Measure, Application, Segment, Industry (MASI):

New Opportunities in the Food Processing Industry

Prepared for:
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Reference No.: 170661
March 31, 2015

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Introduction

This MASI research study explores energy-efficient equipment and process upgrades for the industrial food processing sector.

Food Processing Industry Analysis and Overall Market Trends

California's food processing consumes more than 600 million Therms of natural gas and over 3.7 billion kilowatt hours of electricity per year. Food processing is the third largest industrial energy user in the state.[1]

The food processing industry has the following market trends arranged in the order of importance:

» Certain food processing sub-sectors such as wineries and food canning are seasonal in their operation. Facilities with seasonal operations tend to install energy-efficiency equipment during the downtime of the year.

» Per our secondary research and interview findings, the food processing sector is very aware of energy costs affecting their bottom line and prefers payback of three years or less when making retrofits/installing new equipment.

» Title 24 captures most energy efficiency opportunities for boilers measures; facility managers have limited opportunities beyond Title 24 requirements[2].

» The food processing industry has been slow to adopt new technologies as the industry is heavily regulated by food safety and sanitation standards. All energy efficiency upgrades activities must not jeopardize the facility's compliance with food safety and sanitation standards[3].

Navigant Consulting, Inc. (Navigant), in conjunction with ASWB Engineering,[4] conducted 13 interviews with a variety of stakeholders and industry experts. Table ES-1 provides the specifics for these interviews.

[1] California Energy Commission, California's Food Processing Industry Energy Efficiency Initiative: Adoption of Industrial Best Practices, March 2008

[2] Title 24, Building Energy Efficiency Standards, § 120.9 (2013)

[3] "The Role of Emerging Technologies in Improving Energy Efficiency: Examples from the Food Processing Industry".American Council for an Energy Efficient Economy (ACEEE), Proceeding of the Twenty-Eigth Industrial Energy Technology Conference.

[4] ASWB Engineering, http://www.aswengineering.com/html/index.htm.

Table ES-1. Stakeholder Interviews

Stakeholder/Industry Expert	Number of Interviews
Program Managers	4 utility program managers
Subject Matter Experts	1 (Wineries), 2(Food Processing Industry Experts)
Facility Managers	4 (Wineries), 3 (Cheese)

The three subject matter experts were food processing industry experts including an executive in a food processing trade association, an engineering manager at a global agri-business; and a regulatory analyst at a state regulatory commission (each with decades of experience in the food processing energy space).

The purpose of these interviews included the following:

- Understanding drivers and barriers for priority energy-efficiency measures
- Understanding the decision-making processes for measures and the utilities' involvement in these processes
- Identifying and discussing whether priority measures had the potential risk of being industry standard practice (ISP)

Major Energy Users in Food Processing

As described in Section 3, Navigant identified the top energy consumers in the food processing sector. These sub-sectors groups included cheese manufacturers, fruit and vegetable canneries, and wineries. These three sub-sectors account for 28% of the total electric and 39% of the total gas use in food processing industry in California.

Measure Potential in Food Processing

Using secondary literature and data from the industrial assessment database,[5] Navigant identified the measures with highest energy savings potential in the food processing sector (see Table ES-2). Specific measure descriptions are available in Section 2.2.

Table ES-2. Top Measures by Electric and Gas Savings Potential for the Food Processing Industry

Rank	Electric Measures	Electric Savings (GWh)	Gas Measures	Gas Savings (MM therms)
1	Refrigeration Operations and Controls	354.6	Steam Trap Replacement	22.6
2	Fan VFD	222.0	Power Burner	10.3
3	Air Compressor CFM Reduction	123.4	Air Compressor Heat Recovery	6.9
4	High Efficiency Lighting	98.6	Heat Recovery Hot Water	4.3
5	Properly Sized Pumps	49.9		

Source: Based on California Energy Commission, Quarterly Fuel and Energy Report for California specific energy consumption, IAC database for measure savings and ASWB Engineering's field experience for measure potential [6]

Section 3 breaks out these technical measure potentials by sub-sectors

Recommendations

Through our interviews with facility staff, program managers and sub-sector experts, the Navigant team developed the following recommendations and sub-sector recommendations, for which Section 4 provides further detail.

» **Provide Expert Advice in Energy Audits or Planning Stages of Construction-** Two facility managers and the trade association subject matter expert expressed that a thorough energy audit would help them identify potential opportunities in their facilities. Additionally, receiving expert advice during the early stages of construction would allow the facility to implement energy efficient measures at a much lower cost.

» **Energy Management Tools/ Equipment-** Four out of the seven facility managers felt that they would benefit from tools or equipment that could help them better understand their energy consumption. Through better understanding of their facilities' energy flow, facility managers are better equipped to implement measures targeting energy-intensive equipment or production areas. Utilities may help promote existing educational tools such as the BEST Dairy Benchmarking

[5] Center for Advanced Energy Systems. Industrial Assessment Centers Database. Rutgers State University of New Jersey, 20 Oct. 2014. Web.

[6] Based on California Energy Commission, Quarterly Fuel and Energy Report for California specific energy consumption, IAC database for measure savings and ASWB Engineering's field experience for measure potential

Tool for better understanding facility energy consumption in the dairy industry[7] and the LBNL "BEST-Winery: Benchmarking and Energy and Water Efficiency Savings Tool"[8] for wineries. Industry resources such as the PEC Tool Lending Library by PG&E[9], SDG&E Energy Innovation Center Resource Library & Tool Lending Library[10], and SCE's Energy Manager tool[11] can all help facility managers understand and assess site and equipment level energy consumption and learn more about energy conservation. Facility managers can benefit from the on-line classes and tools about different energy end uses available on the websites of these utilities.

» **Training for Non-Energy Staff-** A major barrier to measure installation was the lack of knowledge regarding the choice of measures, particularly for smaller facilities that do not have dedicated energy teams. Two of the smaller facility managers expressed an interest in training to help them identify and address energy efficient opportunities.

» **Water Recycling Opportunity Awareness-** Water intensive processes are common amongst many sites based on facility managers' feedback. According to the California Food Processing Industry Technology Roadmap[12] , the fruits and vegetable processing industry, cheese manufacturing industry, and wineries are the most water intensive food processing industries in California. Two facility managers mentioned that water recycling and conservation measures could help these sites reduce their water usage and the energy consumption associated with water use.

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[7]Lawrence Berkeley National Laboratory, Benchmarking and Energy/water-Saving Tool (BEST) for the Dairy Processing Industry, http://eetd.lbl.gov/publications/users-manual-for-best-dairy-benchmark.

[8] Lawrence Berkeley National Laboratory , BEST Winery Guidebook - Benchmarking and Energy and Water Savings Tool for the Wine Industry, http://www.energy.ca.gov/2005publications/CEC-500-2005-167/CEC-500-2005-167.PDF

[9] Pacific Gas and Electric, PEC Tool Lending library, http://www.pge.com/pec/tll/

[10] San Diego Gas and Electric, SDG&E Energy Innovation Center Resource Library & Tool Lending Library , https://c95021.eos-intl.net/C95021/OPAC/Index.aspx

[11] Southern California Edison, SCE Energy Manager, https://www.sce.com/wps/portal/home/business/tools/energy-manager

[12] Food Industry Advisory Committee and California Institute of Food and Agricultural Research- "California Food Processing Industry Technology Roadmap". July, 2004.

1 MASI Introduction

1.1 Study Overview

The "New Opportunities in the Food Processing Industry" study focuses on the top energy consumers in the food processing industry in California.

The focus of this study is to identify and present the following:

- » The top energy users in the food processing industry
- » The highest potential measures in food processing sub-sectors
- » Market trends, drivers and barriers as identified by industry experts and facility managers
- » Strategic recommendations for utilities to further assist food processors in reducing energy consumption

Navigant Consulting, Inc. (Navigant) identified cheese manufacturers, fruit and vegetable canneries and wineries as the largest energy consumers in the food processing industry by total energy consumption (electricity and natural gas).[13] For each of these three sub-sectors, Navigant identified key energy-saving measures and prioritized these measures by technical savings potential.

Navigant, in conjunction with ASWB Engineering,[14] conducted 14 interviews with a variety of stakeholders and industry experts including the following:

- Four IOU program staff: PG&E, SCE, SCG and SDG&E
- Three food processing subject matter experts: an executive in a food processing trade association; an engineering manager at a global agri-business; and a regulatory analyst at a state regulatory commission (each with decades of experience in the food processing energy space)
- Seven facility managers: Three cheese manufacturers and four wine producers

The purpose of these interviews included the following:

- » Understanding drivers and barriers for priority energy-efficiency measures
- » Understanding the decision-making processes for measures and the utilities' involvement in these processes

[13] Electric and Gas Consumption of IOUs SDGE, PGE, SCE,California Energy Commission, Quarterly Fuel and Energy Report, 2011
[14] ASWB Engineering, http://www.aswengineering.com/html/index.htm.

» Identifying and discussing whether priority measures had the potential risk of being industry standard practice (ISP)

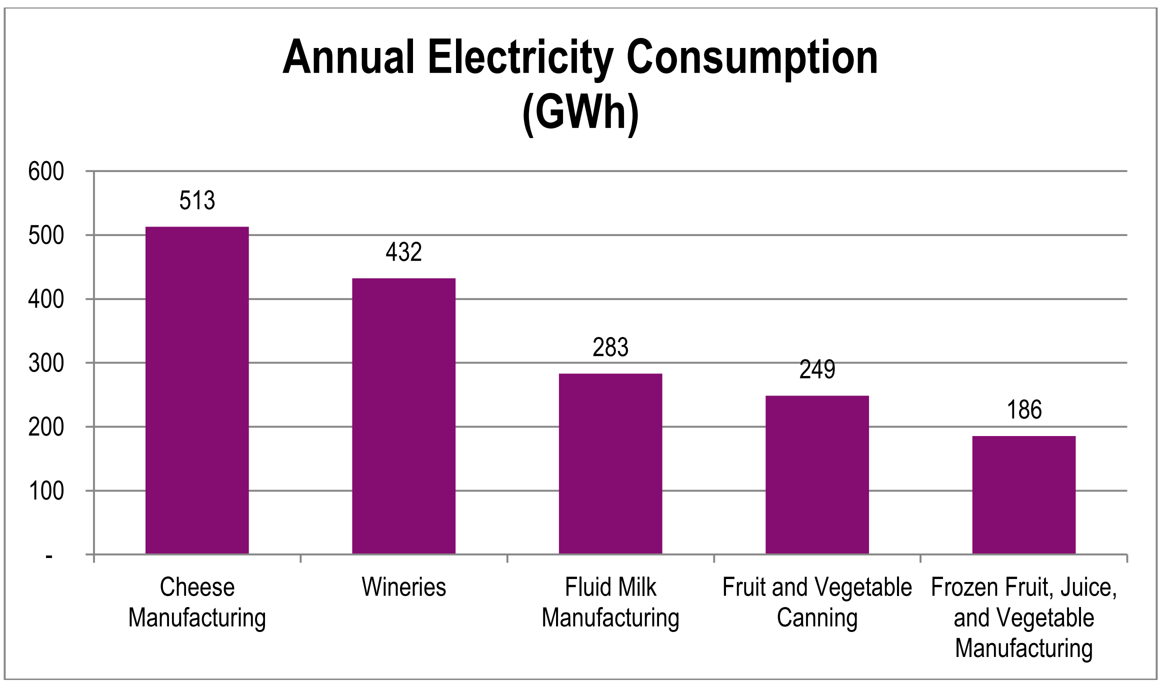
1.2 *Methodology*

1.2.1 Target Sectors

Navigant leveraged electricity and gas consumption data from the Quarterly Fuel and Energy Report (QFER) to determine the three food processing industries of focus for this study[15]. Navigant interpreted "food processing" to include all industries with NAICS (North American Industry Classification System) codes beginning with 311 (Food Manufacturing) or 312 (Beverage and Tobacco Product Manufacturing).

As seen in Figure 1, cheese manufacturing and wineries are the top electricity consumers, at 12.0% and 10.1% of total California food processing electricity consumption, respectively. Similarly, Figure 2 shows that fruit and vegetable canneries use 26% of the natural gas consumed by the food processing industry in the state. Fruit and vegetable canneries also use the fourth most electricity among food processing industries in California. Based on these observations, Navigant decided to focus its study on these three sub-sectors.

