NAVIGANT

MARKET CHARACTERIZATION REPORT

For 2010-2012 Statewide Agricultural Energy Efficiency Potential and Market Characterization Study

FINAL REPORT

Prepared for:

Pacific Gas & Electric
California Public Utilities Commission
San Diego Gas & Electric
Southern California Edison
Southern California Gas Company

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May 6, 2013

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Content of Report

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[May 2013]

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Acknowledgments

Navigant Consulting, Inc. (Navigant) would like to acknowledge a number of individuals for their insight and direction on this study. Namely, we would like to thank this study's Project Manager, Lucy Arnot from Pacific Gas and Electric, for her continued support of and input into this research.

We would also like to thank the Investor-Owned Utility Project Advisory Committee for their guidance on the project. In particular, we would like to thank Reginald Wilkins and Mark Martinez of Southern California Edison, Peter Tanios of Southern California Gas, Rafael Friedmann of Pacific Gas and Electric, Kristina Miller of San Diego Gas and Electric, and Katherine Hardy of the California Public Utilities Commission. We would also like to thank additional utility personnel, including Chris Corinel and Tod Bartholomay of Southern California Edison.

A number of key industry players contributed their advice to and insight into our study. In particular, we would like to thank the following: Ricardo Amon from the University of California (UC) Davis Institute of Food and Agriculture Research; James Bethke, Carol Collar, Gene Miyao, Larry Schwankl, and James Thompson from the UC Cooperative Extension; Edward Hughes from the U.S. Department of Agriculture Agricultural Research Service; Heiner Leith from the UC Davis Plant Sciences Department; Charles Burt from the California Polytechnic State University Irrigation Training & Research Center; David Zoldoske and Peter Canessa from Fresno State's Center for Irrigation Technology; Clark Smith from Monterey Mushrooms; David Beyer and Dennis Buffington from Pennsylvania State University, Elizabeth Mitcham from the UC Davis Postharvest Technology Center; Roger Boulton from UC Davis; and Allison Jordan from the Wine Institute.

Navigant would also like to thank Rich Haener of Haener Farms, Inc., and Patrick and Hayden Hockett of Hockett Farms for their unique insight and willingness to share their knowledge and operations with Navigant's research staff.

Finally, we would like to extend special thanks to Claire Gagne for her diligent work and extraordinary insight into this study.

Executive Summary

This Market Characterization is the public report pertaining to the *2010-2012 Statewide Agriculture Market Characterization and Energy Efficiency Potential Study* managed by Pacific Gas & Electric (PG&E) on behalf of PG&E, Southern California Edison (SCE), Southern California Gas (SCG), and San Diego Gas & Electric (SDG&E), and the California Public Utilities Commission (CPUC). This Study focuses on the following segments within California's agriculture industry: Fruit, Tree Nut and Vine Crops, Vineyards & Wineries, Dairies, Greenhouses & Nurseries, Mushrooms, Field Crops, Refrigerated Warehouses and Post-Harvest Processing.

The purpose of this Market Characterization is to provide all parties involved in the study with current and actionable information from growers, operators and subject matter experts. This Executive Summary contains a summary of key findings extracted from surveys and interviews that took place in the second half of 2012.

Overarching Observations

California's agriculture sector is diverse and robust, with each segment interlinked with the others in a network of common culture and commerce. Unlike the single crop monocultures of wheat and corn in the Mid-West, the farmers and ranchers of California grow a multitude of crops – from alfalfa to yams - that provide the greatest agricultural bounty of any state in the Union. This study's interview respondents associated this abundance with two factors: easy access to water and readily available inexpensive labor. The respondents showed little understanding of the relationship of these factors to energy - or the tradeoff involved in using energy to maintain access to water, or the increase in energy use that will result from changes to the availability of labor.

While respondents to this study's interviews indicated that energy (primarily electricity) was a significant cost to their operations, energy efficiency was not a prevalent concern in any segment other than refrigerated warehouses. In fact, most respondents did not think of energy as a precious resource – like water – and they assumed and expected electricity and natural gas to be available to them indefinitely at reasonable prices. One possible explanation for the lack of appreciation of energy's current and future role in the agricultural sector is that respondents are not getting their energy use/efficiency information or advice from their utilities – none of the respondents cited their utility as a primary source of advice or direction on this topic.

In both the technical and qualitative interviews, the respondents identified utilities as a distant second to their primary source of knowledge regarding energy efficient equipment and measures: equipment vendors. Further, when asked to identify reference partners (organizations that provide thought leadership) respondents did not mention utilities at all. Instead, the respondents (including refrigerated warehouses) mentioned crop or operation-specific trade associations, and the extension services of U.C. Davis as reference partners (Chapter 11 provides a listing of reference partners from each segment).

Analysis of communications and websites showed that very few of these reference partners provide current and consistent information about energy end-use or energy efficiency as related to farm operations. This absence of current or consistent messaging may offer utilities their most actionable opportunity for future energy efficiency programming to each segment. If California utilities can leverage the credibility of these reference partners, and include efficiency opportunities in their messaging, conservation programs will likely increase measure uptake and technology adoption.

Fortunately, most of the sector's current reference partners are in a position to provide information regarding the energy implications of the two factors that growers view as key to their success:

- Water: While the current cost of water was not a significant cost component for any of the segments, the future availability of water was of concern among growers. Climate change, in the form of warmer temperatures or greater intensity of weather variation, may increase demand from irrigators upon a finite supply of water. Similarly, increasing water-use intensity in urban areas will lead to competition with rural areas for this resource. Either scenario can only lead to scarcity. Water scarcity, in turn, may lead to water management practices that trade energy (in the form of increased pumping) for delivery of water over greater distances and depths.

- Labor: Increased labor cost, or decreased labor availability, will affect the viability of each segment. For some (Post-Harvest Processing, Mushrooms, Greenhouses & Nurseries and Refrigerated Warehouses in particular) this may lead to increased mechanization. While automated watering and handling systems would relieve growers and operators of the need for some employees, this transition will add to the electric load of this sector over the next decade. Inexpensive farm labor has prevented this type of automation – which are now commonplace in Japan – from establishing any degree of saturation in the American West.

  As farm labor becomes more expensive, or ceases to be regularly obtainable, growers and operators will be increasingly tempted to test and implement machines in place of labor. As these tests begin, California utilities have the opportunity to influence the design and installation to minimize the load impact of adoption.

The primary opportunity for California utilities is to work with existing reference partners to promote energy efficient measures and practices on a regular basis to overcome existing barriers and address the energy aspects of water and labor issues before these issues become acute. Combining with reference partners' efforts to serve the agriculture sector of California would also allow utilities to address other secondary and tertiary energy efficiency challenges specific to individual operations as well. These challenges, and opportunities for the utilities to address them, include:

- First-Cost/Financing: All of the segments indicated that first-cost of equipment and lack of financing options prevented investment in efficient equipment and energy management. Respondents from the Fruit, Tree Nut and Vine Crop; Vineyards & Wineries; and Post-Harvest Processing segments in particular reported this as an acute challenge. Utility incentives to reduce first-cost or programs to alleviate financing constraints would be meaningful prospects for new programming directed towards these segments.

- Lack of Awareness: Respondents from the Fruit, Tree Nut and Vine Crop; Vineyards & Wineries; Dairy; Greenhouses & Nurseries; and Mushroom segments indicated that they did not think they were fully aware of efficiency opportunities and would welcome information, education and training that was local and fit their seasonal schedules. Utility-funded outreach efforts to inform, educate and train growers and operators near their farms, warehouses and processing facilities would be another noteworthy opportunity for this sector.

- Energy management and metrics: Agriculture has not seen the rise in energy management systems and metrics that are emerging in the manufacturing sector. Utility outreach and incentive efforts to help growers identify energy management approaches and measurement systems would benefit any of the segments. However, the respondents in the Cold Storage; Mushroom; Greenhouse and Nursery; Dairy; and Vineyards & Wineries segments expressed a highly developed interest in this subject.

Segment-Specific Findings

In addition to the overarching observations about the sector as a whole, the study collected specific details from each of the segments.

Fruit, Tree Nut and Vine Crops

This segment continues to enjoy steady growth but respondents indicated limited energy management efforts. While the respondents had a high regard for their utilities, they looked to their local vendors and services providers when choosing which equipment to install. Of all the segments, this one is most integrated with other segments (Refrigerated Warehouses and Post-Harvest Processing in particular) and is most affected by labor costs and water availability. The latter limits capital available for efficiency projects.

Vineyards & Wineries

This segment is experiencing consolidation that is eliminating mid-sized operations in favor of large organizations with global markets and smaller operators who focus on local or niche markets. The sophisticated marketing of this segment has seized upon renewable energy and, to a lesser extent, energy conservation as features to distinguish their brand. Combined with a "systems" approach of operations, this segment is a leader in agricultural energy efficiency. Respondents indicated regular contact with their local utilities and participation in efficiency programming.

Dairies

This segment is similar to the Vineyards & Wineries segment in that mid-sized dairies are diminishing in favor of larger dairy groups and specialized small operations. The largest operations have management metrics that allow for some degree of energy management. The most significant barrier to translating these metrics into efficiency projects is a perception of high first-costs. The foundation of this barrier is a market wherein demand is rising but state regulation caps prices. This limits cash-flow available for such projects and accelerates industry consolidation.

Greenhouses & Nurseries

This segment is concentrated among a relatively small number of tightly integrated growers with strong, local trade associations. While growth is stable, respondents from this segment consider international competition a significant threat to their continued prosperity. Of all the segments, greenhouse & nursery respondents indicated the lowest level of awareness regarding energy efficient options or utility programming. Further, respondents from this segment exhibited the greatest degree of skepticism regarding new technologies to conserve energy.

Mushrooms

Mushroom growing is a stable and highly concentrated segment of California agriculture with only a few firms dominating market share. While respondents from this sector recognized energy use as a significant cost, barriers such as financing and lack of technology-specific awareness prevented actions to address this issue. Respondents also cited increasing labor costs their primary concern which they may try to address through automation. Of all segments, mushroom growers expressed the greatest interest in reducing costs via the development and implementation of energy management systems.

Field Crops

Commodity price cycles tend to dominate the fortunes of this segment but water availability is the primary concern of most field crop respondents. Pumping, whether fueled by electricity or natural gas, is the primary energy end-use for this segment. However, several of the respondents operate integrated farming operations that include elements of post-harvest processing. The respondents described rudimentary energy management techniques that focused on individual components rather than whole system solutions.

Refrigerated Warehouses

Refrigerated warehouses serve as a crucial link in the supply chain between growers and consumers; their services extend the shelf life, safety and quality of locally grown and imported perishable food commodities. These facilities can act as either a service-provider to growers, or a grower-owned means of adding value to their production process. In either case, warehouse operators consider energy to be a primary operational cost. Warehouse operators are therefore keenly aware of this cost and actively seek to manage their energy consumption using sophisticated information technology.

