatically, and store it until a project team member accesses it. At least monthly, a project team member will download or otherwise collect data from each of the proposed meters. This will be accomplished through a dedicated data collection system and/or the facility's existing SCADA system. Data will be delivered, raw, to the third-party verifier, who will assemble the data for subsequent analysis. To support effective data collection and to ensure quality data is collected, Baker staff will also periodically review real-time output and/or interim data collected on a daily (first two weeks after install) and weekly (thereafter) basis, to identify any faults or failures in the data collection system.

The existing natural gas meters do not include remote telemetry functionality. Therefore, on a daily basis at a specified time each day, Baker staff will complete a meter read and compile the meter read data into a single spreadsheet. Baker staff will also track other key daily parameters, including facility throughput and production rates. At least monthly, Baker staff will internally QA/QC the data, then will email the daily tracking spreadsheets to the third-party verifier for data assembly and subsequent analysis.

Electricity savings will be estimated by comparing a 3-month baseline period to a 1-year operational monitoring period. The 3-month baseline period will include monitoring and recording electricity and natural gas consumption of the existing equipment, as well as facility throughput (feedstock input and product output). During the 1-year operational period, the new, project equipment will be monitored, using monitoring equipment installed prior to the baseline period. Facility throughput (feedstock input and product output) will also be monitored and recorded during this period.

Upon completion of data collection, the daily electricity or natural gas consumption during the operation period will be compared against the baseline period. Assuming that the 3-month baseline period is representative of the subsequent 1-year operation period in terms of throughput, we will use the following simple equation to determine electricity or natural gas savings:

$$\text{Electricity Savings (kWh)} = -\frac{365}{90} * \sum_{t=1}^{90} (E_1, E_2, E_3, \dots E_n)_{\text{baseline}} - \sum_{t=1}^{365} (E_1, E_2, E_3, \dots E_n)_{\text{project}}$$

where E_x = electricity consumed by each piece of equipment (kWh) during the monitoring period and time is presented in days.

Similarly, for natural gas,

$$\text{Natural Gas Savings (therms)} = \frac{365}{90} * \sum_{t=1}^{90} (G_1, G_2, G_3, \dots G_n)_{\text{baseline}} - \sum_{t=1}^{365} (G_1, G_2, G_3, \dots G_n)_{\text{project}}$$

where G_x = electricity consumed by each piece of equipment (kWh) during the monitoring period and time is presented in days.

Baker recognizes that the proposed monitoring period may not be wholly representative of operations during the project period. The project team will review data when available and determine whether or not the baseline data can be considered representative. If it cannot, the analysis will be updated as warranted to ensure that the baseline period is comparable to the project period, normalized to facility throughput, and in accordance with International Performance Measurement and Verification Protocol Option B guidelines.

Third-Party Verification

Momentum (formerly Grant Farm) will provide all third-party verification services. Briefly, Momentum's expert data scientists will review and QA/QC all incoming data. Data will be assembled into spreadsheets and/or a database (depending on size of the dataset). Compiled data will be analyzed on a monthly basis (in addition to Baker's internal QA/QC) to identify any faults or potentially erroneous data or errors. If errors are identified, Momentum will work with Baker to fix the problem. Note, during the first two weeks following installation of the meters and following installation of the proposed equipment, Momentum staff will monitor data output on a daily basis to ensure that all metering and data collection systems are fully operational. Once QA/QC has been completed, Momentum will, on a monthly basis, complete a preliminary data analysis to identify any specific trends, and to monitor performance to date. Momentum may provide Baker with feedback, as warranted, although Baker will complete additional analysis internally to support optimization, separate from the Energy Commission reporting process. Upon completion of the data collection periods, Momentum will complete a detailed statistical review and analysis of energy and fuel consumption, complete a comparison of baseline conditions to the project, and complete a comparative analysis and assessment of project benefits. Momentum will incorporate this analysis into the project's final report, and any interim reporting to the Energy Commission, as required.

Appendix A of the M&V Plan

List of Existing Equipment

Several metering elements will be replaced on site (Table A-2)

Table A-2: Internal Metering and Hopper Upgrades

Automation Equipment	Baseline Elec. kWh/yr	Baseline N. Gas BTU/yr	Upgraded Elec. kWh/yr	Upgraded N. Gas MMBTU/yr	Elec. kWh/yr reduction	N. Gas MMBTU/y reduction	GHG/yr MTCO ₂ e reduction
Integrated System	-	-	(-1%)	(-1%)	51,600	4,016	229.3
Electrical Upgrade	-	-	-	-	-	-	-
Control Panel	-	-	-	-	-	-	-
Metering Hopper	31,530	-	15,301	-	16,229	-	3.8
TOTAL	31,530			360,048	67,829	4,016	229.3

BTU/yr = British thermal units per year; kWh/yr = kilowatt-hours per year; MMBTU/yr = million metric British thermal units per year

Source: Baker Commodities, Inc.

Baker will also install a high efficiency boiler at the Kerman facility to replace an older model. The original boiler operated at 900 horsepower and only 65 percent efficiency, while the new boiler will operate at 800 horsepower and 90 percent efficiency. At approximately 45 percent of total Kerman natural gas consumption, this boiler is a critical part of the food production process.

Baker will replace controls associated with controlling throughput of materials into and out of the cookers. This system dictates how steam is introduced into the cooker, which has a large impact on overall process efficiency.