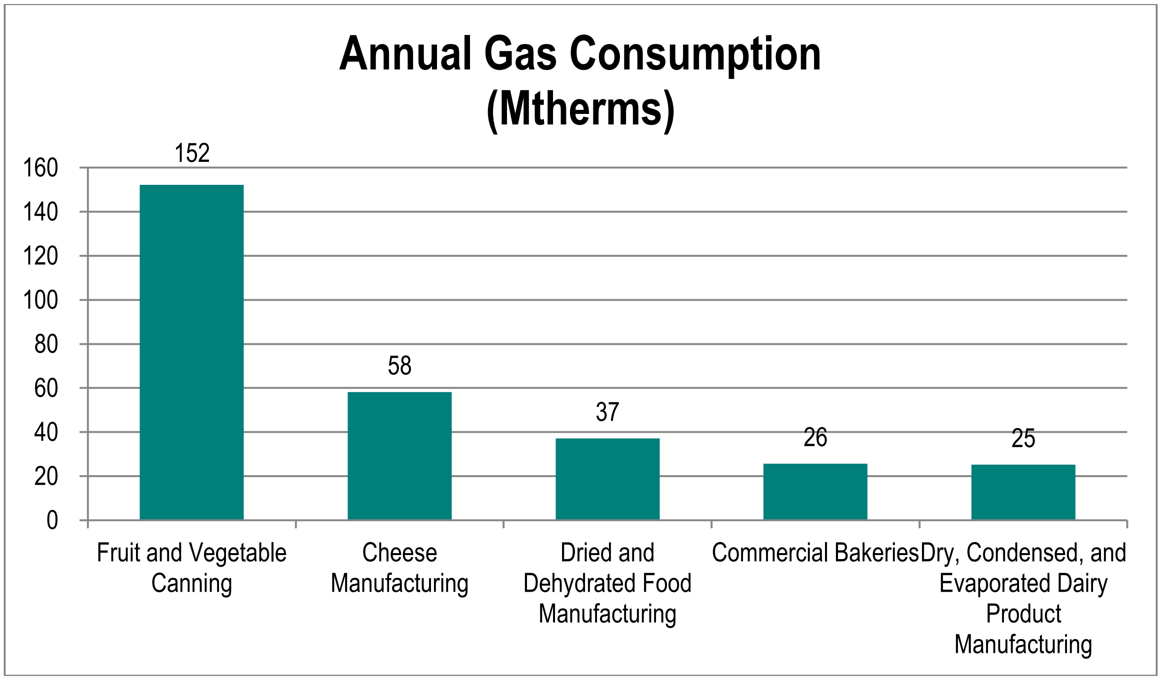
Figure 1. Top Five Electricity Consuming Food Processing Industries



Source: Electric and Gas Consumption of IOUs SDGE, PGE, SCE, California Energy Commission, Quarterly Fuel and Energy Report, 2011

[15] Electric and Gas Consumption of IOUs SDGE, PGE, SCE,California Energy Commission, Quarterly Fuel and Energy Report, 2011

Figure 2. Top Five Natural Gas-Consuming Food Processing Industries



Source: Electric and Gas Consumption of IOUs SDGE, PGE, SCE,California Energy Commission, Quarterly Fuel and Energy Report, 2011

1.2.2 Literature Review

For the three sub-sectors of focus, Navigant referenced a number of Lawrence Berkeley National Laboratory (LBNL) reports that identified energy-efficiency opportunities and best practices. Based on these studies, Navigant identified a number of promising energy-efficiency measures. In order to calculate the technical savings potential for each of these measures, Navigant used savings, cost, and market data from Rutgers University Industrial Assessment Centers Database (Rutgers IAC). These calculations, which Section 1.2.4 explains, provided the basis for measure-specific questions in interviews with food processing facility managers.

1.2.3 In-Depth Interviews

The Program Coordinating Group (PCG) provided Navigant with program manager or staff contacts at the four California IOUs. After interviewing each IOU's representative and leveraging secondary research, Navigant developed subject matter expert interview guides specific to each sub-sector. Similarly, Navigant developed three interview guides for the winery, cheese manufacturer, and cannery facility manager interviews, which included questions on the top five measures for both electric and gas savings potential, as calculated using the 2004 to 2012 Rutgers IAC data. These interview guides are provided in Appendix B, Appendix C, and Appendix D.

Reaching facility managers within the cheese manufacturing and cannery industries was a challenge for this study. One cheese manufacturer explained that in the past, cheese manufacturers have participated in surveys that resulted in new regulations, most likely health and safety regulations. Since then, cheese manufacturers have been extremely wary of any type of survey that may explain the difficulty that Navigant encountered while trying to reach large cheese manufacturers.

For the cannery industry, Navigant placed over 50 calls to the majority of California's fruit and vegetable canneries in an attempt to interview facility managers or engineers. Navigant talked to several facility managers but was unable to set up interviews due to the facility managers' time constraints.

1.2.4 Measure Potential

Navigant worked with ASWB to identify high potential measures for the cheese, fruit and vegetable cannery and winery industries. Navigant utilized data from Rutgers University's IAC to determine average site energy savings for each of these measures. ASWB provided information to Navigant identifying the relative potential of each measure in the three sub-sectors. Navigant utilized the following three factors to describe measure potential:

» **Total Measure Density (%)**: represents the percent of applicable equipment existing in any form in the sector, regardless of whether the equipment is baseline or efficient.

» **Technical Suitability (%)**: indicates the percentage of existing equipment for the particular measure as technically suitable to be upgraded to the energy-efficient measure. This accounts for incidences when a technology cannot be installed due to physical site restrictions or other factors. This factor was also used to account for when a measure would be required to be installed at a higher efficiency level due to codes.

» **Baseline Initial Saturation (%)**: shows the percentage of the existing technology that is at the baseline state for a given measure.

These three factors were then multiplied to calculate overall potential for a given measure in each sub-sector using the following equation:

$$\boldsymbol{Total\ Measure\ Potential} = Total\ Measure\ Density * Technical\ Suitability * Baseline\ Initial\ Saturation$$

Navigant illustrates this process in the following example using Pump Variable Frequency Drives (Pump VFDs) for cheese manufacturers.

Table 1. Pump VFD Total Measure Potential Calculation for Cheese Manufacturers

Measure	Total Measure Density	Technical Suitability	Baseline Initial Saturation	Total Measure Potential
Pump VFD	100%	50%	20%	**10%**

Source: Navigant Calculations[16]

ASWB identified that 100% of cheese manufacturers have installed equipment that could use Pump VFDs[17], meaning a Measure Density of 100%. Next, ASWB recognized that approximately half of all pumps could not utilize Pump VFDs for a variety of technical reasons, resulting in a Technical Suitability of 50%. Finally, only 20% of the technology is in baseline state, meaning that 80% of the technically suitable equipment has already installed Pump VFDs. This means that the Total Measure Potential for Pump VFDs within cheese manufacturers equates to 100% * 50% * 20% = **10%**.

Based on the calculation, it would be technically feasible for 10% of the current pumps in cheese manufacturing facilities to install Pump VFDs. Navigant performed this calculation for each measure identified in each of the three sub-sectors and for these measures in the overall food processing sector.

Navigant multiplied the energy savings for each measure by the Total Measure Potential to calculate technical achievable energy savings for each measure, as shown in the following equation:

$$\textbf{Technical Achievable Energy Savings} = Total\ Measure\ Potential * Per\ Site\ Measure\ Energy\ Savings * Number\ of\ Sites$$

The top results of this process are presented in Sections 3.3.2, 3.4.1, and 3.5.2. These sections address the technical savings potential for each sub-sector individually as well as interview findings regarding each of these measures.

[16] Based on California Energy Commission, Quarterly Fuel and Energy Report for California specific energy consumption, IAC database for measure savings and ASWB Engineering's field experience for measure potential
[17] Based on ASWB Engineering's field experience

2 Current Initiatives, Priority Measures, and Industrial Standard Practice

This section covers the current state of federal and state initiatives concerning food processing and gives a brief overview of each of the identified, high priority measures. This section also addresses the topic of ISP.

2.1 *Initiatives to Date*

There are no specific energy-efficiency programs targeting food processors on either a federal or statewide level but two of the major California IOUs have aggregated applicable commercial & industrial programs that food processors can utilize.

Southern California Gas Company has compiled a number of rebates and incentives for food processors on a website, which covers measures such as steam traps, pipe and tank insulation, heat recovery systems, and water heaters.[18] These rebates exist within its larger Energy-Efficiency Calculated Incentive Program, which is not specific to food processing.

Pacific Gas & Electric has developed an "Agriculture and Food Processing Rebate Catalog" that presents rebates for which food processors are eligible. These measures are within the categories of boilers & water heating, greenhouses, HVAC, insulation, irrigation, lighting and refrigeration.[19] These rebates are a part of the larger Energy-efficiency Rebates for Your Business program.

The California Public Utilities Commission (CPUC) has recently conducted workshops and outreach in an effort to update its strategic plan in the industrial sector. In doing so, the CPUC collaborated with the California League of Food Processors (CLFP) to host an open workshop on November 7, 2014, for all types of food processors and solicited comments on the following topics:

» Major trends and drivers in the industrial sector

» The role of energy in maintaining a competitive business

» Barriers toward further energy reduction

» Future opportunities and barriers for energy reduction

2.2 *Priority Measures*

The following summarizes information on the high priority electric and natural gas efficiency measures that Navigant identified. These measures identified through the LBNL reports specific to each sub

[18] Southern California Gas Company. "Rebates and Incentives for Energy-Efficient Equipment." Food Processing. N.p., Sept. 2011. Web.

[19] Pacific Gas and Electric Company. Agriculture and Food Processing Rebate Catalog. N.p.: Pacific Gas and Electric, n.d. Energy-Efficiency Rebates for Your Business. Jan. 2015. Web.

sector[20] and measure details were collected from the IAC database. The IAC database is a collection of energy measure recommendation based on industrial audits. . From 2004 to 2012 over 28 thousand measure recommendations were made by the IAC's. The IAC recommends a large range of measure with the top savers being lighting, VFD's, air compressor controls and repairs, and process equipment controls. The IAC visits a large range of sites with over 4,000 site visits from 2004 to 2012. Facility energy use at these sites range from less than 100 thousand kWh to over 25 million kWh, with around 50% of the site using 5 million kWh or less. The database provides measure level details that can be used to calculate typical measure savings for over 250 different measures.
Although the cheese, canning, and winery subsectors have process specific measures, the specific measures fall under generic measures in process heating, motor drives, refrigeration, lighting and water heating end uses. Navigant has further highlighted these measures in Section 3 by sub-sector. Detailed information on these subsector measures is extremely limited and site specific. Most of the definition of the measures come from the LBNL report on Energy Efficiency Improvement and Cost Savings Opportunities for the Fruit and Vegetable Processing industry[21].

2.2.1 Air Compressor Cubic Feet per Minute (CFM) Reduction

According to the LBNL report on energy efficiency improvements in fruit and vegetable processing industry[22], "Air leaks can be a significant source of wasted energy. A typical industrial facility that has not been well maintained will likely have a leak rate ranging from 20% to 30% of total compressed air production capacity. Overall, a 20% reduction of annual energy consumption in compressed air systems is projected for fixing leaks.

The magnitude of the energy loss associated with a leak varies with the size of the hole in the pipes or equipment. A compressor operating 2,500 hours per year at 87 psi with a leak diameter of 0.02 inches (½ mm) is estimated to lose 250 kWh per year; 0.04 inches (1 mm) to lose 1,100 kWh per year; 0.08 inches (2 mm) to lose 4,500 kWh per year; and 0.16 in. (4 mm) to lose 11,250 kWh per year. Several industrial case studies suggest that the payback period for leak reduction efforts is generally shorter than two months.

In addition to increased energy consumption, leaks can make air-powered equipment less efficient, shorten equipment life, and lead to additional maintenance costs and increased unscheduled downtime. Leaks also cause an increase in compressor energy and maintenance costs.

The most common areas for leaks are couplings, hoses, tubes, fittings, pressure regulators, open condensate traps and shut-off valves, pipe joints, disconnects, and thread sealants. The best way to

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[20] Ernest Orlando, Lawrence Berkeley National Laboratory, Energy Efficiency Improvement and Cost Savings Opportunities for the Fruit and vegetable Processing Industry, March 2008
Galitsky, Christina, Ernst Worrell, Anthony Radspieler, Patrick Healy, and Susanne Zechiel. BEST Winery Guidebook: Benchmarking and Energy and Water Savings Tool for the Wine Industry. Rep. Lawrence Berkeley National Laboratory, May 2005. Web.
Lawrence Berkeley National Laboratory, Benchmarking and Energy/water-Saving Tool (BEST) for the Dairy Processing Industry, http://eetd.lbl.gov/publications/users-manual-for-best-dairy-benchmark.
[21] Ibid
[22] Ibid

detect leaks is to use an ultrasonic acoustic detector, which can recognize the high frequency hissing sounds associated with air leaks. Leak detection and repair programs should be ongoing efforts."

Navigant experts and ASWB agree that despite its extremely quick payback most sites do not implement this measure on their own. The reason most sites do not implement this measure is that leaks reoccur very quickly unless the site implements this measure as a part of regular maintenance. For this reason, this measure is very prevalent and can result in savings for any site that has air compressors installed.

2.2.2 Air Compressor Heat Recovery

"As much as 90% of the electrical energy used by an industrial air compressor is converted into heat"[23]. In many cases, a heat recovery unit can recover 50% to 90% of this available thermal energy and apply it to other end-use applications.

Heat recovery for space heating is not as common with water-cooled compressors because an extra stage of heat exchange is required and the temperature of the available heat is somewhat low. However, with large water-cooled compressors, recovery efficiencies of 50% to 60% are typical . "

Navigant experts assume that water-cooled recovery ranges in temperature up to 90° F[24] and is most useful for process heating. The air from and air cooled compressor can be directly used for HVAC or process heat and can be above 100° F.

2.2.3 Combined Heat and Power (CHP) Boiler

While the electric technical potential for CHP is extremely high, CHP significantly increases gas usage at the site. CHP boilers can produce a large portion or all electrical energy needs for a site while simultaneously producing steam more efficiently. This is more cost effective than purchasing gas and electricity separately. Due to their high steam requirements, some food processing manufacturers are uniquely qualified to take advantage of CHP boilers. Due to its high gas usage Navigant feels that fruit and vegetable canning sector could benefit greatly from CHP. Although this measure has a high upfront cost and involves an extremely complex installation, overall this measure has high technical achievable energy savings for several food processing subsectors.