Post-Harvest Processing

This segment includes several types of crop-handling and processing. Some types of processing, such as nut shelling and drying, are experiencing strong demand growth. Other types of processing, such as post-harvest cooling, vary depending on the market-specific conditions of each crop. However, all respondents reported concerns with competition, energy costs, and regulation. These processors view energy costs as the most important determinant of production in the future, even more so than labor costs today. Though electric and gas use varies by post-harvest processing type, electricity is a high cost across all of Post-Harvest processing.

Key Evaluation Challenges and Future Research

Future utility evaluation regarding agriculture in California should begin with an accurate categorization of customer operations and build upon the data sources identified in this study. Key research topics should include water and operations.

Classification of Agriculture Sector Operations

One of the basic assumptions in this study was that the NAICS codes used by the sponsoring utilities accurately described the actual operations of interviewees. This assumption proved to be wrong. Significant portion of the provided contact numbers led to organizations that were never farming operations, the remaining numbers led to many respondents with diversified operations that defied easy classification. For example, all of the dairy respondents also irrigated acreage to grow fodder for their animals. Similarly, several of the Fruit, Tree Nut and Vine Crop respondents reported limited post-harvest processing operations as did some field crop growers. While the NAICS code may have accurately describe the operation's primary function, this code does not capture the diversity of end-sues and technologies of vertically-integrated farming operations.

In these circumstances, designing efficiency programs based in NAICS codes will likely miss significant opportunities for conservation. For example, dairies may need irrigation pump measures; fruit growers may need measures for refrigerated storage; and tree nut growers may need process heating measures. Any program design based on NAICS coding will fail to capture these elements of integrated farm operations.

The first step to addressing this issue is to conduct a data integrity survey of existing agricultural customer data for all California utilities to determine if they are, in fact, growing or warehousing agricultural products. Once the agricultural contact data has a higher degree of accuracy, it would be possible to conduct a broad telephone survey to determine specific operations on individual farms. Combined with more current production data from secondary sources (see below), California utilities could develop a clear picture of operation types and growing patterns. This, in turn, would lay the foundation for data-based program design.

Data Mining the Census of Agriculture

In February 2014, the U.S. Department of Agriculture will release the results of the 2012 Census of Agriculture. The census is the largest primary data collection activity in North American agriculture and will include the most up-to-date information available. Much of this data is available on a county-by-county basis that could be translated into utility service territory-specific information.

Rather than wait until after the release of the census results to begin developing a research plan, California utilities should define information objectives in advance and develop a plan to examine the data upon release. The deliverables from this examination would provide insights into shifts in crop production; changes in farm operation size; and availability of cold storage. All of these factors would be crucial to program planning and design for agriculture customers of California utilities.

Linking Water Conservation to Energy Efficiency

Since water management is a high priority for California growers, future utility-sponsored research should identify the technologies and techniques most likely to conserve water, electricity and, to a lesser extent, natural gas.

Assessing the Impact of Automation

Respondents from several sectors indicated interest in adopting mechanization to offset labor costs. Many factors would affect the selection of automation technology and the rate of any such adoption. California utilities could influence the technology selection by conducting research proactively to identify the most energy efficient options and provide this information to growers and vendors – before active adoption takes place.

1 Introduction

California's agriculture is more vibrant and diverse than that of any other state in the nation. The state's growers, ranchers, and dairy producers help feed America and are a leading exporter of food to the world. Perhaps the best description of the state's current agricultural circumstances is that offered by the University of California's (UC's) Agricultural Issues Center (AIC)'s Measure of California Agriculture:

> *Including multiplier effects, California farms and closely related processing industries generate 6.7 percent of the state's private sector labor force (including part-time workers), 1.3 percent of the Gross State Product (GSP) and 6.1 percent of the state labor income (2009). California agriculture is the largest among the 50 states and ranks sixteenth globally . . . California accounts for about 11.9 percent of national cash receipts from agriculture, but receives only about 2.9 percent of direct government payments to agriculture (2010).*[1]

While the AIC makes note of the agriculture sector's effect upon the state's economy (with particular emphasis on labor employment and income), conspicuously absent is any mention of energy consumption or efficiency of energy use.

In order to understand the role of energy and the opportunity for efficiency within the agricultural sector, Pacific Gas & Electric (PG&E), on behalf of Southern California Edison (SCE), the Southern California Gas Company (SCG), and San Diego Gas & Electric (SDG&E) (collectively, "the Investor-Owned Utilities" [IOUs]), and the California Public Utilities Commission (CPUC), engaged Navigant Consulting, Inc. (Navigant) to undertake the 2010-2012 Statewide Agriculture Market Assessment and Energy Efficiency Potential Study ("the Study"). As stated in the Scope of Work, the Study seeks to inform a better understanding of the agriculture sector, its energy consumption, and opportunities for energy efficiency, demand response, and self-generation. This understanding included an assessment of market structure and reference partners as well as issues related to water and waste management.

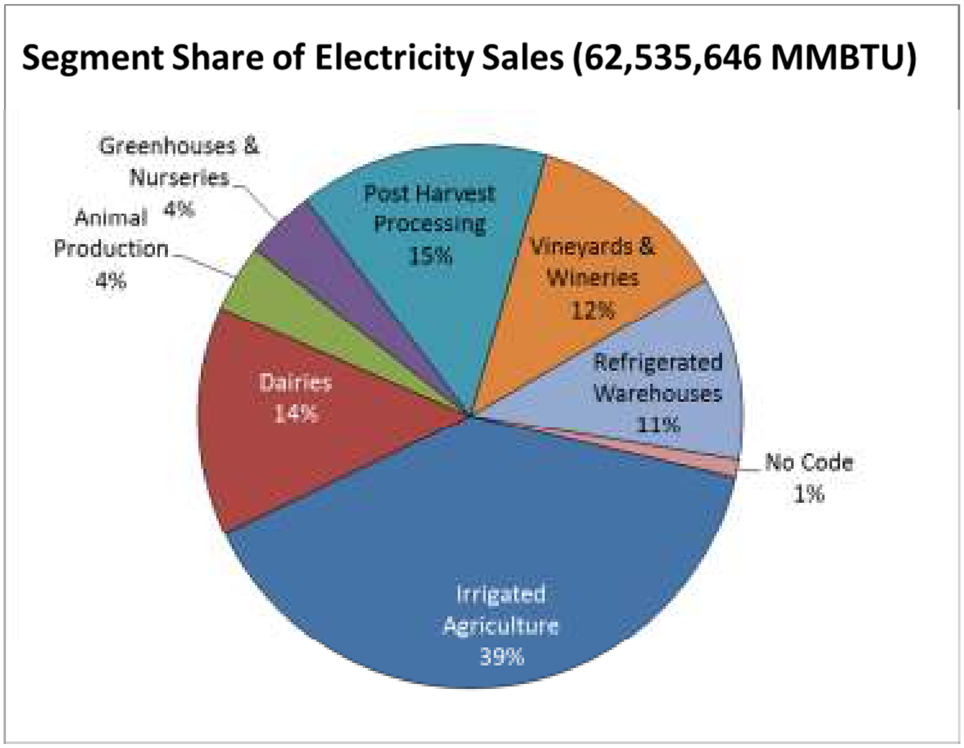
Previously, Navigant conducted a literature review and developed an annotated bibliography as foundational elements to a market characterization of this diverse sector. Using these elements, as well as energy sales data for 2010 -2011(as shown in figures 1.1and 1.2), to inform this market characterization, Navigant (and its subcontractors) conducted telephone and field interviews with growers, dairymen, trade association officials, university researchers, and subject matter experts throughout the state. Navigant has structured this market characterization to reflect the diversity of California's agricultural sector by dividing its data collection and analysis into the following segments:

1. Fruit, Tree Nut, and Vine Crops
2. Vineyards and Wineries
3. Greenhouses and Nurseries

[1]University of California Agricultural Issues Center, The Measure of California Agriculture – Highlights (2012 Update), page 2.

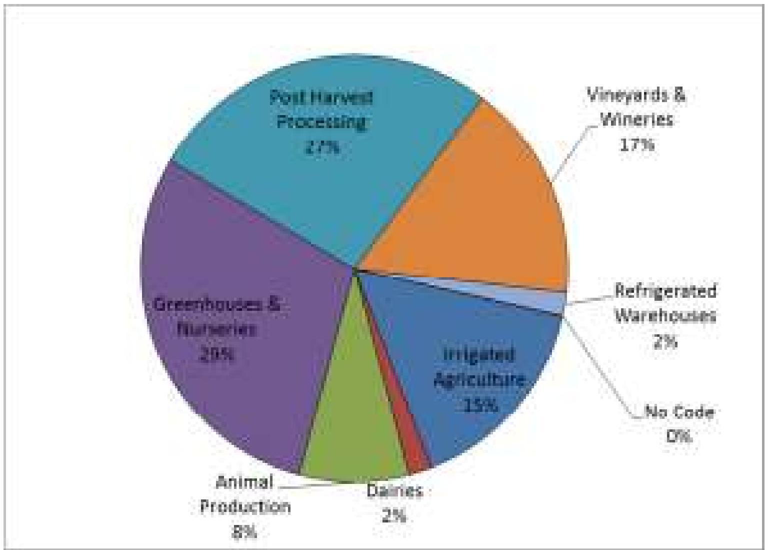
4. Mushrooms
5. Dairies
6. Field Crops
7. Refrigerated Warehouses
8. Post-Harvest Processing

Figure 1.1. Proportion of Electricity Sales by Segment



Source: Navigant analysis of IOU sales data

Figure 1.2. Proportion of Natural Gas Sales by Segment



Source: Navigant analysis of IOU sales data

For each of the market segments examined in the Study, Navigant has developed a separate chapter with the following organization:

1. Key Findings and Recommendations – a synopsis of the findings and recommendations for individual segments
2. Methodology – a description of primary and secondary data collection including interview techniques and respondent Firmographics
3. Description of Market Segment – a narrative of background information regarding market actors and reference partners
4. Status of Market Segment – a description of market trends and current issues facing each market segment
5. Energy and Efficiency – a discussion of electric and natural gas consumption within the segment as well as energy management practices and installed efficiency measures
6. Water Management – a discussion of water sources and uses as well as water conservation efforts and regulatory issues
7. Waste Management – a discussion of waste sources and uses as well as waste disposal efforts and regulatory issues
8. Detailed Conclusions and Recommendations – a synthesis of findings and observations from the previous sections of the chapter along with actionable proposals to address energy efficiency (EE) opportunities in the agricultural sector

2 Methodology

To understand the information that currently exists on the California agricultural market, Navigant's research team began by conducting secondary research. Sources ranged from trade association reports to peer-reviewed publications and scientific research papers. Having gained an understanding of information that currently exists in the market, Navigant was able to identify the knowledge gaps on which to focus primary data collection. This data collection included interviews with subject matter experts, technical surveys – both via telephone and in-person – as well as qualitative interviews.

2.1 *Subject Matter Experts*

2.1.1 Sources

The earlier development of the literature review and annotated bibliography allowed Navigant to identify qualified individuals from trade associations, the U.S. Department of Agriculture (USDA), and the University of California (UC) as potential candidates for these interviews.

2.1.2 Interview Content

The interview guide for this data collection activity is located in Appendix G. The primary content areas covered in these interviews were:

- Overall industry trends and drivers
- Market/actors
- Energy and other cost concerns
- Technologies and EE drivers and barriers

2.1.3 Disposition

The research team completed 16 telephone interviews with subject matter experts.

Table 2.1. Subject Matter Expert Interviews

Segment	Completes
Greenhouses and Nurseries	2
Field Crops	4
Dairies	2
Post-Harvest Processing	3
Vineyards and Wineries	2
Mushrooms	3

2.2 Technical Surveys

2.2.1 Sources

The primary source of contact information for the technical was customer contact information from each of the California IOUs. In the process of conducting the survey, the research team pursued a progressive interview strategy to identify potential respondents in hard-to-reach segments.

The research team contacted each respondent by telephone to collect basic operation and energy use information. For those respondents who were willing and able to articulate their energy use and management efforts, the research team conducted full surveys. For those respondents who had energy management metrics, the research team used a "Detailed" survey instrument. For those who did not have metrics but had pursued energy conservation efforts, the research team employed an "Intermediate" survey instrument. Finally, for those respondents who did not have energy management metrics and had not implemented conservation measures but could still articulate their energy use, the research team used a "General" survey instrument.

2.2.2 Interview Content

Appendices A, B, and C provide these survey instruments. The primary content areas covered in these interviews were:

- Expertise
- Energy Awareness
- Energy Management
- Adoption, Practices, and Payback
- Sources of Information
- Waste and Water

2.2.3 Disposition

The research team completed 95 telephone interviews with farmers. The research team then conducted the full technical survey with 86 of the telephone respondents. These interviews usually took place on the respondent's farm although the research team completed ten surveys at the 2012 California Farm Bureau's annual meeting in Pasadena, CA.

Table 2.2. Technical Survey Disposition

	Field Crops	Fruit, Tree, and Vine	Vineyards and Wineries	Greenhouses and Nurseries	Mushroom	Dairies	Refrigerated Warehouses	Post-Harvest Processing	Total
PG&E									
Target	5	5	8	4	5	5	3	8	*43*
Telephone Screen	8	12	11	4	6	6	2	9	*58*
Full Technical	6	11	10	4	4	5	2	9	*51*
SCE									
Target	2	2	2	2	2	4	2	2	*18*
Telephone Screen	2	5	1	0	1	6	2	3	*20*
Full Technical	2	5	1	0	1	4	2	3	*18*
SDG&E									
Target	1	2	0	2	1	0	1	0	*7*
Telephone Screen	0	2	0	1	1	0	1	0	*5*
Full Technical	0	2	0	1	2	0	1	0	*6*
SCG									
Target	2	2	2	2	2	1	1	2	*14*
Telephone Screen	4	1	1	2	0	1	2	1	*12*
Full Technical	4	0	1	2	1	1	1	1	*11*
TOTAL									
Target	10	11	12	10	10	10	7	12	*82*
Telephone Screen	14	20	13	7	8	13	7	13	*95*
Full Technical	12	18	12	7	8	10	6	13	*86*

Figure 2.1. Map of All Technical Survey Respondent Locations

Source: Navigant analysis

2.2.4 Challenges

For each of the segments, the research team found that the contact information provided by the IOUs did not consistently lead to the expected respondent. In many cases, the contact telephone numbers were disconnected or led to organizations that were no longer (or never were) in the desired segment. In total, the interview team made 1,725 calls to complete 95 telephone screener interviews. This is a completion rate of 5.5%

2.3 *Qualitative Interviews*

2.3.1 Sources

Navigant began the qualitative interview process by contacting board members and public information officers of trade associations in each market segment. If these personnel were willing to speak with the research team, Navigant conducted interviews and pursued a progressive interview strategy to identify potential respondents. This led to approximately ten completes. Subsequently, Navigant employed an unused portion of the IOUs' contact information interviews.

2.3.2 Interview Content

The guides for these interviews are located in Appendices D, E, and F. The primary content areas covered in these interviews were:

- Costs, business fluctuations/drivers
- Near-term market changes/ expectations/implications
- Impacts/effects/limitations imposed by the regulatory environment
- Energy/resource efficiency considerations

2.3.3 Disposition

The research team completed 47 qualitative interviews over the telephone.

Table 2.3. Qualitative Interview Disposition

Segment	Completed Interviews
Greenhouses and Nurseries	6
Field Crops	6
Fruit, Tree Nut, and Vine Crops	6
Dairies	6
Post-Harvest Processing	9
Vineyards and Wineries	6
Mushrooms	6
Refrigerated Warehouse	2

3 Fruit, Tree Nut, and Vine Crops

3.1 Key Findings and Recommendations

California's Fruit, Tree Nut, and Vine Crop segment has seen **steady growth for the last decade** and its growers are **optimistic about domestic and international demand** for their produce. The limiting factor on future growth is the potential for **increasing labor costs and/or decreasing labor availability**. This segment is exceedingly **diverse in its crops and operations**. This diversity **complicates program design, yet it could also provide an opportunity to promote a wide range of measures** to a single market.

Growers in this segment have **high regard for their local utilities but turn to the advice of their vendors** when making equipment-purchasing decisions. **Inserting the utilities' program messaging into this purchasing decision would likely result in greater adoption** of energy-efficient equipment in this segment.

The integrated nature of agricultural, commercial, and residential activities within Fruit, Tree Nut, and Vine Crop operations lends itself to program design that can **offer measures for all three types of activities**. Navigant recommends developing offerings that can address a wide variety of end uses from a single source.

Navigant also recommends **prioritizing delivery of programming based on the level of production**. If demand for California produce continues to increase, programs that reduce costs will enhance national and international price competitiveness. Energy efficiency, however, **will have limited opportunity within the context of segment stagnation or decline due to labor scarcity**. In the latter context, programming focused on other segments may be the best option for utilities and their ratepayers. Finally, utilities should conduct **outreach to both growers and equipment** vendors to explain how program incentives can **overcome first cost barriers and provide whole-system solutions**—including life-cycling costing. Within the context of expanding production, growers and vendors can focus on equipment that will meet increasing demand while minimizing operating costs. This would also **enhance the profile of utilities as reference partners** among growers in this segment.

3.2 Methodology

3.2.1 Secondary Research and Literature Review

To understand the information that currently exists on the Fruit, Tree Nut, and Vine Crop segment, Navigant's research team began by conducting secondary research. Sources ranged from trade association reports to peer-reviewed publications and scientific research papers. Navigant researched the Fruit, Tree Nut, and Vine market segment for the literature review; however, secondary research for this particular segment originally fell under the irrigated agriculture section. Navigant did not conduct a formal, extensive literature review specifically for this market segment. Navigant recommends that the IOUs further investigate this market segment on an individual basis.

3.2.2 Primary Data Collection

As Table 3.1 shows, the primary sources for data collection were technical surveys (both telephone and in-person) as well as qualitative interviews (telephone only). In addition, the research team reviewed relevant trade association websites for energy-related content and examined relevant data from the USDA. The guides for these interviews are located in Appendices A through G.

Table 3.1. Data Collection for the California Fruit, Tree Nut, and Vine Segment

	Number of Completed Interviews
Technical Surveys (Telephone/In-Person)	20/18
Qualitative Interviews	6

3.2.2.1 Subject Matter Experts

Navigant did not interview subject matter experts for this segment.

3.2.2.2 Technical Surveys

The research team conducted technical phone surveys with 14 individuals in the Fruit, Tree Nut, and Vine Crop market segment. These surveys addressed topics such as operation firmographics, energy management and practices, waste and water issues, and business cycles. The team conducted an initial phone survey with each respondent that covered these topics at a high level. For those respondents who agreed to participate in a follow-up survey, a member of the research team gave one of three subsequent surveys—typically at the respondent's farm—based on the respondent's sophistication of energy metrics and history of measure implementation. These follow-ups included a General Technical Survey, an Intermediate Technical Survey, and a Detailed Technical Survey. Eighteen of the 20 telephone respondents agreed to participate in the follow-up surveys.

Figure 3.1. Map of Fruit, Tree, and Vine Technical Survey Respondent Locations

Source: Navigant analysis

3.2.2.3 Qualitative Interviews

The research team conducted six qualitative interviews via telephone. The qualitative interviews were designed to complement the technical information, examining agricultural energy usage and efficiency potential. The qualitative interviews focused on market expectations, behaviors and practices, and potential barriers and opportunities related to increased efficiency.

3.2.2.4 Firmographics

The Fruit, Tree Nut, and Vine market segment is extremely diverse in terms of market actors. This is largely due to the variety of crops that exist and the tendency for farmers to grow multiple crop types. Much of California's production includes table grapes and citrus, both of which are commonly grown in the South San Joaquin Valley. Many producers irrigate their farms with well water, using either pressurized or gravity-fed systems, depending on the crop. The consolidation of the segment's major producers is highly variable, depending on the crop type. Large players such as Paramount Farms or Blue Diamond dominate the nut market, while international heavyweights, such as Dole and Sunkist, have their headquarters in California.

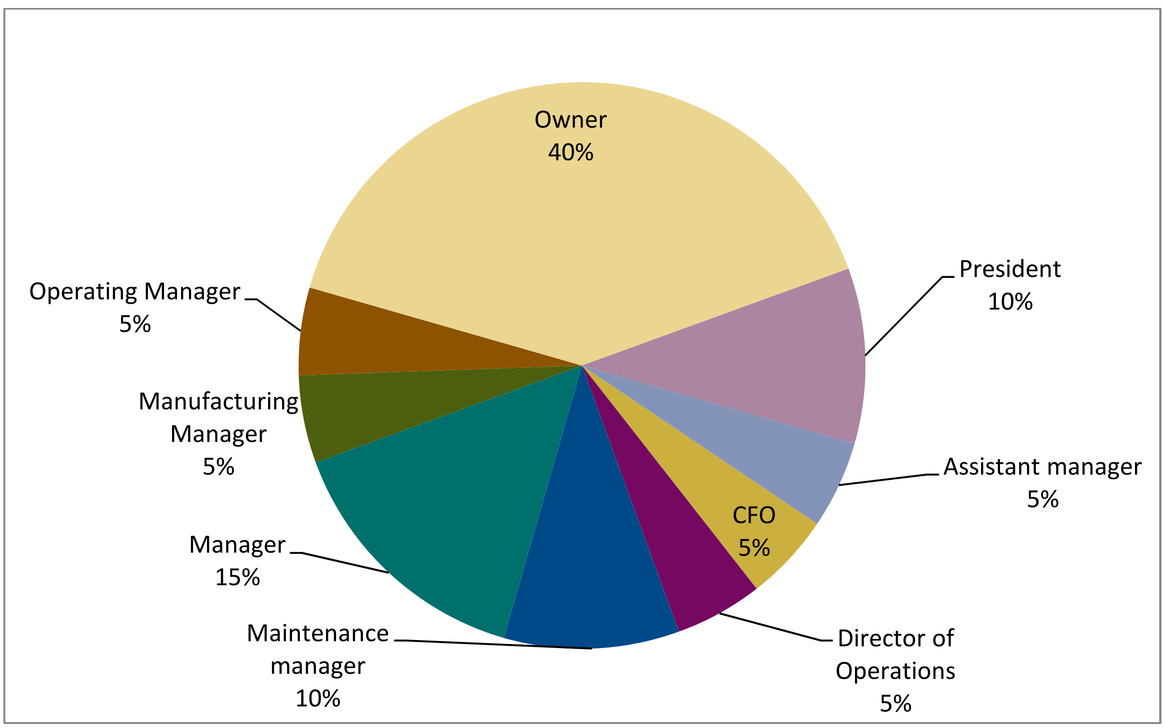
The USDA's 2007 Census of Agriculture reported 31,937 Fruit, Tree Nut, and Vine farms in California with a total bearing acreage of 1,592,206. Based on these figures, the average Fruit, Tree Nut, and Vine farm in California is approximately 50 acres. Smaller farms tend to be "hobby" farms without great incentive to improve energy efficiency; therefore, Navigant chose to collect data from larger operations. Hence, the distribution of these respondents represents larger, more commercial growers. The 20 technical survey telephone respondents were a cross section of this segment, as detailed by Table 3.2. As shown in Figure 3.2, respondents had a variety of titles but the majority of the 20 interviewees were either owners or senior executives.