According to the LBNL report on energy efficiency improvements in fruit and vegetable processing industry[25], "In general, the energy savings of replacing a traditional system (i.e., a system using boiler-based steam and grid-based electricity) with a standard gas turbine-based CHP unit is estimated at 20%-30% (Galitsky et al. 2005a). However, savings may be greater when replacing older or less maintained boilers."

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[23] Ibid

[24] Atlas Copco Compressed Air Manual 7th edition

[25] Ibid

2.2.4 Fan and Pump Variable Frequency Drive (VFD)

Adjustable-speed drives better match speed to load requirements for motor operations, and therefore ensure that motor energy use is optimized to a given application. Energy audits carried out at seven fresh fruit and vegetable processing plants in California estimated simple payback periods for VFDs ranging from 0.8 to 2.8 years[26].

Four medium/large facility managers confirmed ASWB Engineering's field experience that most facilities are generally aware of the benefits of VFD's, however, he cost of a VFD can be a barrier to whether one is installed. Motors that operate for a high number of hours at low partial loads, either through throttling or other methods, benefit the greatest from VFD's. Previous evaluations complete by Navigant[27] have shown that VFD's cost can range from $0.20- $1.00 per kWh saved depending on motor size and hours of operation.

2.2.5 Properly Sized Pumps

Replacing oversized pumps with pumps that are properly sized can reduce the electricity use of a pumping system by 15% to 25%. Belt drivers or a slower speed motor are cost-effective alternative measures to replace significantly oversized pumps[28]. In industry in general, pumps are commonly oversized to account for future expansion and to ensure that the new equipment will meet the needs of the facility.[29] For this reason oversized pumps are quite common. Pumps that are consistently throttled or have VFD's that are set to a single speed are indicators of an oversized pump. By trimming the impeller of a pump, sites can often increase the efficiency of pump and also increase the flow.

2.2.6 Heat Recovery Hot Water

Industrial refrigeration systems produce a high level of waste heat. This heat can be recovered in a hot water heat exchanger. Much like the other heat recovery measures, a process that requires this waste heat needs to be identified. If the site can identify a heat need that is located relatively nearby, the site can greatly reduce the energy usage of that process by taking advantage of this waste heat.

2.2.7 High Efficiency Lighting

High efficiency lighting has a myriad of advantages over conventional lamp technologies (e.g. high bay mercury vapor or metal halide lamps) but is more expensive upfront. These advantages include lower energy consumption, longer lifespans and more operational flexibility and durability. Due to the high initial cost associated with these measures, many facilities rely on utility programs to create a feasible return on investment for high efficiency lighting.

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[26] Ibid

[27] Navigant, Energy Trust of Oregon PEP Evaluation for PY's 2009-2011

[28] Ibid

[29] Navigant industrial energy efficiency expertise

2.2.8 Power Burner

Power burners control the mixture of gas and air that is injected into the boiler's combustion chamber. These burners increase the efficiency of the boiler by providing an optimal ratio of gas to air. Due to Title 24[30], new boilers already require the installation of power burners to meet efficiency standards but this measure can still be installed as a retrofit to and existing boiler.

2.2.9 Refrigeration Operations and Control

Large industrial refrigeration systems are extremely complex and must consistently be adjusted to match the needs of the facility. Control systems can improve refrigeration system efficiency by balancing cooling demand and component loads.

Through careful system commissioning, overall operation and efficiency can greatly be increased, resulting in average overall site savings 8.5%[31]. Activities associated with this measure include: floating head and floating suction controls, installation of fan controls, and adjustments to system temperature set points based on operational needs.

2.2.10 Refrigeration System Upgrades

Industrial refrigeration systems are custom systems that are made up of many interacting pieces of equipment. This equipment includes compressors, condensers, evaporators, valves, and heat exchangers. By upgrading any of this equipment the entire refrigeration system efficiency can increase. Common projects include oversized condensers and high efficiency compressors. These types of projects save around 2.5% on average[32] of the entire facilities energy usage.

2.2.11 Steam Trap Replacement

Between 15% to 20% of steam traps malfunctions in a steam distribution system.[33] By fixing these steam traps a site can save on average 5.5% of its total gas usage[34].

2.3 *Codes and Standards and Industrial Standard Practice*

Navigant leveraged ASWB Engineering's field experience and facility manager interviews to determine if any of the measures described above had the potential of being code or an industrial standard practice (ISP) measure Navigant identified the following as code or potential ISP measures:

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[30] Title 24, Building Energy Efficiency Standards, § 120.9 (2013)

[31] Navigant, Energy Trust of Oregon PEP Evaluation for PY's 2009-2011

[32] Ibid

[33] Ernest Orlando, Lawrence Berkeley National Laboratory, Energy Efficiency Improvement and Cost Savings Opportunities for the Fruit and vegetable Processing Industry, March 2008

[34] Center for Advanced Energy Systems. Industrial Assessment Centers Database. Rutgers State University of New Jersey, 20 Oct. 2014. Web.

Boiler Power Burner: ASWB indicated that this measure may likely be an ISP measure due to the minimum boiler efficiency requirements of Title 24[35]. The required boiler efficiency can easily be achieved with a power boiler. For older boilers, this measure may be installed as a retrofit.

Motor VFDs: ASWB identified this measure has the potential risk of being an ISP measure for several different industrial subsectors. One cheese manufacturing and three winery facility managers identified this as a measure they have installed or considered installing in the past. These mangers also mentioned that cost, access to the motors, and system operation have prevented some VFD's from being installed. The smaller facilities were especially sensitive to cost. The smaller sites that were interviewed had not installed VFD's on the majority of their motors.

[35] Title 24, Building Energy Efficiency Standards, § 120.9 (2013)

3 Interview Findings & Sector-Specific Results

3.1 *Industry Analysis and Market Trends*

California's food processing consumes more than 600 million therms of natural gas and over 3.7 billion kilowatt hours of electricity per year. Food processing is the third largest industrial energy user in the state.[36]

The food processing industry has the following specific market trends arranged in the order of importance that differentiate it from other industries

- Certain food processing sub-sectors such as wineries and food canning are seasonal in their operations. Facilities with seasonal operations tend to install energy-efficiency equipment during the downtime of the year.
- Per our secondary research and interview findings, the food processing sector is very aware of energy costs affecting their bottom line and prefers payback of three years or less when making retrofits/installing new equipment.
- Title 24 captures most energy efficiency opportunities for boilers measures; facility managers have limited opportunities beyond Title 24 requirements[37].
- The food processing industry has been slow to adopt new technologies as the industry is heavily regulated by food safety and sanitation standards. All energy efficiency upgrades activities must not jeopardize the facility's compliance with food safety and sanitation standards[38].

Understanding the technical nature of each food processing industry is paramount to developing insights for their energy usage and energy-efficiency savings opportunities. This section provides a brief overview of each industry's production processes and energy-efficiency measures based on secondary literature and interview findings.

3.2 *Description of Sub Sector Calculations*

Navigant calculated the subsector savings potential for a variety of using the following process:

- Measures were identified by the using the LBNL studies for each subsector
- These measures were than matched up with equivalent measures in the industrial assessment center (IAC) database

[36] California Energy Commission, California's Food Processing Industry Energy Efficiency Initiative: Adoption of Industrial Best Practices, March 2008

[37] Title 24, Building Energy Efficiency Standards, § 120.9 (2013)

[38] "The Role of Emerging Technologies in Improving Energy Efficiency: Examples from the Food Processing Industry".American Council for an Energy Efficient Economy (ACEEE), Proceeding of the Twenty-Eigth Industrial Energy Technology Conference.

- The IAC database provided measure details including savings (as a % of total site usage), and measure cost
- Subsector energy usage was collected from CA QFER data
- ASWB and Navigant worked together to understand how potential of each measure was in each subsector as shown in section 1.2.4.
- These number represent measure total potential in each subsector and should be used to compare measure to each other

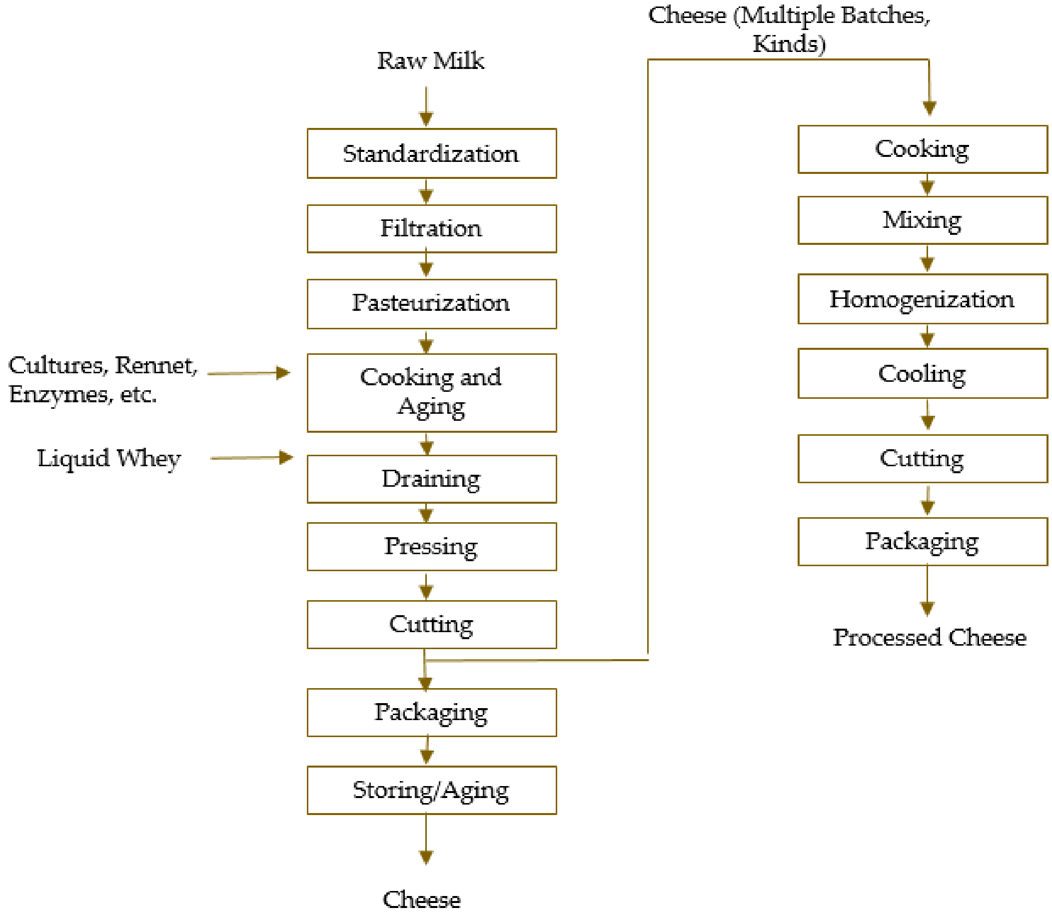
3.3 Cheese Manufacturing

Cheese is California's fastest growing dairy product with 44 percent of the state's milk supply going to cheese production. California's 50+ cheese producers make 250 different varieties and styles of cheese with operations ranging from small producers famous for handmade cheese to some of the country's largest cheese plants. Cheese varieties are dependent on several factors, including proportions of milk fat, solids nonfat, and water, and strains of bacteria used and the parameters of each processing step. In 2013, California's cheese manufacturers produced 2.3 billion pounds of cheese.[39]

There are four basic steps for natural cheese manufacturing- coagulating, draining, salting, and ripening. Processed cheese requires the extra steps of cleaning, blending, and melting. In the process of making processed cheese, several varieties of natural cheeses may be mixed and other substances such as powered milk, cream or butter, and water may be added. Manufacturing different cheeses follows the same procedures with variations in order, special application, or ripening practices. Figure 3 shows a detailed process diagram.

[39] California Milk Advisory Board, California – The Nations Dairy Leader, http://www.californiadairypressroom.com/Press_Kit/Nations_Dairy_Leader.

Figure 3. Process Flow Diagram for Cheese Manufacturing[40]



Source: Lawrence Berkeley National Laboratory, Energy Efficiency Improvement and Cost Saving Opportunities for the Dairy Processing Industry, October 2011.

Navigant spoke with operations/maintenance managers at two small and one medium-sized cheese manufacturing facilities in California. Of the two small facilities, one employs 20 staff members and the other was reported to be 9,000 sq. ft., while the medium company employs 120 people. All three of the cheese manufacturers are growing their businesses and two of the manufacturers are in the process of planning to build an additional facility.

All cheese manufacturing facilities Navigant spoke with operate six days a week with the small facilities operating 10.5 hours per day and 16 hours per day and the medium facility operating 20 hours per day. Two of the facilities reported that they use energy uniformly year-round throughout hours of operation. The third facility indicated that energy consumption varies slightly depending on the type of cheese being

[40] Brush, Adrian, Eric Masanet, and Ernst Worrell., Energy Efficiency Improvement and Cost Saving Opportunities for the Dairy Processing Industry: Energy Star Guide for Energy and Plant Managers, October 2011.

made. The main end uses that consume electricity include pumps and walk-in refrigeration units used for aging cheese.