Table 3.2. California Fruit, Tree Nut, and Vine Crop Respondent Distribution

Primary Crop	Number of Respondents	Secondary Crop or Activity
Walnuts	3	Almonds, rice, wheat, sorghum, alfalfa
Almonds	4	Walnuts, wine grapes, raisins, rice, olives, and pistachios
Pistachios	1	Other nuts, potatoes, and carrots
Table Grapes	3	Bell peppers and citrus
Wine Grapes	2	Wine
Grapes for Juice Concentrate	1	
Avocados	4	Citrus, mushrooms, nursery stock (trees), organic vegetables
Citrus	1	Packing shed
Strawberries	1	

Source: Technical Phone Survey, n = 20, "What do you consider your primary product?"

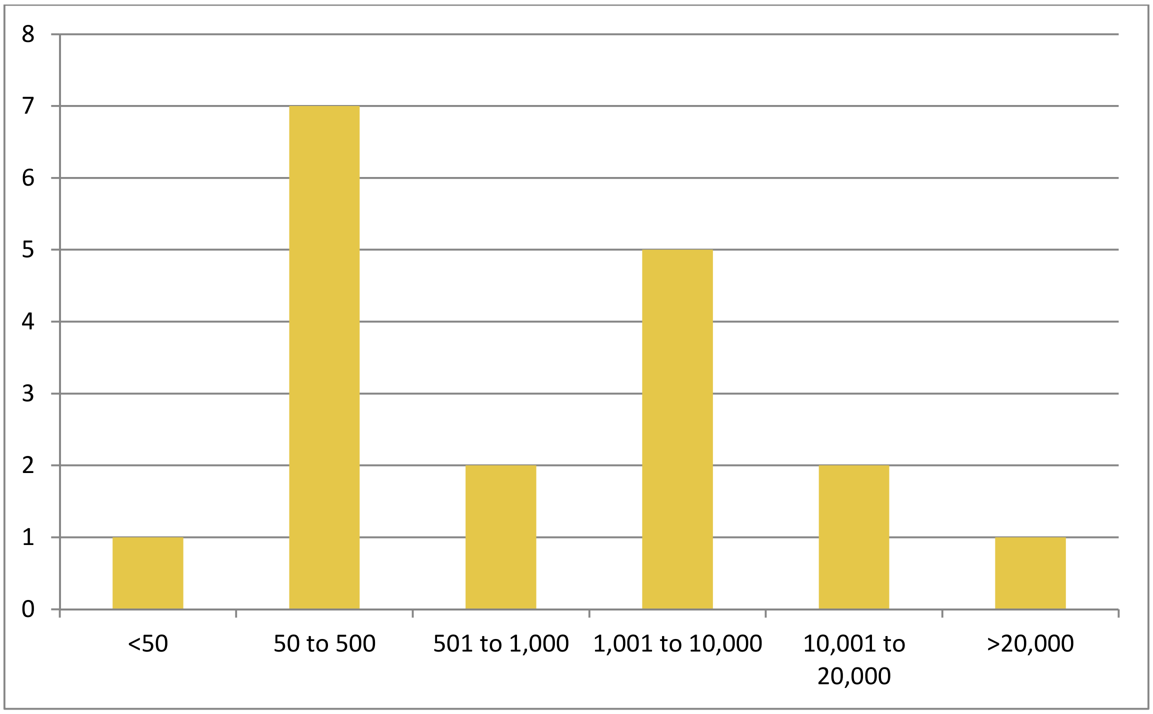
Figure 3.2. Fruit, Tree Nut, and Vine Technical Survey Respondent Roles



Source: Technical Phone Survey, n=20, "What is your role in the operation?"

The reported productive ("bearing") acreage from the 20 telephone interviews ranged from 35 to 45,000 (as shown in Figure 3.3), 92% of which were reportedly irrigated, overall. Few of these growers relied on one crop for their livelihood. Most diversified their efforts away from orchard plantings and established field crops, nursery stock, cattle holdings, and organics as well as value-added activities such as fruit packing and wine making. This diversification mitigates some of the growers' risks, but complicates efforts to design efficiency programs to meet their needs.

Figure 3.3. Distribution of Respondents by Cultivated Acres



Source: Technical Phone Survey, n = 18, "How many acres do you have under cultivation?"

When asked about electric and natural gas end uses, respondents revealed that some operated cold storage facilities, crop-drying facilities, and greenhouses. Other chapters in this report (Refrigerated Warehouses, Post-Harvest Processing, and Greenhouses and Nurseries respectively) provide details on operations that focus on these end uses as a primary business. In addition, one grape grower had a small winery. For these respondents, these end uses appear to be a form of vertical integration—particularly with larger operations—rather than a primary source of revenue. Within this context, program design for these growers should not be limited to orchard operations but instead offer measures to address energy consumption for these end uses.

3.3 *Structure of Fruit, Tree Nut, and Vine Crop Market Segment*

3.3.1 Description of the Market Segment

The "Fruit and Tree Nut Farming" market segment falls primarily under North American Industry Classification System (NAICS) code 1113. The fruit and tree nut crops in this classification "are generally not grown from seeds and have a perennial life cycle."[2] Grape cultivation also falls under this category as long as the crop is grown for purposes other than the production of wine. It is important to note, however, that some grape growers may operate wineries as a secondary means of business.

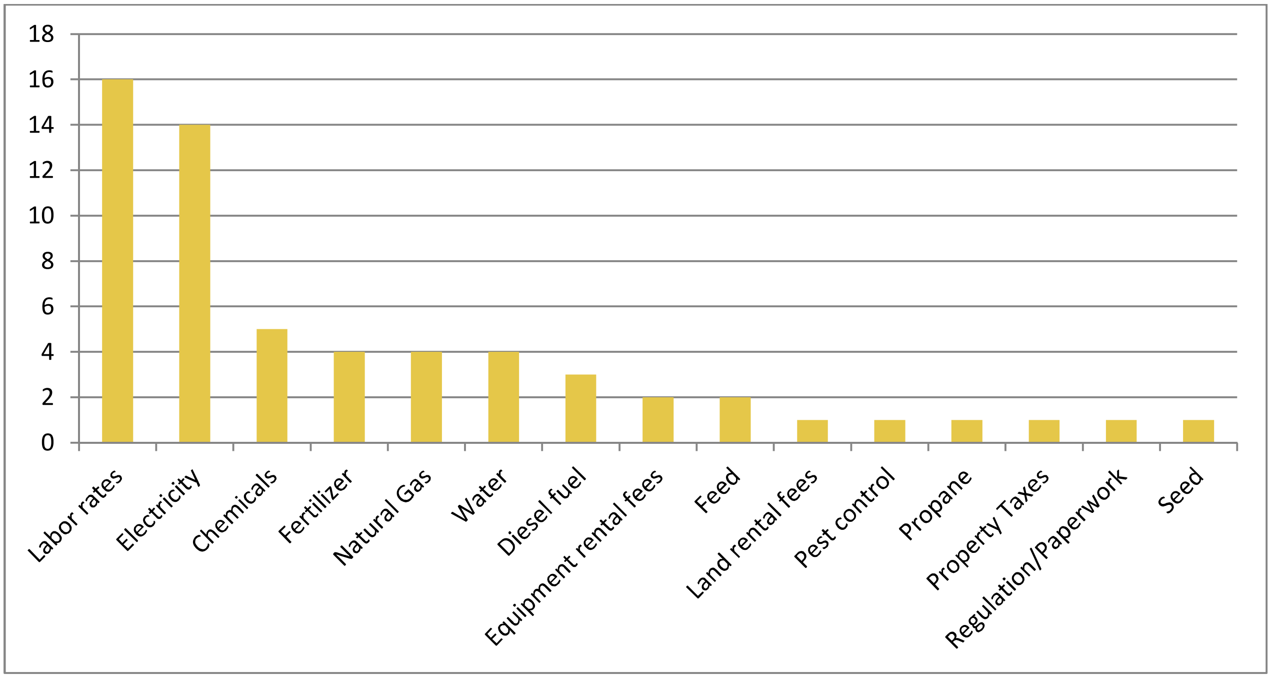
3.3.2 Description of the Supply Chain

Fruit, Tree Nut, and Vine production falls into the initial stages of the supply chain. Some of the Fruit, Tree Nut, and Vine producers sell their product to packing companies who take ownership and transport the products to their facility. Of the qualitative interview respondents, one farmer claimed to retain ownership of his product while the packer sold it forward, receiving a commission from the sale. Another farmer's marketing company is reportedly responsible for the sale of the produce. Only one interviewee claimed to have a fruit stand. Some of the other farmers send their product to the East Coast by an outside trucking company, UPS or FedEx.

Figure 3.4 provides a distribution of technical survey responses to the question, "*What have been the three greatest production costs in your operation over the last two years?*" The figure illustrates that labor was the most frequently mentioned cost, while electricity was the second most mentioned. Mention of natural gas was limited. The six qualitative interviews provided similar responses, with labor ranking as the highest cost, electricity costs ranging from less than 5% to as much as 50% of operating costs, and natural gas equaling less than 5% of costs for all respondents.

[2] North American Industry Classification System 2007, http://naics-code-lookup.findthedata.org/l/123/Fruit-and-Tree-Nut-Farming.