3.3.1 Decision-Making Process within Cheese Manufacturers

The facility/maintenance managers Navigant interviewed at the cheese manufacturing facilities are the decision makers when it comes to installing and replacing energy-efficient equipment or controls. At one of the small manufacturing companies, the facility manager we spoke with handles all equipment, capital upgrades, and production management. At the medium-sized facility, the maintenance manager we spoke with handles equipment purchases and maintenance. Both facility managers indicated that due to their continued growth and success, they are getting to the size where they need to develop a better process to implement energy-efficiency measures.

All three facility managers expressed interest in energy-efficiency measures that made economic sense and were eager to learn more about existing measures. One of the cheese manufacturers had only been in operation for five years, none of the facility managers have had the time to look into the latest energy-efficient equipment or technologies. All facilities expressed interest in developing a better system for implementing energy-efficiency upgrades to lower their operating expenses.

3.3.2 Energy Savings Opportunities for Cheese Manufacturers

Through the process explained in Section 1.2.4Navigant identified the top energy-efficient measures in the cheese manufacturing industry. Navigant chose the top five measures with highest technical achievable energy savings in both gas and electric to investigate further. Table 2 shows these measures.

Table 2. Top Measures by Electric and Gas Savings Potential for Cheese Manufacturers

Rank	Electric Measures	Electric Savings (GWh)	Gas Measures	Gas Savings (MM therms)
1	CHP Power Boiler	10.7	Steam Trap Replacement	0.8
2	Refrigeration Operations and Controls	5.8	Air Compressor Heat Recovery	0.7
3	Fan VFD	5.5	Heat Recovery Hot Water	0.5
4	Air Compressor CFM Reduction	2.7	Power Burner	0.3
5	High Efficiency Lighting	2.2		

Source: Navigant Calculations[41]

[41] Based on California Energy Commission, Quarterly Fuel and Energy Report for California specific energy consumption, IAC database for measure savings and ASWB Engineering's field experience for measure potential

Navigant further explored these measures during phone interviews with site staff at cheese manufacturing facilities. The results of these interviews are consolidated in Table 3 and are further explained throughout the rest of Section 3.3.2

Table 3. Summary of Interview Findings for Cheese Manufacturers

Rank	Measures	Installed at Medium Site 1	Installed at Small Site 1	Installed at Small Site 2	Barriers to Installation
		Electric Measures			
1	CHP Power Boiler	No	No	No	Very high cost
2	Refrigeration Operations and Controls	No	No	Yes	Lack of knowledge of measure
3	Fan VFD	Yes	No	No	High cost
4	Air Compressor CFM Reduction	Yes	No	Yes	Lack of knowledge of measure
5	High Efficiency Lighting	Yes	Yes	Yes	N/A
		Gas Measures			
1	Steam Trap Replacement	Yes	No	No	Lack of knowledge of measure
2	Air Compressor Heat Recovery	No	No	No	High cost
3	Heat Recovery Hot Water	No	No	No	High Cost
4	Power Burner	Not Discussed	No	Not Discussed	Lack of knowledge of measure

Source: Interview Findings from 3 Cheese Manufacturer Interviews

Each measure is addressed in more detail below. Based on the measure information and the results of the interview Navigant feels that the following measures have especially high potential in the cheese subsector:

» Refrigeration Operation and Controls showed high savings with the main barrier being lack of knowledge. Contractors that have the knowledge to recognize these opportunities could realize these savings through refrigeration retro-commissioning.

» Fan VFD has high potential due to the large number of motors that exist in the industrial sector. Although this measure is somewhat known by the sites we talked to, it is very unlikely that all opportunities have been addressed.

» Steam trap replacement show huge potential and the main barrier is knowledge. Navigant feels that through training, industrial staff could identify and address these measures for a very low cost.

3.3.2.1 *Air Compressor CFM Reduction*

In cheese manufacturing facilities, the medium facility and one of the small facilities regularly monitors the air compressor system for leaks while the other small facility had not heard of this measure to reduce facility energy consumption.

3.3.2.2 *Air Compressor Heat Recovery*

For cheese manufacturing facilities, neither of the small facilities was aware of the measure and the medium-sized facility said that this measure was too cost prohibitive.

3.3.2.3 *CHP Boiler*

Navigant asked facility managers about their knowledge and implementation of CHP power boilers to ascertain more market information. All three cheese manufacturers had heard about CHP power boilers, however, none of the facilities have implemented the measure and all indicated that upfront it was very cost prohibitive.

3.3.2.4 *Fan Variable Frequency Drive (Fan VFD)*

The medium-sized manufacturer said that it uses VFDs commonly across its facilities. However, one of the smaller cheese manufacturers only uses 4 VFDs among its applicable 30 fans. This interviewee cited cost as the main barrier toward installing more fan VFDs, as VFDs were only economical when replacing fans upon failure. The other small facility does not use VFD fans.

3.3.2.5 *Heat Recovery Hot Water*

One of the small cheese facilities was told that their refrigerators did not produce enough hot water to be of much use, while the medium cheese facility found this measure to be too expensive to implement. None of the facilities interviewed have implemented this measure.

3.3.2.6 *High Efficiency Lighting*

All three cheese manufacturing facilities have upgraded or were in the process of upgrading lighting. One of the small facilities indicated that they would be interested in upgrading more of their lighting if there was a utility program. There facility currently has fluorescents throughout the building and a few exterior light-emitting diodes (LEDs). The other small facility indicated that they had not installed LEDs yet due to their cost.

3.3.2.7 *Power Burner*

One of the small cheese manufacturers was not aware of the power burner measure. It was not discussed with the medium facility or the other small facility manufacturer due to time limitations of the facility manager.

3.3.2.8 *Refrigeration Operations and Controls*

Refrigeration Operations and Controls is a high potential measure for the cheese industry. Among cheese makers, all three facility managers indicated they had a maintenance program in place. One of the small facilities stated that evaporator and condenser coils are maintained multiple times per year, while the medium facility regularly uses an external refrigeration maintenance company. While several cheese manufacturers commented on maintenance practices, there were no remarks regarding operational practices or refrigeration controls.

3.3.2.9 Steam Trap Replacement

The medium cheese manufacturer has a monthly steam Trap Replacement program; however, neither small facility has a program. One of the small facilities indicated that they only have three steam traps and that was the reason that they did not have a steam Trap Replacement program.

3.3.3 Key Drivers and Market Trends for Cheese Manufacturers

Cheese manufacturing is California's fastest growing dairy process and all manufacturers spoken to indicated that their facilities are expanding. Increasing energy costs require manufacturers to reduce operational costs to stay competitive in the cheese manufacturing business. [42] All facility managers interviewed indicated that the biggest driver to making energy-efficient equipment upgrades was whether the upgrade was cost effective and did not hinder production. Being able to easily purchase and install equipment that is more efficient was also mentioned as a key requirement for improving facility equipment energy efficiency. These interview results are consistent with findings from secondary literature review citing that capital expense is the biggest roadblock to making energy efficiency improvements[43]. Often times, the food processing sector has very low profit margins which prohibits new technologies adoption[44].

3.3.4 Key Barriers to Energy Efficiency for Cheese Manufacturers

A lack of measure information and interaction from the utilities was one of the key barriers identified for the cheese manufacturing industry. Additionally, both of the small manufacturers indicated that the upfront cost and effort to replace equipment that still works is a barrier.

The cheese facility managers we spoke to felt that they have not received sufficient energy-efficiency information from their utilities in the past and were eager to change that. One facility manager mentioned that information they had received in the past was of limited use since it focused on large capital intensive projects and not incremental improvements that they could implement over time. Although this facility manager had worked with the utility a long time ago to upgrade two to three facility motors, the manager received very few communications from the utility on an annual basis. Two facility managers indicated that their companies had never participated in utility programs and the last site indicated that they were familiar with the utility's auto-demand response program but were not

[42] Adriano Sun, Douglas Reindl, Douglas Reinemann, Energy Use in Wisconsin's Dairy Industry and Options for Improved Energy Efficiency.
[43] Nathan Adams and Pamela H. Milmoe, The Food Processing Industry at a Glance, 2001. http://www.aceee.org/files/proceedings/2001/data/papers/SS01_Panel1_Paper22.pdf
[44] Robert Lung, Eric Masanet, Aimee McKane, The Role of Emerging Technologies in Improving Energy Efficiency: Examples from the Food Processing Industry, 2006. http://repository.tamu.edu/bitstream/handle/1969.1/5645/ESL-IE-06-05-28.pdf?sequence=4

participating because curtailing their energy consumption in the middle of a cheese-make could pose health and safety issues.

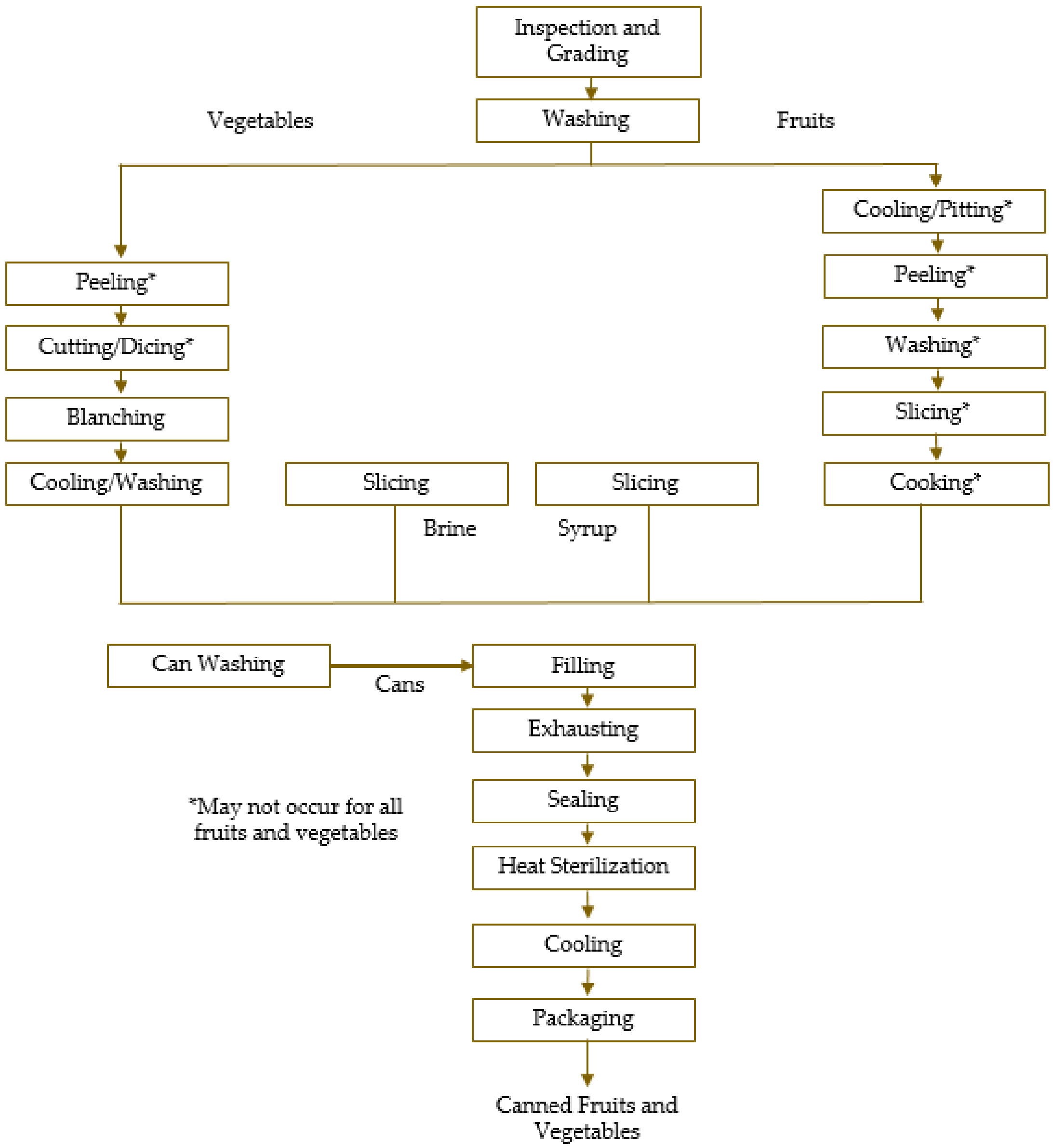
3.4 Fruit & Vegetable Canneries

California is a prominent world player in the fruit and vegetable canning industry, with a significant portion of the world's tomato products, fruits, vegetables, jellies, and jams canned in the state. Tomato-based canning products from California alone accounted for 33% of the world's processed tomato products.[45]

The actual canning of fruits and vegetables can be separated into roughly four production processes: filling, exhausting and sealing, sterilization, and cooling. After cans are machine-filled (and infrequently, hand-filled) with the appropriate product, a vacuum is created within the can, which is quickly sealed. Next, the can is subjected to varying levels of heat for sterilization (duration and intensity dependent on the type of product being sterilized) and is then quickly cooled. The can sterilization process requires a tremendous amount of thermal energy. Consequently, there are abundant opportunities to improve energy usage, as detailed in the next section. Figure 4 shows a complete process diagram.

[45] Masanet, Eric, Ernst Worrell, Wina Graus, and Christina Galitsky. Energy Efficiency Improvement and Cost Saving Opportunities for the Fruit and Vegetable Processing Industry. Rep. Lawrence Berkeley National Laboratory, Mar. 2008. Web.

Figure 4. Process Flow Diagram for Fruit & Vegetable Canning



Source: Energy Efficiency Improvement and Cost Saving Opportunities in the Fruit and Vegetable Processing Industry

Besides the actual canning of products, numerous other energy-intensive processes like evaporation, pasteurization, drying and dehydration are used to prepare the food products themselves. According to LBNL estimates, the majority of the energy usage in fruit and vegetable canneries comes in the form of natural gas used for boiler fuel, which generates steam for the heat-intensive processes mentioned above.

3.4.1 Energy-Saving Opportunities for Fruit & Vegetable Canneries

Navigant was unable to conduct any facility manager interviews for the fruit and vegetable canning industry due to the busy nature of fruit and vegetable cannery engineering and operations staff in California. However, with secondary literature, technical field experience from ASWB and measure potential calculations from the QFER data, Navigant estimated the technical potential for the following high priority measures for fruit and vegetable canneries. Table 4 shows the top five measures with highest technical achievable energy savings in both gas and electric.

Table 4. Top Measures by Electric and Gas Savings Potential for Fruit & Vegetable Canneries

Rank	Electric Measures	Electric Savings (GWh)	Gas Measures	Gas Savings (MM therms)
1	CHP Power Boiler	53.6	Heat Recovery Hot Water	1.4
2	Fan VFD	6.2	Steam Trap Replacement	1.4
3	Air Compressor CFM Reduction	6.2	Air Compressor Heat Recovery	1.4
4	Heat Recovery Hot Water	5.5	Power Burner	0.5
5	High Efficiency Lighting	4.9		

Source: Navigant Calculations[46]

Based on the measure information Navigant feels that the following measures have especially high potential in the cheese subsector:

- CHP power boilers are especially attractive to this sub-sector due to the extremely high gas usage associated with the fruit and vegetable canning. These sites require a high level of steam and would be able to achieve the maximum benefit of this measure.
- This subsector in general showed the highest potential for gas savings measures.

3.4.2 Key Drivers and Barriers for Fruit & Vegetable Canneries

A key driver in the fruit and vegetable canning industry is the distributed and competitive nature of the business. According to the LBNL's report on "Energy Efficiency and Cost Saving Opportunities in the Fruit and Vegetable Processing Industry," the largest 20 canneries in the United States only comprised 60% of all industry shipments in 1997. This means that any impact energy-efficiency measures have on reducing energy costs will directly affect the competitiveness of the cannery by increasing its margin.

A key challenge for canneries is the seasonality of product harvests. For example, according to the same report from LBNL, the majority of tomato canning occurs between July and October, when the canning facility operates nonstop. During other parts of the year between harvests, these plants sit idle. For

[46] Based on California Energy Commission, Quarterly Fuel and Energy Report for California specific energy consumption, IAC database for measure savings and ASWB Engineering's field experience for measure potential

plants that are only open during these harvesting periods, this means that energy savings only occur during these active times, which lengthens payback periods for replaced equipment compared to plants that operate year-round.

3.5 Wineries

With 214.6 million cases sold in the United States in 2013, 4,100 wineries operate in California, accounting for approximately $23.1 billion domestic wine sales annually.[47] California uses 432 GWh of energy to produce wine.[48]

After the grapes are harvested, wine production includes four main processes: stemming, crushing, fermentation/pressing (order depends on type of wine produced), aging and bottling/corking. Within these processes, aging is the most energy-intensive process due to the refrigeration needed to maintain narrow cold storage temperature ranges. Other significant energy end uses include hot water for the cleaning and fermentation processes, compressed air, and bottling operations.[49]

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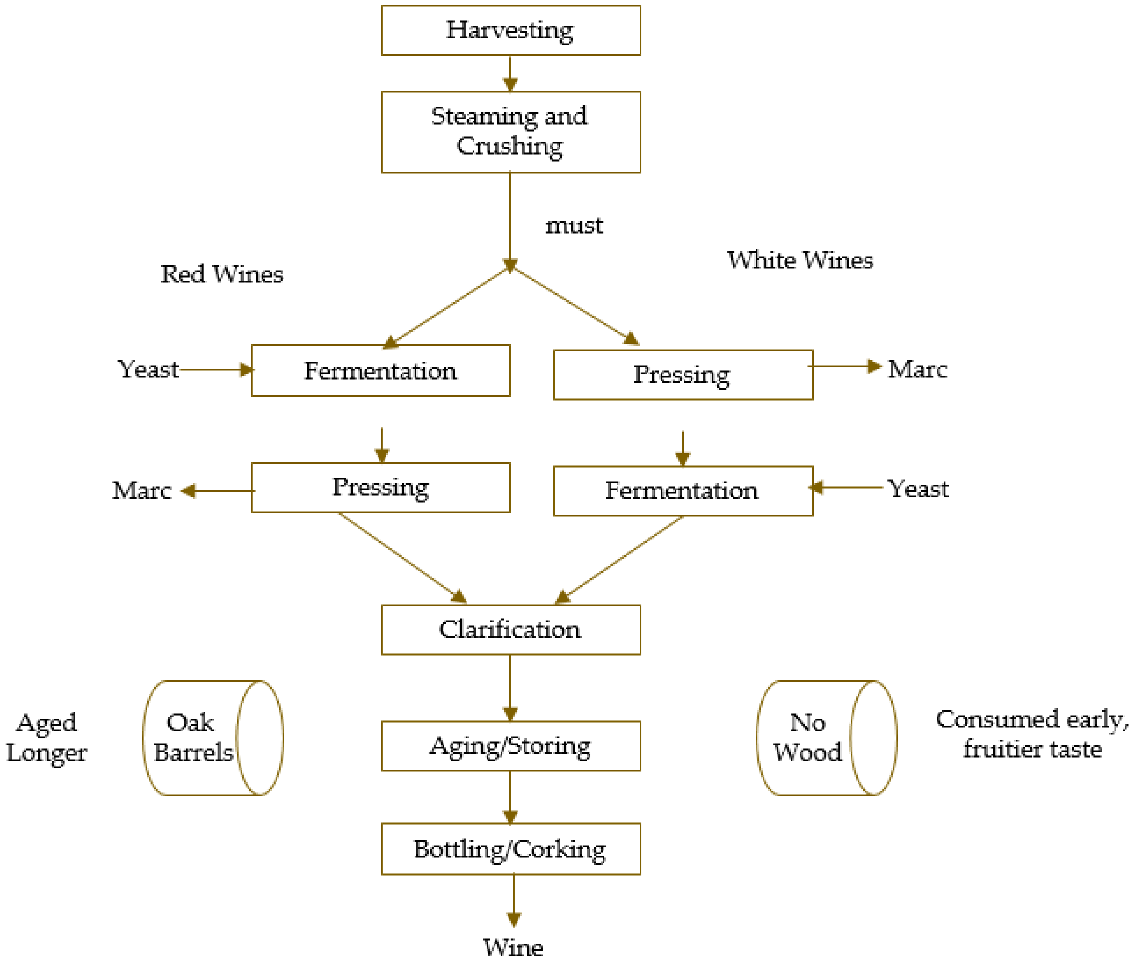
[47] California Wine Profile 2013. San Francisco: Wine Institute, 2014. California Wine Industry Statistical Highlights. Wine Institute, 15 May 2014. Web.

[48]Electric and Gas Consumption of IOUs SDGE, PGE, SCE,California Energy Commission, Quarterly Fuel and Energy Report, 2011

[49] Galitsky, Christina, Ernst Worrell, Anthony Radspieler, Patrick Healy, and Susanne Zechiel. BEST Winery Guidebook: Benchmarking and Energy and Water Savings Tool for the Wine Industry. Rep. Lawrence Berkeley National Laboratory, May 2005. Web.

Figure 5. Process Flow Diagram for Wine Production



Source: BEST Winery Guidebook – Benchmarking and Energy and Water Savings Tool for the Wine Industry

3.5.1 Decision-Making Process within Wine Producers

Navigant spoke to operations/maintenance managers and engineering personnel at two medium-sized and two large-sized wine producers in California. The medium-sized facilities produce approximately half a million standard cases of wine per year,[50] while the large-sized facilities produce upwards of tens of millions of cases per year.

Navigant found that the decision-making process varies among different wineries and is dependent on winery size. At one of the large wineries interviewed, potential equipment replacement or installation projects are generated at the site level, usually by 'site champions' that exist for each site and meet on a quarterly basis. A formal project review is created that evaluates all stages of analysis (i.e., financial or operational benefits) and it is run through the capital committee. This represents a bottom-up approach.

[50] 1 case = 12 x 750 milliliter bottles = 9 liters

The other large winery makes decisions using a top-down approach. Manager and supervisors submit potential projects at the management level; these projects are then addressed at the vice president level. The medium-sized winery interviewed had a threshold approach – projects under $100,000 are implemented using the facility's capital improvement budget. Headquarters need to review projects over that threshold.

All the winery facility managers were aware of the impact of energy on their operational costs. Operational and engineering managers stay current on energy management via multiple avenues, including the following:

- Trade magazines (New Engineering Digest, Pumps and Systems, Uptime Magazine)
- Dedicated information websites (The Wine Institute)
- General word of mouth from other wineries
- Industry seminars (Wine and Grape Symposium, water-focused meetings)

The interviewee from one medium winery indicated that small- and medium-sized wineries learn from what larger wineries, such as E. & J. Gallo and Sutter Home, do, as they are trendsetters in the energy management space. The other medium-sized winery did not specifically discuss decision-making within their business.

3.5.2 Energy-Saving Opportunities for Wine Producers

Through the process explained in Section 1.2.4, Navigant identified the top energy-efficient measures in the wine production industry. Navigant chose the top five measures with highest technical achievable energy savings in electric to investigate further. Navigant only looked at one gas measure because savings for other gas measures were too low to warrant further investigation. Table 5 shows these measures.

Table 5. Top Measures by Electric and Gas Savings Potential for Wineries

Rank	Electric Measures	Electric Savings (GWh)	Gas Measures	Gas Savings (MM therms)
1	Refrigeration Operations and Controls	28.0	Air Compressor Heat Recovery	0.1
2	High Efficiency Lighting	17.5	-	-
3	Refrigeration System Upgrade	7.8	-	-
4	Fan VFD	4.4	-	-
5	Properly Sized Pumps	3.7	-	-

Source: Navigant Calculations[51]

[51] Based on California Energy Commission, Quarterly Fuel and Energy Report for California specific energy consumption, IAC database for measure savings and ASWB Engineering's field experience for measure potential

Navigant further explored these measures during telephone interviews with site staff at wine manufacturer facilities. The results of these interviews are consolidated in Table 3 and are further explained in throughout the rest of Section 3.5.2.

Table 6. Summary of Interview Findings for Wine Producers

Rank	Measures	Installed at Medium Site 1	Installed at Medium Site 2	Installed at Large Site 1	Installed at Large Site 2	Barriers to Installation
Electric Measures						
1	Refrigeration Operations and Controls	Y	-	Y	Y	Downtime is not allowable under most circumstances
2	High Efficiency Lighting	Y	N	Y	Y	High costs - rebates are critical for ROI targets
3	Refrigeration System Upgrade	N	-	Y	Y	Can be prohibitively expensive sometimes
4	Fan VFD	Y	-	Y	Y	Technical suitability, technical ability
5	Properly Sized Pumps	Y	-	Y	Y	-
Gas Measures						
1	Air Compressor Heat Recovery	N	-	N	N	Technically infeasible – applicable to design stage only

Source: Interview Findings from 4 Winery Interviews

Each measure is addressed in more detail below. Based on the measure information and the results of the interview Navigant feels that the following measures have especially high potential in the cheese subsector:

» Refrigeration Operation and Controls showed high savings with the main barrier being issues with downtime of these systems. With proper planning Navigant feels that contractors could address these opportunities without having negative impact due to downtime issues. These refrigeration system are much less seasonal that the rest of the winery operation greatly increasing the savings potential for this measure.

» Although most site have addressed some lighting opportunities, Navigant feels that there remains a high potential for these measure for more advanced technologies like LED's.

» Wineries do not use gas as much as other food processing facilities and are not good candidates for gas savings measures

3.5.2.1 Air Compressor Heat Recovery

All but one of the wineries interviewed were aware of this measure but indicated that they currently do not plan to use heat recovery in air compressor systems in the future. The main obstacle is that this measure can only be effectively implemented in the plant design stage. The air compressor heat sources and heat needs are too far away to be cost effective in current winery plants. While the heat recovery itself is technically feasible, the transfer of recovered heat to other applications is the main barrier to installing more heat recovery equipment in air compressors.

3.5.2.2 Fan Variable Frequency Drive

VFDs for fans are common for medium- and large-sized wineries but appear to not be common for smaller wineries. Three wineries mentioned that they all utilize fan VFDs, but costs remain high, while one medium-sized winery did not respond on this measure. One of the large wineries stated that small wineries would not have the technical expertise or work force to install and operate fan VFDs, while also stating that fan VFDs are not always the right technology for every situation.