Figure 3.4. Greatest Production Costs for Fruit, Tree Nut, and Vine Growers



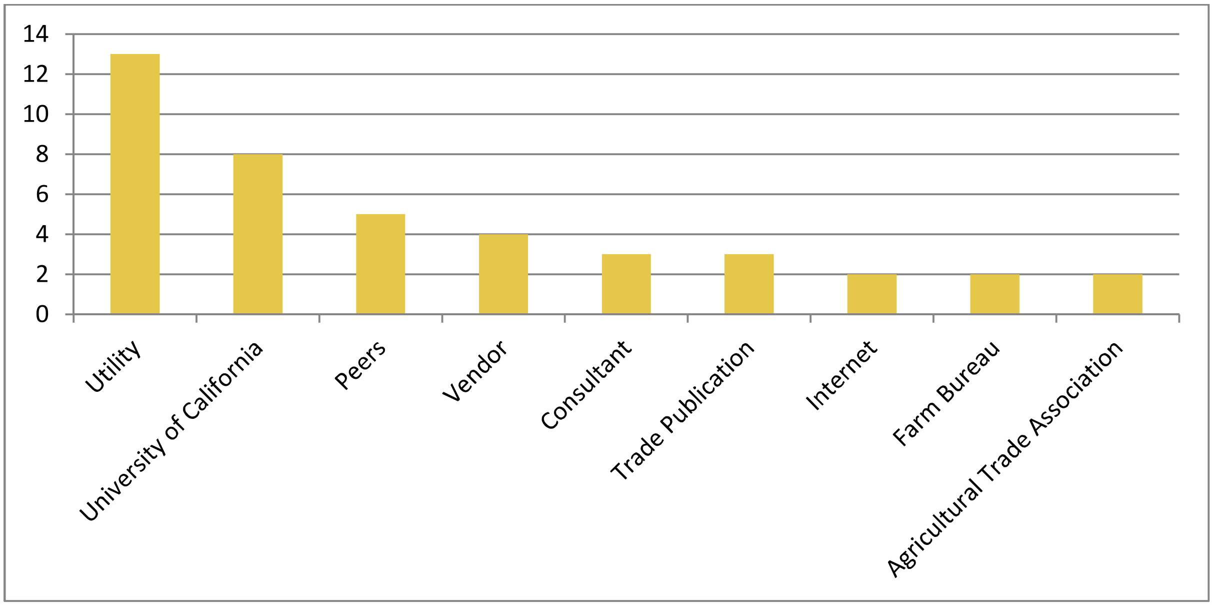
Source: Technical Phone Survey, n= 20 - multiple responses, "What are your three highest costs?"

3.3.3 Description of Market Segment Reference Partners

A number of industry reference partners exist for the Fruit, Tree Nut, and Vine market segment. As identified through the qualitative interviews, these organizations include the California Farm Bureau Federation (CFBF), Western Growers Association (WGA), and a number of local farm bureaus. Navigant's research team reviewed these organizations' respective websites to gauge their levels of energy efficiency promotion. The research team found that while the CFBF offers brief publications on energy and fuel efficiency, the WGA makes virtually no mention of energy or energy efficiency on its site. Utilities should work with trade associations to inform them about growers' energy efficiency options and work to disseminate energy information through these sites. Furthermore, cooperation with trade associations may open new avenues through which to promote utility programs and incentives.

To understand information channels that individual growers use regarding energy-related issues, the research team asked technical survey respondents about their most common sources of information. Almost all respondents mentioned their local utility, as shown in Figure 3.5. Approximately half of the survey respondents also mentioned the University of California. Respondents offered a number of other resources, as well, indicating that this market segment has a variety of information channels that feed into it. Given the influence that utilities have over existing information channels, and the array of other resources to which growers turn, utilities should collaborate with market reference partners beyond trade associations. These partners could include private consultants, trade publications, and vendors. By utilizing the segment's existing information infrastructure, utilities could greatly expand their network of energy trade allies.

Figure 3.5. California Fruit, Tree Nut, and Vine Crop Information Channels



Source: Technical Phone Survey, n = 18 - multiple responses, "What are your three most likely sources for gathering information about reducing energy use or generating energy?"

3.4 Status of Fruit, Tree Nut, and Vine Crop Market Segment

California produces more fruit, tree nuts, and vine crops than any other state. Nuts alone—including almonds, pistachios, and walnuts—make up a significant portion of crop production in California. In 2009, there were 810,000 acres of irrigated land planted with almond trees, an additional 126,000 acres of pistachios, and 250,000 acres with walnuts.[3] California also produces a number of other crops, as illustrated in Table 3.3. The crops in **bold** indicate those for which California is a leading producer. The asterisks indicate that California produces 99% or more of the respective crop's national production.[4] Figure 3.6 shows the 2011 acreage for California fruit, tree nut, and vine crop growers. Grape growing, including table, wine, and raisins, occupies over 796,000 acres of cultivated land.[5] Wine grape production alone makes up approximately 35% of fruit, tree nut, and vine crop acreage in California, which Chapter 4 discusses in greater detail. Excluding wine grapes, grape vineyards represent 205,000 acres (raisin) and 85,000 (table) for a combined total of nearly 300,000 acres. The rest of the market segment is quite diverse in terms of crop types. However, operations are generally similar in terms of dependence on seasonal labor, high perishability, and reliance on irrigation. The latter two characteristics make this segment ripe for programs focusing on refrigeration and pump efficiency.

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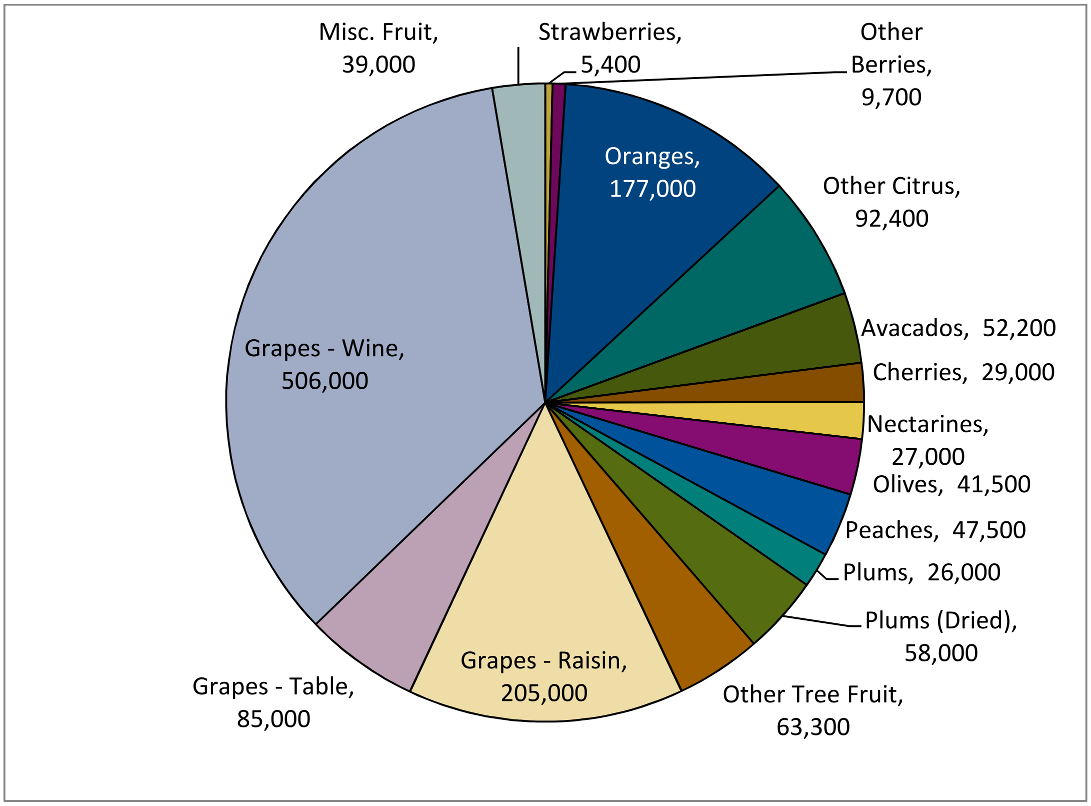
[3] CDFA, 2011.
[4] USDA National Agriculture Statistics Service, California Field Office. California Agriculture Statistics 2011 Crop Year, page 1.
[5] CDFA, 2011.

Table 3.3. Crops Produced by California Fruit, Tree Nut, and Vine Growers

Crops		
Apples	**Table Grapes**	**Plums (dried)***
Apricots	**Wine Grapes**	Grapefruit
Avocados	**Grapes for Raisin Production***	Oranges
Blueberries	**Kiwi Fruit***	Tangerines
Strawberries	**Nectarines**	Mandarins and Mandarin Hybrids
Raspberries	**Olives***	**Almonds***
Sweet Cherries	**Peaches***	Pecans
Dates*	**Pears (Bartlett)**	**Pistachios***
Figs*	**Plums**	**Walnuts***

Source: California Agriculture Statistics 2011 Crop Year, USDA National Agriculture Statistics Service, California Field Office

Figure 3.6: California Fruit, Tree Nut, and Vine Crop Acreage 2011

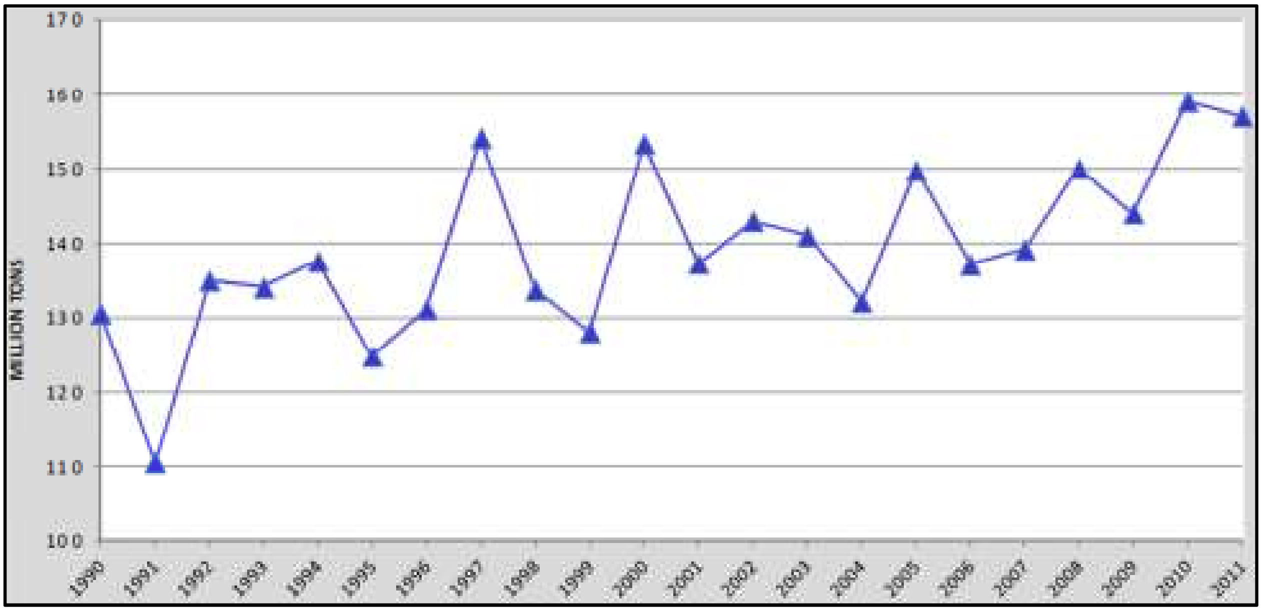


Source: California Agriculture Statistics 2011 Crop Year, USDA National Agriculture Statistics Service, California Field Office

3.4.1 Current Trends and Issues

Production for Fruit, Tree Nut, and Vine market segment has generally been increasing over the last two decades, as illustrated in Figure 3.7. The technical surveys mirrored these findings, in that 12 of 20 technical survey respondents stated that their production has increased, while four stated it had stayed the same. Reasons for increased production reportedly included increased demand and increased prices. Those reporting decreased production identified poor plant stock and a need to shift from old varieties to varieties that are now in demand.