3.5.2.3 High Efficiency Lighting

All of the winery interviewees are interested in and are currently implementing high efficiency lighting measures, chiefly in the form of LED lighting. One of the large facilities and one of the medium-sized facility currently rely on LED rebates to achieve reasonable return on investment (ROI) targets and both indicated that not having the rebate would make installing LEDs extremely difficult. The other large wine facility stated that LEDs are still too expensive, even with the utility rebate. That same facility said that they do not want to be first in the technology or on the cutting edge and would prefer to see predictable savings and results before jumping in, although they are first trying some test systems. The other medium wine facility is currently looking into but has not yet implemented LED lighting.

3.5.2.4 Properly Sized Pumps

Pumps are generally sized for targeted applications as needed in wineries as it makes economic sense not to over- or under-size pumps. Three of the four wineries commented that they aim to purchase properly sized pumps, while one of the medium-sized wineries did not comment on this measure.

3.5.2.5 Refrigeration Operations and Controls

Refrigeration Operations and Controls is a high potential measure for the cheese and winery industries. Three of the wineries regularly maintain their refrigeration equipment, as temperature-controlled spaces are paramount to wine production processes. One of the large wineries went as far as to say that there are no barriers to maintaining refrigeration equipment. While several wineries commented on maintenance practices, there were no remarks regarding operational practices or refrigeration controls.

3.5.2.6 Refrigeration System Upgrade

Refrigeration systems are key, always-on systems for wineries where any downtime can result in significant spoilage and negative impact on wine quality. Hence, all three wineries that commented on this measure stated that they would not hesitate to upgrade their refrigeration systems as necessary, as it is a central part of their business. However, these large-scale equipment replacements at times can become very expensive.

3.5.3 Key Drivers and Market Trends for Wine Producers

Medium- to large-sized wineries are keenly aware of the energy savings measures available to their facilities. As a result, all four of the facility manager interviewees were aware of each of the electric and gas measures discussed. The key driver behind implementing any measure is ROI, to the point where the phrase "ROI is king" was mentioned in multiple interviews.

One of the largest drivers for wineries is the competitive nature of the business. California wineries are increasingly competing with international wineries on a global scale. There are high pressures to stay as cost competitive as possible and energy costs are a large target. As a result, sustainability is viewed as more of a luxury than a key driver behind lowering energy usage via equipment upgrades or maintenance. One of the large wineries sets a relatively strict 15% internal rate of return (ROR) requirement and estimates that its cost of capital is around 9%. For longer-term investments in strategic areas, that same winery may drop its ROR requirement to 2-4%.

3.5.4 Key Barriers to Energy Efficiency for Wine Producers

One of the largest market barriers to reducing energy consumption in California wineries is the recent multi-year drought. While not directly linked to energy usage, the drought has made it increasingly difficult to make businesses cases to obtain capital allocation for energy reduction projects, with higher prioritization placed on water and irrigation projects.

Some wineries mentioned that specific measures have been removed by their local utilities because they are now considered standard practice. They indicated that utility rebates were critical to meeting ROI requirements for these measures. One example measure is tank insulation – one winery stated that since the rebate was removed, they no longer install tank insulation and use more energy to maintain stable tank temperatures.

3.6 Overall Barriers to Energy Efficiency in Food Processing

A key technical barrier to energy reduction is the lack of knowledge-sharing across the food processing industry. Four food processors have mentioned that there is no platform for connecting with other food processors, whether that is via regular industry meetings or online discussion forums. Additionally, knowledge-sharing would also help industry benchmarking.

One large food processor mentioned that demand charges within the current rate structure increase focus on reducing peak demand and diminish the attention given to reduce energy consumption – a trend that the food processor noticed across the industry.

Additionally, two wineries have stated that there are a number of general rebates that utilities have removed because they consider certain measures to be industry standard practice. The rebates are often critical toward achieving a minimum, internal return on investment target.

Finally, energy management and monitoring systems are extremely cost-prohibitive to food processors. Food processors want to be able to understand and manage their energy consumption at a more localized level but are unable to because the equipment and software is too expensive. This was mentioned by four different food processors as well as the engineering manager subject matter expert at a global agri-business firm.

4 Recommendations

Navigant has consolidated interview findings and developed recommendations for utilities to help further reduce energy usage in food processing facilities, while also strengthening the relationship between utilities and food processors.

4.1 Energy Management Equipment and Software

Two of the four wineries interviewed specifically mentioned that they would strongly benefit from rebates for energy management and measurement tools. Both wineries indicated that the energy consumption information that they received from utilities was too high-level. The wineries want more information on how much energy is consumed within different operational sections (i.e. within bottling or crushing), including information for specific pieces of equipment.

Wineries were not the only facilities interested in more in-depth energy measurement; two of the cheese manufacturers were particularly interested in understanding the energy consumption of key equipment. Additionally, the state regulatory analyst subject matter expert directly stated that facilities "can't improve on what they can't measure."

This could be accomplished by implementing the following recommendations:

1. Utilities could focus on programs that offer rebates for energy management systems or energy measurement equipment.
2. California Utilities like PG&E, SCE and SDG&E all have tool lending libraries where home owners and businesses can borrow tools for short periods of time to measure energy at equipment level. [52] These libraries can be advertised to the facility managers who are currently unaware of these available tools.

4.2 *Invest in Better Training for Non-Energy Personnel*

Many facility managers mentioned that they would highly appreciate opportunities to learn more about energy-efficiency opportunities and management. As the majority of food processing companies that we interviewed had no dedicated energy personnel, operations staff and facility managers are responsible for energy management.

These personnel could be trained through the development of a dedicated energy training center for food processors. This center could be responsible for providing regular training sessions (either in-person or in webinars) on focused topics such as the following:

» Upcoming regulations: demand charges, renewable portfolio standards, greenhouse gas credits

» Utility energy-efficiency programs: demand response, ISPs, new or discontinued incentive programs

» New technologies and best practices: energy management systems, new energy-efficiency measures

California Utilities have established training centers which can be leveraged for the purpose of educating the facility managers. Advertising these available resources to the facilities can be beneficial for their education of energy use.

These training sessions could also serve as conduits for information exchange and networking among different food processors. By using the following, utilities can increase the efficiency of this process:

» Collaborating with trade associations and industry organizations to tailor trainings to the needs of their constituents

» Developing case studies for successful installations of energy-saving measures, promoting measures that are currently being implemented in the industry

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[52]Pacific Gas and Electric, Pacific Energy Center Tool Lending library, http://www.pge.com/pec/tll/,San Diego Gas and Electric, SDG&E Energy Innovation Center Resource Library & Tool Lending Library , https://c95021.eos-intl.net/C95021/OPAC/Index.aspx; Southern California Edison, SCE Energy Manager, https://www.sce.com/wps/portal/home/business/tools/energy-manager

4.3 Promote Use of Existing Industry Resources

Navigant recommends that utilities promote existing industry specific resources. In addition, the BEST Dairy Benchmarking Tool is an educational tool for better understanding facility energy consumption in the dairy industry.[53] The tool was developed for industrial users to compile data on energy and water usage in their own dairy processing plants, and compare their efficiency levels with state of the art efficient facilities to determine where opportunity exists. Utilities can also promote this tool for wineries, with the LBNL "BEST Winery: Benchmarking and Energy and Water Efficiency Savings Tool."[54] Apart from the tool lending libraries, California utilities also have energy training centers for their respective service territories. These centers, that offer a variety of courses and seminars on a variety of energy topics, can be a great resource for facility managers to learn and understand energy management. Information about these courses can be found on the utility websites.

The California League of Food Processors is a great forum to learn, grow and connect with industry experts as well as other facility managers. They have several workshops offered year around as well as an annual Food Processing expo that brings together more than 230 exhibitors from 11 countries with over 2000 attendees, is the largest tradeshow in California devoted exclusively to food processing.[55] These resources can be very beneficial for facility managers to understand, evaluate and learn about their energy use.

The CPUC collaborated with the California League of Food Processors conducted an open workshop and outreach to update its knowledge on the energy efficiency and identify opportunities and barriers in the industrial and hence the food processing sector. There may be more opportunities for the sector to engage in energy efficiency dialogue at the state level as a part of the CPUC Industrial Action Plan. [56]

4.4 Cheese Manufacturing

4.4.1 Provide Support in Energy-Efficiency Investments

The cheese manufacturers interviewed were relatively small facilities. Both the small and medium cheese manufacturer spoken to indicated that having specific measure information and the potential energy savings opportunity would be the most helpful way for utilities to provide support. Two of the cheese manufacturers expressed that they will be expanding their operations facilities over the course of the next couple of years and advice regarding energy-efficient equipment and practices would be much appreciated.

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[53] Lawrence Berkeley National Laboratory, Benchmarking and Energy/water-Saving Tool (BEST) for the Dairy Processing Industry, http://eetd.lbl.gov/publications/users-manual-for-best-dairy-benchmark.

[54] Lawrence Berkeley National Laboratory , BEST Winery Guidebook - Benchmarking and Energy and Water Savings Tool for the Wine Industry, http://www.energy.ca.gov/2005publications/CEC-500-2005-167/CEC-500-2005-167.PDF

[55] California League of Food Processors, Food Processing Expo, http://www.foodprocessingexpo.net/

[56] California Public Utilities Commission, Industrial Action Plan, http://www.cpuc.ca.gov/PUC/energy/Energy+Efficiency/eesp/iap.htm

4.4.2 Water Recycling Program

Within water-intensive process of cheese manufacturing, utilities can explore program options to help facilities recycle industrial wastewater, which could have a dramatic impact on both water and energy consumption. The small cheese manufacturing facility is currently looking into the feasibility of recycling water as they produce 3,500 gallons of wastewater each day or one million gallons annually. According to the California Food Processing Industry Technology Roadmap[57], cheese manufactures in California use 600 million gallons of water annually. This recommendation will be useful for other food processing sub-sectors that have water-intensive processes such as wineries and the fruits and vegetable canning industries.

4.5 Wineries

4.5.1 Provide Expert Advice in Energy Audits

All four of the larger wineries interviewed have been investing in energy efficiency for many years. At this point, they have installed majority of the low hanging fruit measures. These facilities felt that although they have received some assistance from third-party consultants hired by the utilities for energy audits, the majority of those audits were insufficient to identify measures that are more complex.

Utilities may explore helping wineries evaluate opportunities in these highly complex facilities by providing technical expert advice. These experts should have an understanding of the current regulatory framework and utility energy-efficiency programs.

4.6 Fruit and Vegetable Canning

4.7 Although Navigant was not able to conduct interviews with facility managers in this sub-sector, we identified this sub-sector due to its extremely high gas usage. This sub-sector had the highest gas consumption of over 25% in the food processing sector. Navigant recommends focusing on this sub-sector for programs with gas measures and conducting further in-field research for the canning sector. Future Research Topics

One of the biggest barriers while conducting this study was getting participation from the facilities. Navigant strongly suggests that the utilities identify opportunities to increase lines of communication with their customers. This could be done in several ways, such as. Newsletters for the food processing sector, conducting in person/on-line surveys to help customers identify energy savings opportunities, strengthening their ties with the California League of Food Processors, etc.

Navigant recommends focusing on the canning sector for programs with gas measures and conducting further in-field research for the canning sector. CHP measures have one of the highest gas consumption within this sector. Navigant further recommends conducting a CHP study targeting the large gas users

[57] Food Industry Advisory Committee and the California Institute of Food and Agricultural Research, "California Food Processing Industry Technology Roadmap", July 2004.

in the canning sector. Navigant suggests that utilities conduct retro-commissioning pilot studies with large wineries to identify remaining energy efficiency potential in this sector.

Future Research? What should it focus on? How? What lessons did you learn in conducting this research that should be taken into account in future efforts?

Need to caveat more the findings/recommendations as they were based on a few interviews.

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Appendix B Program Manager Interview Guide

Begin interview by providing background on the project and highlighting the purpose of the call. Allow the interviewee to elaborate on their industry, businesses objectives, and where they see the remaining potential. **NOTE: While we may ask certain questions about the program managers wants and needs, SOWs has been finalized and we are using these interviews to focus, not expand the scope.**

(Sample introduction)
*Hello, my name is [**your name**] and I'm calling from Navigant Consulting on behalf of SCE (replace with utility consortium). We are performing a baseline study for SCE on the food processing industry, specifically cheese manufacturing, wineries and fruit and vegetable canning. As part of this study, we are interviewing program managers in existing utility efficiency programs to further focus our subsequent interviews with facilities managers and subject matter experts. Are you the correct person to talk to regarding IOU programs related to food processing? [**If not**] Can you direct me to the appropriate person?*

B.1 Program Manager Introduction Questions

(1) Please take a few minutes to describe your industry, current involvement in this study's specific area of focus, related programs and knowledge of /involvement in related studies.
(2) While we do have a set scope of work for the food processing study, can you tell us what you hope to gain from this research we are conducting?
(3) What information about food processing in California would be most useful to you? How would you use this information?

B.2 Market Assessment and Program Activities Questions

(4) Can you describe any current or recent program activities including:
   a. Program history and targeted sub-sectors
   b. Program designs and implementation approaches
   c. Baseline assumptions
   d. Targeted processes and equipment?
   e. Program marketing
(5) *Data Request: Do you have any information on these topics you can share (previously targeted opportunities or equipment, etc.)?
   a. *Clarification on data requests: We understand that customer-sensitive information may be difficult or not possible to share. We are happy to remain flexible to accommodate confidentiality requirements. For example, high-level program data or details stripped of sensitive customer information would still be beneficial to us.*
(6) Tell us about any lessons learned or best practices developed during current and/or historical program activities.
(7) What are the most important regulations governing food processing efficiency?
(8) What are the most significant trends and drivers in efficiency in the food processing industry?

a. Do they differ across sub-sectors? (ex. cheese manufacturing, wineries, canning)

(9) How are you marketing your programs to each sector?

(10) Are there any technical or market barriers you are currently facing in food processing efficiency programs? (ex. Cheese manufacturing: information on energy-efficiency opportunities, heterogeneity of cheese manufacturing process across cheese types makes it difficult to benchmark)

a. How do these barriers vary across the three sub-sectors of study?

(11) Can you talk about any industry standard practice (ISP) you are currently focusing on or ISPs that concern you?

B.3 Identify New Opportunities Questions

(12) Do you have ideas for programs that would be applicable across California?

a. What efficiency measures to do you believe have the most potential to save energy in each sub-sector?

(13) Do you have any programs you are planning or envision launching in the near future?

(14) Besides energy savings, what are the drivers you see behind these efforts to pursue new opportunities for equipment or process changes?

a. General drivers we expect to see here are maintenance (cost & time) savings, environmental concerns, federal and/or state requirements, etc.

b. What specifically are non-energy drivers that you see in food processing?

(15) Do you know of any new emerging technologies or processes not yet discussed that provide new opportunities for the industry?

B.4 Market Actors Questions

(16) *Data Request: Can you identify additional interview candidates for each sub-sector:

a. Subject matter experts - *Regulators, State and Federal organizations, Trade organizations*

b. Trade allies - *Suppliers/vendors*

c. Facility managers

(17) Can you tell us about any other specific resources (market actors or other) you use to support your work in this area?

B.5 Concluding Questions

(18) Do you have any additional comments or concerns?

Appendix C Subject Matter Expert Interview Guide

Navigant Consulting, Inc. (Navigant) developed three separate interview guides for subject matter experts.

C.1 Cheese Manufacturing

1. Goal of the Interview (for interviewer only)

Ascertain information regarding industry trends, sector operations, market drivers and barriers, promising technologies and future opportunities for energy efficiency within the industry.

2. Introduction

Hi, my name is ***[interviewer's name]*** *and I am calling from Navigant Consulting, We are an energy consulting firm located in San Francisco, California that is conducting a research study into energy-efficient technologies and controls used in the cheese manufacturing industry. We are conducting this study on behalf of* ***the California investor-owned utilities,*** *who want to know what technologies that* ***fruit and vegetable canning facilities*** *are installing or should be installing to save energy and operating costs. As a subject matter expert in this industry, we are hoping that you can help broaden our understanding of your industry and its operations, what energy-efficient technologies are being installed and what future opportunities are available in the industry.*

3. Overview – Interviewee Information

a. Would you mind if we record this conversation to assist our note taking?
b. What is your current role in your company? What is your involvement in the cheese manufacturing industry?
c. How long have you been in this role?

4. Sector-Specific Questions

A. Overview:

a. Can you give us a brief overview of energy and water consumption in the cheese manufacturing industry?
    i. What are the primary sources of energy and water consumption?
    ii. How aware are cheese manufacturers on energy and water consumption cost impacts to their business bottom lines?
    iii. What kind of trends have you seen with regards to energy and water consumption in the cheese manufacturing industry?
b. What kind of energy-efficiency measures have been implemented to date in the cheese manufacturing business?

i. What do you see as the main drivers of energy efficiency?
   1. Give Example if needed: Wisconsin study mentioned that milk production has been flat but cheese demand has been raising → difficulty to purchase milk inexpensively. Additionally, energy costs have been rising. These two things have driven manufacturers to reduce operational costs through efficiency.

ii. What do you see as the main barriers to energy efficiency? (Ex. data on economics of efficiency measures, education, etc.)

B. Mechanical and Equipment-Based:

a. Do you consider installing [Measure X] to be a common practice in your industry or ISP?
b. Do rebates or tax incentives currently exist for replacing [Measure X]?
c. What kind of challenges does replacing [Measure X] encounter? Can this equipment be swapped out quickly without affecting production too much?
d. What are the leading technologies in the [Measure X] category?
e. What (if any) are the major barriers that prevent facility managers to apply for rebates for [Measure X]?
f. Do rebates and tax incentives currently exist for replacing [Measure X]?

The following tables list the top measures for the cheese manufacturing industry:

Measure Type	Measure X for Cheese Industry
Electric	CHP Power Boiler
Electric	Refrigeration Operations and Controls
Electric	Fan VFD
Electric	Air Compressor CFM Reduction
Electric	High Efficiency Lighting
Gas	Steam Trap Replacement
Gas	Heat Recovery Hot Water
Gas	Air Compressor Heat Recovery
Gas	Power Burner

g. Do you know of any other dynamic or emerging technologies/processes that will drive new opportunities for manufacturing plants to reduce energy consumption?
   i. For example, regeneration which cools outlet steam by using the outgoing steam to heat incoming steam seems to be a very effective process to save energy during pasteurization.
h. What do small-volume cheese manufacturers prefer when it comes to deciding between (and why?):
   i. New, efficient motors/fans/equipment
   ii. New, cheap and inefficient equipment

        iii. Extremely cheap used equipment
        iv. Repairs and stopgap measures
    i. What do large-volume cheese manufacturers prefer when it comes to deciding between (and why?):
        i. New, efficient motors/fans/equipment
        ii. New, cheap and inefficient equipment
        iii. Extremely cheap used equipment
        iv. Repairs and stopgap measures
    j. What processes that are energy intensive utilize motors?
        i. Describe motor type, size, age, and features specific to the cheese manufacturing industry?
        ii. What is the repair/replacement protocol when motors fail? (Send out for repair, replace with a spare, purchase a new motor, etc.)
        iii. Are motors typically repaired using green rewind practices?
        iv. What practices and technologies are being implement to improve energy efficiency? (optimal sizing, drives, controls, NEMA premium, etc.)
        v. What are the drivers behind these efforts to pursue new motor-related opportunities for equipment or process changes? Example: Energy savings vs. maintenance (cost & time) savings etc.

C. Operational and Behavioral:
    a. What are the challenges/barriers toward getting cheese manufacturing staff to change their practices (start/stop times for equipment, upfront cost, limited information on energy-efficiency opportunities)
    b. Are you aware of the Lawrence Berkeley National Laboratory BEST Dairy tool? Do you think it has been an effective tool for dairy processing plants to evaluate and reduce their energy and water consumption?
        i. This BEST Dairy Benchmarking Tool (V1.2, 2011) was developed for industrial users to compile data on energy and water usage in their own dairy processing plants, and to compare the efficiency levels with those of best references.
    c. What differences do you see in energy and water usage between small-volume cheese manufactures versus high-volume cheese manufacturers (e.g., amount of electricity used per pound of cheese manufactured and usage patterns across different phases of the cheese manufacturing process)?
    d. How does the cheese manufacturer industry view early retirement of equipment to achieve higher efficiencies?
        i. Is it common practice to wait until the equipment burns out to upgrade its efficiency or are they willing to remove existing operating equipment with remaining useful life (RUL) to increase efficiency?

    ii. What are the barriers to early retirement? (i.e., the cost of downtime, "why fix it if it isn't broken" mentality, lack of knowledge on how to install new higher efficient equipment, lifecycle cost, etc.)

D. Financing:
   a. How large of an issue is financing when it comes to investing in energy-efficient motors, fans and refrigeration devices?
   b. Do facility managers have access to capital for energy-efficient investments? If not, where are the priority investment areas for facility managers?
   c. Do facility managers have access to favorable financing rates for energy-efficient investments? If not, why?
   d. Do small-volume and large-volume cheese manufacturers have the same financial resources?

E. Future:
   a. What kind of support is needed to drive stronger energy efficiency in the cheese manufacturing business – rebates, standards, outreach/education programs, certification programs, etc.?
   b. What kind of support is needed to overcome many of these existing barriers to reducing energy consumption?
   c. What would you like to see utilities do to drive energy efficiency in cheese manufacturing?
   d. What would you like to see from the state of California or the federal government to drive efficiency in cheese manufacturing?
   e. Is there any other information that you believe may be helpful toward us accomplishing our research study?
   f. Can you identify industry organizations with the most influence that utilities can partner with? (Ex: California League of Food Processors)

5. Conclusion
   a. Do you have any recommendations for other subject matter experts or contacts that may have useful information?
   b. Would you mind if I followed up with you if I find I have a few more questions or need to clarify any of today's discussion (either via phone or email)?
   c. We would like to list your name, title, and organization in the acknowledgements section of our report. Would that be ok with you?
   d. Thank you for your time and willingness to share your information with Navigant!

C.2 Fruit & Vegetable Canning

1. Goal of the Interview (for interviewer only)

Obtain information regarding industry trends, sector operations, market drivers and barriers, promising technologies and future opportunities for energy efficiency within the industry.

2. Introduction

*Hi, my name is **[interviewer's name]** and I am calling from Navigant Consulting, We are an energy consulting firm located in San Francisco, California that is conducting a research study into energy-efficient technologies and controls used in the **[food processing industry name]** industry. We are conducting this study on behalf of **the California investor-owned utilities,** who want to know what technologies that **fruit and vegetable canning facilities** are installing or should be installing to save energy and operating costs. As a subject matter expert in this industry, we are hoping that you can help broaden our understanding of your industry and its operations, what energy-efficient technologies are being installed and what future opportunities are available in the industry.*

3. Overview – Interviewee Information

a. Would you mind if we record this conversation to assist our note taking?
b. Could you please describe your background within the fruit and vegetable canning industry?
c. How long have you been in this role?

4. Sector-Specific Questions

A. Overview:

a. Can you give us a brief overview of energy and water consumption in the canning industry?
   i. What are the primary sources of energy and water consumption?
   ii. How aware are fruit and vegetable canneries on energy and water consumption cost impacts to their business bottom lines?
   iii. What kind of trends have you seen with regards to energy and water consumption in canneries? What direction has the sector taken in this regard?
b. What kind of energy-efficiency measures have been implemented to date in canneries?
   i. What do you see as the main drivers of energy efficiency?
   ii. What do you see as the main barriers to energy efficiency?

B. Mechanical and Equipment-Based:

a. Do you consider installing [Measure X] to be a common practice in your industry or ISP?
b. Do rebates or tax incentives currently exist for replacing [Measure X]?
c. What are the major barriers to replacing [Measure X]? Can this equipment be swapped out quickly without affecting production too much?
d. What are the leading technologies in the [Measure X] category?

e. What (if any) are the major barriers that prevent facility managers to apply for rebates for [Measure X]?

Measure Type	Measure X for Canning Industry
Electric	CHP Power Boiler
Electric	Fan VFD
Electric	Air Compressor CFM Reduction
Electric	Heat Recovery Hot Water
Electric	High Efficiency Lighting
Gas	Heat Recovery Hot Water
Gas	Steam Trap Replacement
Gas	Air Compressor Heat Recovery
Gas	Power Burner

f. Do you know of any dynamic or emerging technologies that will drive new opportunities for fruit and vegetable canneries to reduce energy consumption? *For example, have you used any of the new drying or heating mechanisms (Ohmic heating, infrared drying, pulsed fluid-bed drying, pulsed electric field pasteurization)? Have you used or thought about using geothermal heat pumps?*

g. What do canneries prefer when it comes to deciding between the following (and why?):
   i. New, efficient motors/fans/equipment
   ii. New, cheap and inefficient equipment
   iii. Extremely cheap used equipment
   iv. Repairs and stopgap measures

h. What processes utilize motors and which processes are energy intensive?
   i. Describe motor types, sizes, ages and features specific to the canning industry?
   ii. What are the repair/replacement protocols when motors fail? *(Prompt: send out for repair, replace with a spare, purchase a new motor, etc.)*
   iii. Are motors typically repaired using green rewind practices?
   iv. What practices and technologies are being implement to improve energy efficiency? (optimal sizing, drives, controls, NEMA premium, etc.)
   v. What are the drivers behind these efforts to pursue new motor-related opportunities for equipment or process changes? Example: Energy savings vs. maintenance (cost & time) savings etc.

C. Operational and Behavioral:

a. What are the challenges toward getting cannery staff to change their practices (start/stop times for equipment, upfront cost, and limited information on energy-efficiency opportunities)?

b. What differences do you see between different types of canning?
   i. Is there a huge difference in energy usage between peaches and baby corn?

ii. How about between orange juice and peach juice?

c. What kind of resources are common in energy usage planning within the fruit and vegetable canning industry? *(Prompt if needed: Have you seen planning tools like the Steam System Assessment Tool from the US Department of Energy [DOE] or the Quick Plant Energy Profiler tool (also from DOE) being used?)*

d. How does the canning industry view early retirement of equipment to achieve higher efficiencies?

   i. Is it common practice to wait until equipment burns out to upgrade its efficiency or are operators generally willing to remove existing operating equipment with remaining useful life (RUL) to increase efficiency?

   ii. What are the barriers to early retirement? *(Prompt if necessary: the cost of downtime, "why fix it if it ain't broken" mentality, lack of knowledge on how to install new higher efficient equipment, lifecycle cost, etc.)*

D. Financing:

   a. How large of an issue is financing when it comes to investing in energy-efficient motors, fans and refrigeration devices?

   b. Do facility managers have access to capital for energy-efficient investments? If not, where are the priority investment areas for facility managers?