Figure 3.7. Fruit and Nut Production in California



Source: California Agriculture Statistics 2011 Crop Year, USDA National Agriculture Statistics Service, California Field Office

Qualitative interviews and technical survey responses revealed that producers are increasingly wary of the cost and availability of water and labor. Respondents also expressed concern over competition at various levels. Five of six qualitative interview respondents suggested that producers are largely reliant on changes in foreign competition, particularly due to differences in competing countries' import/export tax structure. The rising demand for local, farmers' market-style produce could also impact the sales of large operations. However, one respondent offered an optimistic outlook, suggesting that strong demand for produce on the Pacific Rim could be beneficial for West Coast producers.

3.4.2 Future Prospects

When asked about expected trends, qualitative interview respondents generally anticipated an increase in future demand for their crops due to population increases, the desire for organic products, and consumers' healthier eating habits. International competition arose again as a concern. One farmer expressed his uncertainty about future production, stating, "It's hard to tell; depends on crops from Mexico, Chile, and Peru, and prices fluctuate. Demand will increase somewhat but not a lot, [although] costs will increase more." The concerns naturally varied with the crop type. Specialty producers must overcome additional obstacles of consumer preference that may not be an issue for producers of staple foods. One respondent, an avocado grower, claimed that because his products are "discretionary," people will only buy them when they can afford to.

It is important to note that variation in consumer preferences, coupled with fluctuating commodity prices, could significantly affect the production of certain crop types while having little to no effect on another. Indeed, some farmers are currently expanding acreage in order to plant more crops, and others intend to begin growing new, additional crops. One farmer claimed to be expanding his operation, expecting to employ more workers and increase his hours. Meanwhile, another respondent expressed concerns over the increasing cost of his existing labor, compounded by increasing utility costs.

These findings suggest that the ability for Fruit, Tree Nut, and Vine producers to invest in energy efficiency will depend heavily on economic factors, as well as the availability of labor. Utilities should be cognizant that consumer demand, operating costs, and international competition may limit some growers' ability to finance energy-efficient measures while others may feel significantly less constraint. When designing programs for this market segment, utilities should be cognizant of the various economic factors that could affect producers, and the polarizing effects that these factors can have *within* the segment.

3.5 Energy Use and Efficiency in Fruit, Tree Nut, and Vine Crop Segment

3.5.1 Energy Consumption

In 2010, irrigated farms received 35.3% of California IOU agricultural energy sales, of which Fruit, Tree Nut, and Vine Crops were the largest sub-segment at 16.3% (see Table 3.4). As identified through secondary research, electric water pumping is the main energy end use among these growers. Technical survey respondents agreed, claiming that electricity is used primarily for pumping and irrigation within the market segment. Table 3.5 shows the self-reported estimates of energy end-use consumption in California's Fruit, Tree Nut, and Vine segment.

Table 3.4. 2010 Irrigated Agriculture Segment Energy Sales Compared to All Agriculture Sales

<table>
<tr><th>Category</th><th>Segment</th><th>Total MMBTU</th><th>% of Electric MMBTU</th><th>% of Gas MMBTU</th><th>% of Total MMBTU</th><th>MMBTU by Category</th><th>% of Total MMBTU</th></tr>
<tr><td rowspan="4">Irrigated Agriculture</td><td>Oilseed & Grain Crops</td><td>1,412,982</td><td>2.1%</td><td>0.6%</td><td>1.9%</td><td rowspan="4">26,515,322</td><td rowspan="4">35.3%</td></tr>
<tr><td>Vegetable & Melon Crops</td><td>2,611,615</td><td>3.7%</td><td>2.2%</td><td>3.5%</td></tr>
<tr><td>Fruit, Tree & Vine Crops</td><td>12,244,763</td><td>18.2%</td><td>6.9%</td><td>16.3%</td></tr>
<tr><td>Misc. Crops</td><td>10,245,962</td><td>15.2%</td><td>5.9%</td><td>13.7%</td></tr>
<tr><td></td><td>All Segments</td><td>75,032,670</td><td>100%</td><td>100%</td><td>100%</td><td>75,032,670</td><td>100%</td></tr>
</table>

Source: Navigant analysis of CPUC electric consumption data

Table 3.5. Self-Reported Estimates of Electric End Use among Fruit, Tree Nut, and Vine Growers

End Use	Number of Mentions	Range of Consumption Estimates	Average Consumption Estimate
Pumping/Irrigation	19	25% - 100%	79%
On-Farm Shop/Homes	7	3% - 15%	9%
Refrigeration	5	20% - 36%	60%
Lighting	3	5% - 10%	8%
Other	3	25% - 30%	28%

Source: Technical Field Survey, n = 18 – multiple responses, "Which processes or equipment use the most electricity?"

Based on the end-use estimates outlined in Table 3-5, the greatest opportunity for electrical energy efficiency is likely refrigeration systems and pumps. It is important to note that the sum of the average consumption estimates in this table is greater than 100%, due to the variety of configurations and techniques used in growing operations. For instance, within the Fruit, Tree Nut, and Vine segment, refrigeration could fall under the "private cooler" refrigerated warehouse space classification, as discussed in Section 9 of this report.[6]

In addition to offering pump and refrigeration measures, utility programming for this segment should also include lighting, residential and even small commercial measures – the latter because the on-farm repair shops may include services to local communities. Just as these growers have diverse crop varieties, so do they engage in non-agricultural enterprises from their farms. The inclusion of on-farm repair shops and residential consumption in the end-use totals is indicative of how business and personal life can be difficult to distinguish on the farm. While a grower's local utility may designate a tariff to be "Agriculture," an individual grower's meter may also read his or her family activities. Growers' descriptions of their operations may not capture these nuances. However, utilities should be aware that a single operation could involve any number of activities and could be accounted for in numerous agricultural programs.

Of the 20 in-person technical surveys, only eight used natural gas in any capacity. Table 3.6 shows the distribution of consumption for the end uses mentioned by respondents. Again, the sum of the average consumption estimates is greater than 100% because of the variety of configurations and techniques used in growing operations.

[6] See the Refrigerated Warehouse chapter of this report for more details regarding this designation.

Table 3.6. Self-Reported Estimates of Natural Gas End Use among Fruit, Tree Nut, and Vine Growers

End Use	Number of Mentions	Range of Consumption Estimates	Average Consumption Estimate
Crop Dryers	2	85%-100%	93%
Heating Greenhouse	1	100%	100%
Frost Protection	1	50%	50%
Boiler	1	100%	100%
De-Greener	1	50%	50%

Source: Technical Field Survey, n = 7 - multiple responses, "Which processes or equipment use the most natural gas?"

Most of the natural gas consumption appears to be associated not with primary production, but rather with vertical integration. For instance, greenhouses produce seedlings that the grower will later plant in his or her orchard. Similarly, growers use crop dryers for processing before sale at the farm gate to distributors or food manufacturers. Growers may utilize crop drying solely for their own production, or the grower may offer drying services to their neighbors on a fee basis.

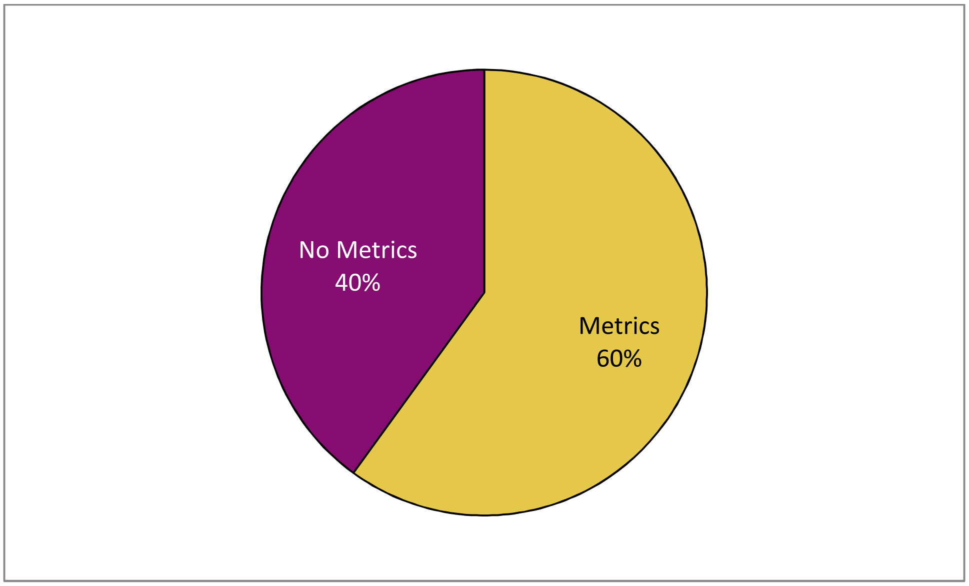
Utility programs that focus on larger Greenhouse and Nursery or Post-Harvest Processing segments run the risk of discounting this type of grower because these end uses represent only an element of production, not necessarily a primary revenue source. To deliver natural gas conservation measures to this segment, utility programming should engage the reference partners mentioned earlier. The University of California's Cooperative Extension Service and equipment vendors can lend their credibility to promote programs and measures to this segment.

3.5.2 Energy Management

3.5.2.1 Metrics

Qualitative interviews indicated that many growers believe they are maximizing energy efficiency potential. One grower stated, "Things are already done as efficiently as [they] can be. With water pumps, you have machines in many locations, which is difficult because it doesn't make sense to improve only one, so it will cost you more." However, 40% of respondents indicated that they had no energy management metrics in place, as show in Figure 3.8. The interviews suggested that the larger the grower's acreage, the more likely he or she was to use performance metrics. This characteristic provides an opportunity for utility programming to take a more sophisticated, data-driven approach with larger growers, and focus on basic energy efficiency education with smaller growers.

Figure 3.8. Proportion of Energy Metrics among California Fruit, Tree Nut, and Vine Crop Growers



Source: Technical Phone Survey, n = 20, "Do you have metrics or performance measures?"

3.5.2.2 *Efficient Measures and Savings*

Although many growers are making concerted efforts to maximize energy efficiency, improvements can still be made. Secondary research suggests that to achieve energy savings from the use of micro-irrigation technologies, the segment must make additional technical improvements. The Irrigation Training and Research Center (ITRC) has documented the potential to reduce pump discharge pressures through improved irrigation system design; namely, the ITRC estimates a technical potential to reduce pump discharge pressures by 13 to 17 pounds per square inch of pressure. The ITRC calculated the potential energy savings in the southern San Joaquin Valley, as illustrated in Table 3.7. The ITRC's research offers a specific area in which utilities may be able to promote energy savings within this market segment. Utilities should work to inform growers of further savings that improved irrigations systems may provide.