E. Do facility managers have access to favorable financing rates for energy-efficient investments? If not, why? Future:

   a. What kind of support is needed to drive stronger energy efficiency in canneries – rebates, standards, outreach/education programs, certification programs, etc.?

   b. What kind of support is needed to overcome many of these existing barriers to reducing energy consumption?

   c. What would you like to see utilities do to drive energy efficiency in canneries?

   d. What would you like to see from the state of California or the federal government to drive efficiency in wineries?

   e. Is there any other information that you believe may be helpful toward us accomplishing our research study?

   Can you identify industry organizations with the most influence that utilities can partner with? *(For example, the California League of Food Processors)*

5. Conclusion

   a. Do you have any recommendations for other subject matter experts or contacts that may have useful information?

   b. Would you mind if I followed up with you if I find I have a few more questions or need to clarify any of today's discussion (either via phone or email)?

   c. We would like to list your name, title, and organization in the acknowledgements section of our report. Would that be ok with you?

d. Thank you for your time and willingness to share your information with Navigant!

C.3 Wineries

1. Goal of the Interview (for interviewer only)

Ascertain information regarding industry trends, sector operations, market drivers and barriers, promising technologies and future opportunities for energy efficiency within the industry.

2. Introduction

*Hi, my name is **[interviewer's name]** and I am calling from Navigant Consulting, We are an energy consulting firm located in San Francisco, California that is conducting a research study into energy-efficient technologies and controls used in the **[food processing industry name]** industry. We are conducting this study on behalf of **the California investor-owned utilities,** who want to know what technologies that **fruit and vegetable canning facilities** are installing or should be installing to save energy and operating costs. As a subject matter expert in this industry, we are hoping that you can help broaden our understanding of your industry and its operations, what energy-efficient technologies are being installed and what future opportunities are available in the industry.*

3. Overview – Interviewee Information

a. Would you mind if we record this conversation to assist our note taking?
b. Could you please describe your background within the winery industry?
c. How long have you been in this role?

4. Sector-Specific Questions

A. Overview:
   a. Can you give us a brief overview of energy and water consumption in the winery industry?
      i. What are the primary sources of energy and water consumption?
      ii. How aware are wineries on energy and water consumption cost impacts to their business bottom lines?
      iii. What kind of trends have you seen with regards to energy and water consumption in wineries?
   b. What kind of energy-efficiency measures have been implemented to date in wineries?
      i. What do you see as the main drivers of energy efficiency? (Ex. Water drought in California means higher water usage rates, more incentive to reduce usage)
      ii. What do you see as the main barriers to energy efficiency? (Ex. data on economics of efficiency measures, education, etc.)

B. Mechanical and Equipment-Based:
   a. Do you consider installing [Measure X] to be a common practice in this industry or ISP?
   b. Do rebates or tax incentives currently exist for replacing [Measure X]?

c. What are the major barriers to replacing [Measure X]? Can this equipment be swapped out quickly without affecting production too much?
d. What are the leading technologies in the [Measure X] category?
e. What (if any) are the major barriers that prevent facility managers to apply for rebates for [Measure X]?
f. Do rebates and tax incentives currently exist for replacing [Measure X]?

The following tables list the top measures for the wine industry:

Measure Type	Measure X for Wine Industry
Electric	Refrigeration Operations and Controls
Electric	High Efficiency Lighting
Electric	Refrigeration System Upgrade
Electric	Fan VFD
Electric	Properly sized pumps
Gas	Air Compressor Heat Recovery

g. Do you know of any dynamic or emerging technologies that will drive new opportunities for wineries to reduce energy consumption? (*Prompt if necessary: Electro dialysis seems to be an interesting replacement for the cold stabilization process of removing tartrate)*
h. What do premium, small-volume wineries prefer when it comes to deciding between the following options (and why?):
    i. New, efficient motors/fans/equipment
    ii. New, cheap and inefficient equipment
    iii. Extremely cheap used equipment
    iv. Repairs and stopgap measures
i. What do low-end, high-volume wineries prefer when it comes to deciding between the following options (and why?):
    i. New, efficient motors/fans/equipment
    ii. New, cheap and inefficient equipment
    iii. Extremely cheap used equipment
    iv. Repairs and stopgap measures
j. What processes utilize motors and are energy intensive?
    i. Please describe motor types, sizes, ages and features specific to the wine industry?
    ii. What is the repair/replacement protocol when motors fail (send out for repair, replace with a spare, purchase a new motor, etc.)?
    iii. Are motors typically repaired using green rewind practices?
    iv. What practices and technologies are being implement to improve energy efficiency? (optimal sizing, drives, controls, NEMA premium, etc.)

v. What are the drivers behind these efforts to pursue new motor-related opportunities for equipment or process changes? (*Example: Energy savings vs. maintenance (cost & time) savings.*

C. Operational and Behavioral:

a. What are the challenges toward getting winery staff to change their practices (start/stop times for equipment, upfront cost, and limited information on energy-efficiency opportunities)?

b. What differences do you see in energy and water usage between premium, small-volume wineries versus low-end, high-volume wineries?

c. Are you aware of the Lawrence Berkeley National Laboratory BEST Winery tool? Do you think it has been an effective tool for wineries to evaluate and reduce their energy and water consumption?

i. Background from LBNL: "BEST Winery is a software tool designed to evaluate the energy and water efficiency at a winery, and to help assess the environmental and financial impacts of potential improvement strategies."

ii. "Given the necessary data, BEST Winery calculates an energy intensity index (EII) and water intensity index (WII), performance indicators that compare the user's winery to a benchmark or reference facility, incorporating information about winery-specific process steps and characteristics affecting energy and water use and volumes processed by the winery."

iii. "BEST Winery also allows the user to evaluate preliminary opportunities for energy and water efficiency improvement, to assess the impact on the performance of the facility, and to evaluate operation costs. This can help the user in developing a preliminary implementation plan for energy and water efficiency improvement."

d. How do wineries view early retirement of equipment to achieve higher efficiencies?

i. Is it common practice to wait until the equipment burns out to upgrade its efficiency or are they willing to remove existing operating equipment with remaining useful life (RUL) to increase efficiency?

ii. What are the barriers to early retirement? (i.e., the cost of downtime, "why fix it if it ain't broken" mentality, lack of knowledge on how to install new higher efficient equipment, lifecycle cost, etc.)

D. Financing:

a. How large of an issue is financing when it comes to investing in energy-efficient motors, fans and refrigeration devices?

b. Do facility managers have access to capital for energy-efficient investments? If not, where are the priority investment areas for facility managers?

c. Do facility managers have access to favorable financing rates for energy-efficient investments? If not, why?

d. Do small-volume and high-volume wineries have the same financial resources?

E. Future:

a. What kind of support is needed to drive stronger energy efficiency in wineries – rebates, standards, outreach/education programs, certification programs, etc.?
b. What kind of support is needed to overcome many of these existing barriers to reducing energy consumption?
c. What would you like to see utilities do to drive energy efficiency in wineries?
d. What would you like to see from the state of California or the federal government to drive efficiency in wineries?
e. Is there any other information that you believe may be helpful toward us accomplishing our research study?
f. Can you identify industry organizations with the most influence that utilities can partner with? (Ex: California League of Food Processors)

5. Conclusion

a. Do you have any recommendations for other subject matter experts or contacts that may have useful information?
b. Would you mind if I followed up with you if I find I have a few more questions or need to clarify any of today's discussion (either via phone or email)?
c. We would like to list your name, title, and organization in the acknowledgements section of our report. Would that be ok with you?
d. Thank you for your time and willingness to share your information with Navigant!

Appendix D Facility Manager Interview Guide

Hi, my name is ***[interviewer's name]*** *and I am calling from Navigant Consulting, We are an energy consulting firm located in San Francisco, California that is conducting a research study into energy-efficient technologies and controls used in the* ***[food processing industry name]*** *industry. We are conducting this study on behalf of* ***[specific IOU]****, who wants to know what technologies that* ***[food processing industry name]*** *are installing or could be installing to save energy and operating costs. As a facility manager in this industry, we are hoping you can help broaden our understanding of your industry and its operations, what energy-efficient technologies you are installing, and what future opportunities you would like to pursue. Your feedback will help improve the energy-efficiency program offerings (specific IOU) offers so these are more aligned to your needs.*

D.1 Introduction

1. Please take a few minutes to discuss what takes place at your facility and how your role affects energy use in your facility.

D.2 Facility Operations and Decision-Making Process

2. Please describe the general operating hours of your facility including peak hours and seasons as well as scheduled down time. Are there different parts of the facility that operate on different schedules? Please specify.
3. Please explain the process of developing your energy-efficiency projects (i.e., decision-making process when it comes to installing and replacing energy-efficient equipment or controls).
4. Who typically makes the decision when it comes to installing and replacing energy-efficient equipment or controls?
5. What are the key drivers for making energy-efficient equipment investments?

D.3 Awareness, Attractiveness, Availability of Energy Efficiency

Equipment:

6. What energy-efficient equipment upgrades have you implemented in the past five years?
7. Are there any energy-efficient equipment upgrades that have been identified that you have not implemented?
8. What are your reasons for not installing the equipment you just mentioned?

(If guidance is needed) Was it due to: (capture verbatim – all reasons-and perhaps try to elicit info on which were more important)? If you read these—change the order as you do each interview

a. The cost of the equipment did not seem worth it.
b. You did not have financing available to cover the high initial cost.

c. You were unable to install the equipment due to operational issues (e.g., no time available for scheduling a plant shut down to install the equipment.).
d. There was too much cost associated with removing the old equipment and/or systems in place.
e. Cost to service the energy-efficient equipment/controls were too high.
f. You did not have the necessary engineering expertise to run the equipment.
g. Using the equipment and controls would negatively impact production processes (lower operational flexibility, longer run times).

9. Which of these had the greatest impact on why you did not install the equipment?
10. Do you have suggestions to overcome the barriers you mentioned?
11. For the equipment you did not install-
    a. Do you know where you could purchase it?
    b. Do you know who could install it?
    c. Do you know who could service it?

Controls:

12. What energy-efficient control upgrades have you implemented in the past five years?
13. Are there any energy-efficient control upgrades that have been identified that you have not implemented?
14. What are the reasons you did not install the controls you mentioned?

(If guidance is needed) Was it due to:

a. The cost of the controls were not worth it
b. You did not have financing available to cover the high initial cost
c. You were unable to install the measure due to operational issues (ex: no time available for scheduling a plant shut down to install the equipment etc.).
d. There was too much cost associated with removing the old equipment and/or systems in place
e. Cost to service the energy-efficient equipment/controls were too high
f. You did not have the necessary engineering expertise to run the equipment
g. Using the equipment and controls would negatively impact production processes (lower operational flexibility, longer run times)

15. Which of these had the greatest impact on why you did not install the control measure?
16. Do you have suggestions to overcome the barriers you mentioned?
17. For the controls you did not install-
    a. Do you know where you could purchase it?
    b. Do you know who could install it?
    c. Do you know who could service it?

Automation:

18. Does your facility use automation in its processes? Do you intend to install any automated controls in your facility in the near future?

D.4 Measure-Specific Questions

19. Are you familiar with the energy-saving technology or practice [Measure X]?
20. Does your facility currently utilize [Measure X]?
    a. If so, have you seen the energy savings in your utility bills?
21. Are you considering implementing [Measure X]?
    a. What are your concerns or barriers for implementation?
22. Do you consider installing [Measure X] to be a common practice in your industry or ISP?

The following tables list the top 10 measures for the cheese, canning, and wine industries:

Measure Type	Measure X for Cheese Industry
Electric	CHP Power Boiler
Electric	Refrigeration Operations and Controls
Electric	Fan VFD
Electric	Air Compressor CFM Reduction
Electric	High Efficiency Lighting
Gas	Steam Trap Replacement
Gas	Heat Recovery Hot Water
Gas	Air Compressor Heat Recovery
Gas	Power Burner

Measure Type	Measure X for Canning Industry
Electric	CHP Power Boiler
Electric	Fan VFD
Electric	Air Compressor CFM Reduction
Electric	Heat Recovery Hot Water
Electric	High Efficiency Lighting
Gas	Heat Recovery Hot Water
Gas	Steam Trap Replacement
Gas	Air Compressor Heat Recovery
Gas	Power Burner

Measure Type	Measure X for Wine Industry
Electric	Refrigeration Operations and Controls
Electric	High Efficiency Lighting
Electric	Refrigeration System Upgrade
Electric	Fan VFD
Electric	Properly sized pumps
Gas	Air Compressor Heat Recovery

D.5 Industry Standard Practice or Baseline Assessment

23. What type of lighting technology does your facility employ?
24. What type of air compressor controls does your facility employ?
25. When purchasing pumps, do you typically size the pumps to current production rates or oversize the pumps to accommodate future production growth?

D.6 Program Recommendations and Awareness

26. Where do you get information on how to better manage your facility's energy use?
27. Are you aware of any assistance the utilities provide to quantify or identify energy savings opportunities? Are you aware of any utility energy-efficiency incentives such as rebates and financing
28. Have you participated in any utility energy-efficiency programs in the past five years? If not, why?
29. Do you have any recommendations for the kind of assistance utilities could provide to incentivize Facility Managers to implement energy-efficient measures?
30. Are you aware of other industry organizations such as the California League of Food Processors that influence the food processing industry?
31. Can you identify additional interview contacts for this sub-sector or the food processing industry in general?

Thank you for your time!