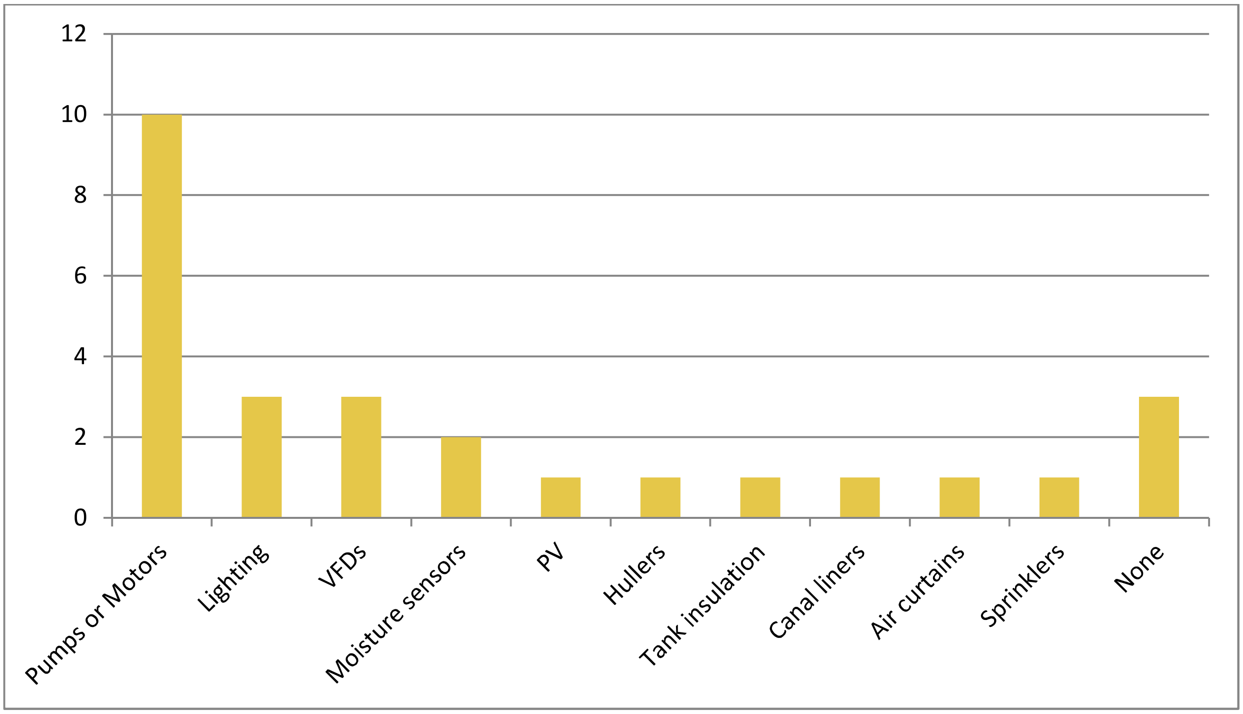
Table 3.7. ITRC Estimated Annual Energy Savings per Acre in the Southern San Joaquin Valley

Crop Category	Energy Savings (kWh/Acre/Yr)	Demand Reduction (kW/Acre)
Deciduous Orchards	192	0.1
Vines	125	0.08
Row Crops (Drip Tape)	132	0.13

Source: ITRC

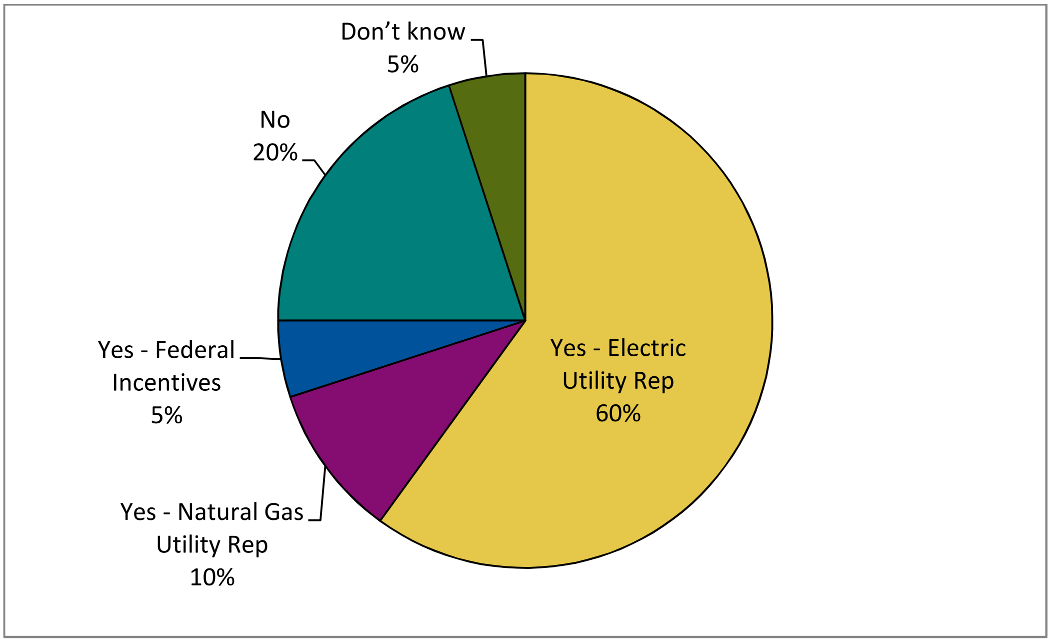
When asked about installed efficiency measures, 16 of the 18 Fruit, Tree Nut, and Vine telephone survey respondents referred to a range of 24 equipment installations dating from 1997 to 2012. As shown in Figure 3.9, individual measures such as pumping or motor measures received the most mentions (ten), along with lighting (three) and VFDs on fans (two). As Figure 3.10 shows, for the Fruit, Tree Nut, and Vine segment, the majority of growers used utility incentives for at least some of the energy- efficient equipment that they installed, indicating that growers do recognize the benefits of incentives when they are informed about their options.

Figure 3.9. Energy-Efficient Equipment Installations



Source: Technical Field Survey, n = 18, “What equipment or devices have you installed to reduce energy use?”

Figure 3.10. Fruit, Tree Nut, and Vine Crop Grower Participation in Incentive Programs



Source: Technical Field Survey, n = 18 - multiple responses, "Has your operation accepted incentives or rebates from your local utility or a government agency for energy efficiency work"?

When asked about the savings achieved through their installations, respondents could recall 18 of the 24 original savings estimates. These expected savings ranged from 9% for conveyor motors to 60% for premium efficiency motors, with the average expected savings coming to 20% overall. When asked if they had achieved the promised savings, the respondents stated that they did achieve the expected savings for 19 of the 23 measures. Three of the respondents had reportedly measured the results, while 12 claimed to have "tracked their utility bills" and four relied on their best guess. In determining their return on investment, 13 of the 16 growers who had installed measures relied on simple payback over two to five years. Two of the remaining three relied on internal rate of return and net present value calculations. The final grower did not know how to calculate a return on investment. The relatively high number of respondents who calculated their savings in some way indicates that growers in this market segment are aware of their energy usage and track the savings that they achieve. This level of awareness suggests that utilities may be able to have meaningful conversations with these growers about further energy-saving opportunities.

When asked how they learned of the installed equipment, growers reportedly relied on information from vendors for 15 of the 24 measures and on utility representatives for eight of the measures. The Internet was the source of information for the remaining measure. All respondents identified first cost as the primary barrier preventing them from installing further energy-efficient equipment. This sentiment was echoed in the qualitative interviews. These respondents recognized that while individual pieces of equipment may help to manage costs, most of the growing systems are complex and may not benefit from limited optimization of individual elements. By offering agricultural energy audits and designing a systems approach to agricultural incentives, utilities have an opportunity to overcome both the barriers of first cost while promoting a holistic approach to energy savings. Given growers' heavy reliance on equipment vendors, utilities should work with these vendors to promote further efficiency measures, as they are a common source of information in the segment. Vendors, in turn, will have a vested interest in helping to promote systemic energy savings, as increased efficiency could lead to increased equipment sales.

3.5.3 Fruit, Tree Nut, and Vine Crop Water Management

Although growers in the Fruit, Tree Nut, and Vine segment are actively working to reduce their on-site water usage, water availability is still a concern for the segment. In fact, growers' sensitivities to disruptions of water and electric service were nearly the same, coming to 8.7 and 9.0 out of 10, respectively.[7] However, per Figure 3.4, only four technical survey respondents mentioned water as a significant current cost. This is largely because during the winter and spring, many plants are dormant and plants are naturally irrigated by rainwater. However, these costs rise during the summer months when rainfall is unavailable.

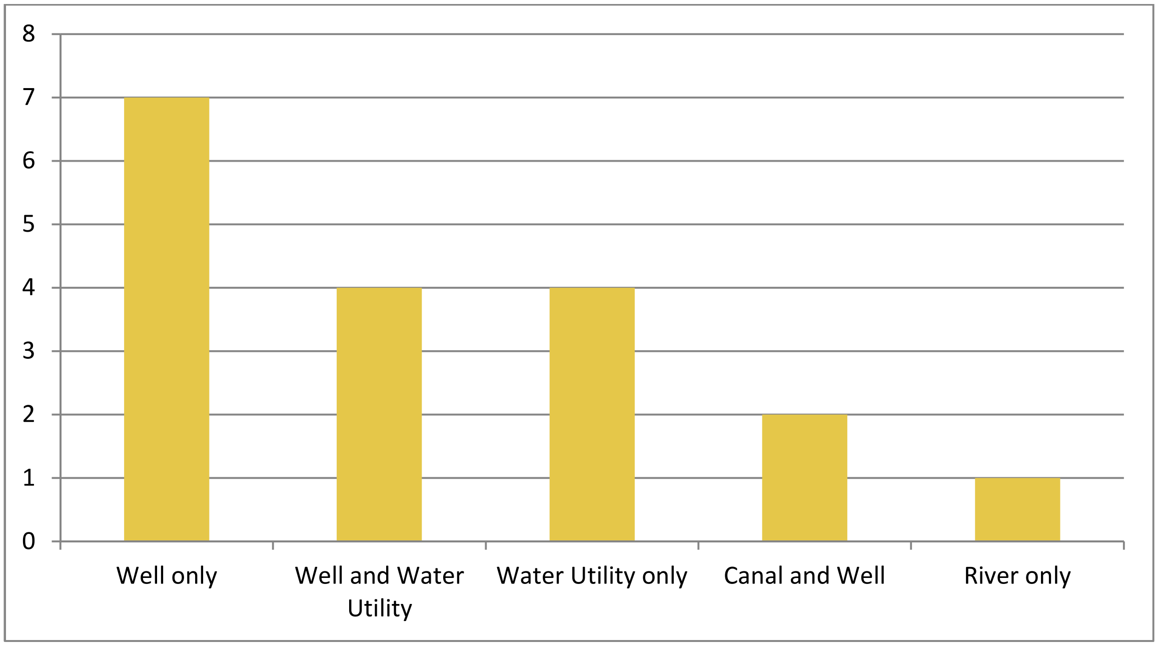
Geographic location plays a large role in growers' water costs not only because of the availability of natural precipitation. Geography can also determine the quality of groundwater sources in particular regions. One qualitative interview respondent claimed that his water costs were higher than others' because his groundwater was saline and he relied more heavily on irrigation pumping. Efficient pumping measures may therefore be more applicable to certain growers in a market segment than others, based solely on their location within the state. Qualitative interviews further revealed that some growers in this segment were more concerned with water regulations than were respondents from other segments. Many respondents reported that they could not allow water to run off the property, and instead must capture runoff in wastewater lagoons. Some also indicated that they were required to conduct regular well monitoring. One grower explained that, because of current regulations, he could not use certain pesticides because his operation is near Monterey Bay, a wildlife refuge that is very ecologically sensitive and subject to strong water regulations. Conversely, another grower, expressing a minority viewpoint, claimed to have very little water runoff because the operation is organic and has their own well, thus using only what they need. Overall, it appeared that smaller growers following these stringent regulations were forced to recoup their costs from their customers. Larger growers indicated they could find other ways to comply with regulations, such as conducting the required monitoring and constructing wastewater treatment systems.

3.5.4 Sources and Uses

As shown in Figure 3.11, the majority of the technical in-person survey respondents sourced at least some of their water directly from wells. Utilities were the sole suppliers to four of the 18 respondents, while three relied on canals or rivers. Figure 3.12 illustrates water end uses in this segment, showing that growers use water primarily for irrigation and seed germination, as well as produce washing/cleaning. The common use of irrigation pumps and pressurized water systems indicates that pump efficiency measures could be a worthwhile pursuit for utilities developing incentives for this market segment.

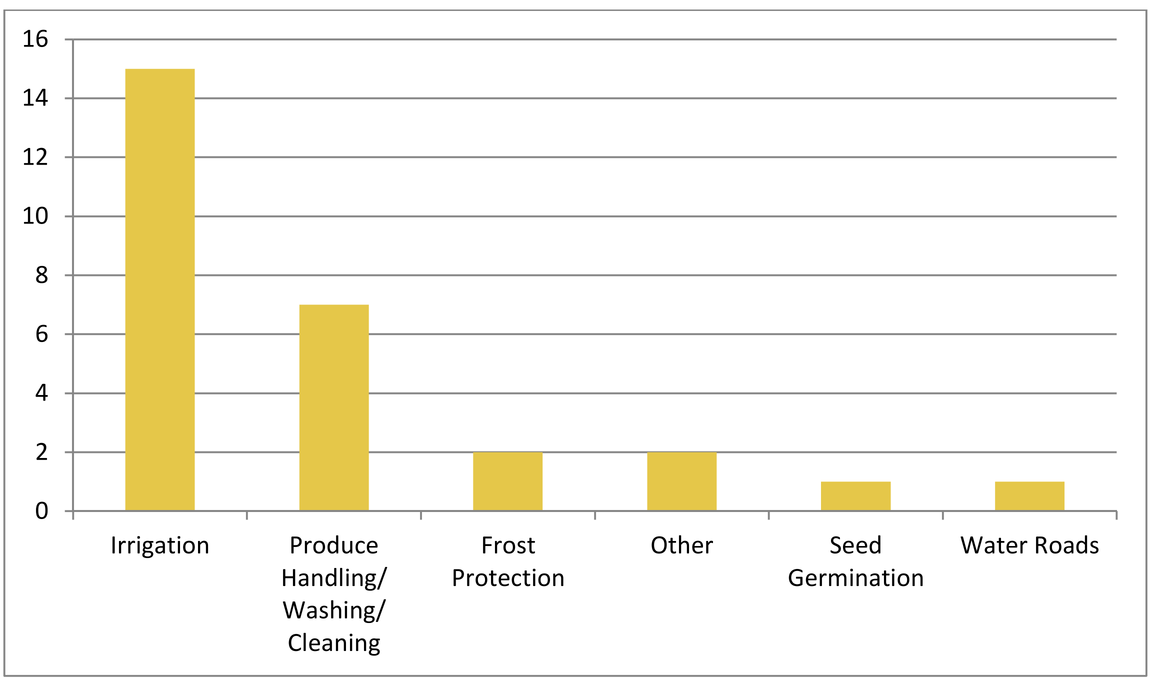
[7] On a scale of 1 to 10, how sensitive is [your operation] to interruptions in your water/electric supply?

Figure 3.11. Water Sources for Fruit, Tree Nut, and Vine Crop Growers



Source: Technical Field Survey, n = 18, "From what source do you receive your water?"

Figure 3.12. Uses of Water by Fruit, Tree Nut, and Vine Crop Growers



Source: Technical Field Survey, n = 18 - multiple responses allowed, "What are the major production or process applications that require water in your operation?"

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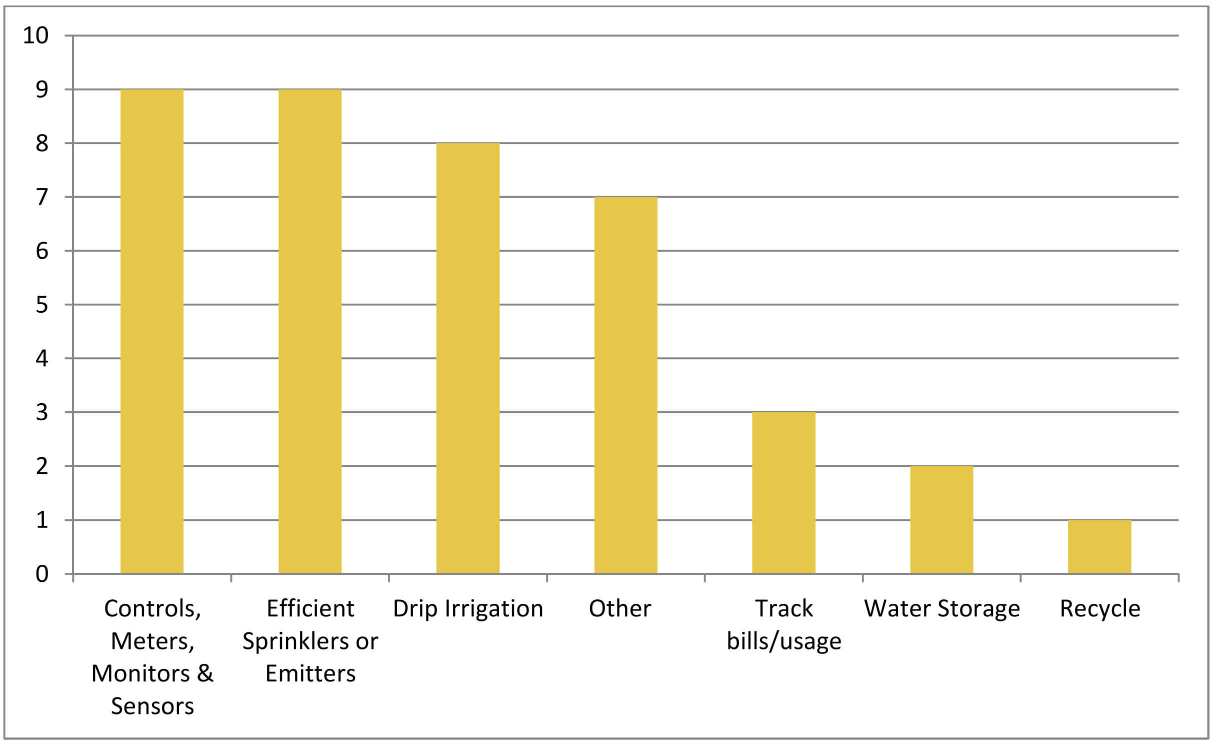
3.5.5 Management and Equipment

Growers in the Fruit, Tree Nut, and Vine segment rely on a combination of controls, meters, monitors, and sensors combined to manage water use. Common irrigation systems also include efficient sprinklers and emitters and drip irrigation systems. Although there is no academic report on the subject, visual inspection by trade allies reveals that most of the nut crops are using pressurized drip and micro-irrigation systems. Again, given the significant use of electricity for pumping (see Table 3.5) and this segment's sensitivity to water regulations, pump measures—coupled with water management systems—present the most viable program offerings to these growers.

Figure 3.13. Fruit, Tree Nut, and Vine Crop Water Management Approaches



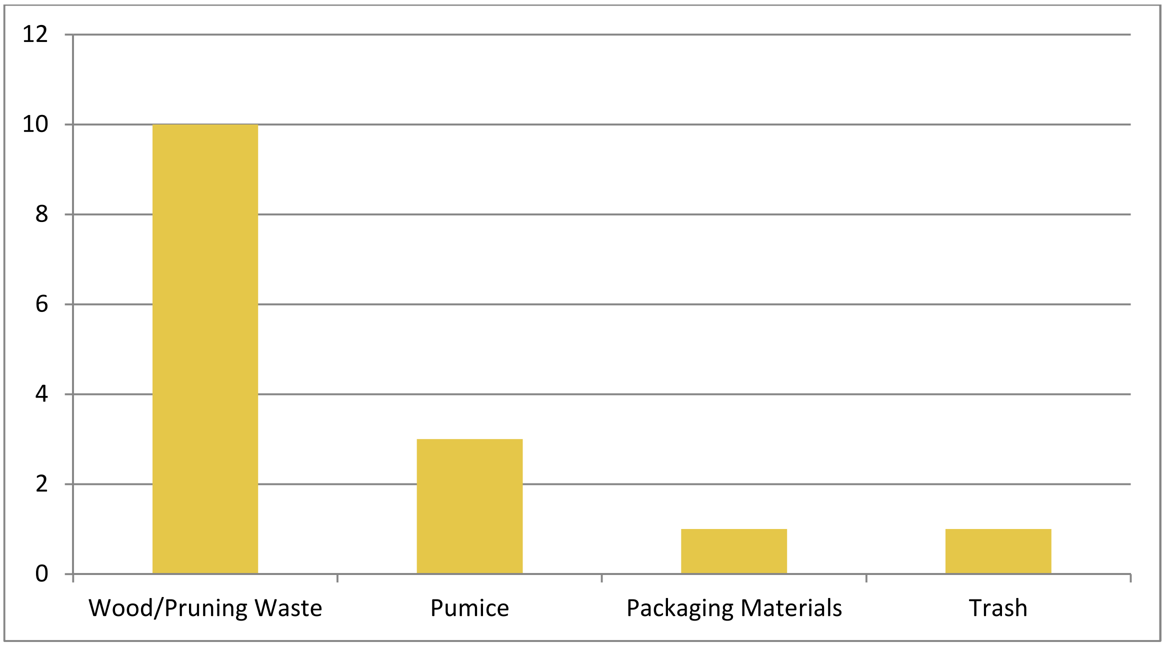
Source: Technical Field Survey, n = 18, multiple responses, "How do you manage water usage in your operation?"

3.6 Fruit, Tree Nut, and Vine Crop Waste Management

3.6.1 Sources, Management, and Equipment

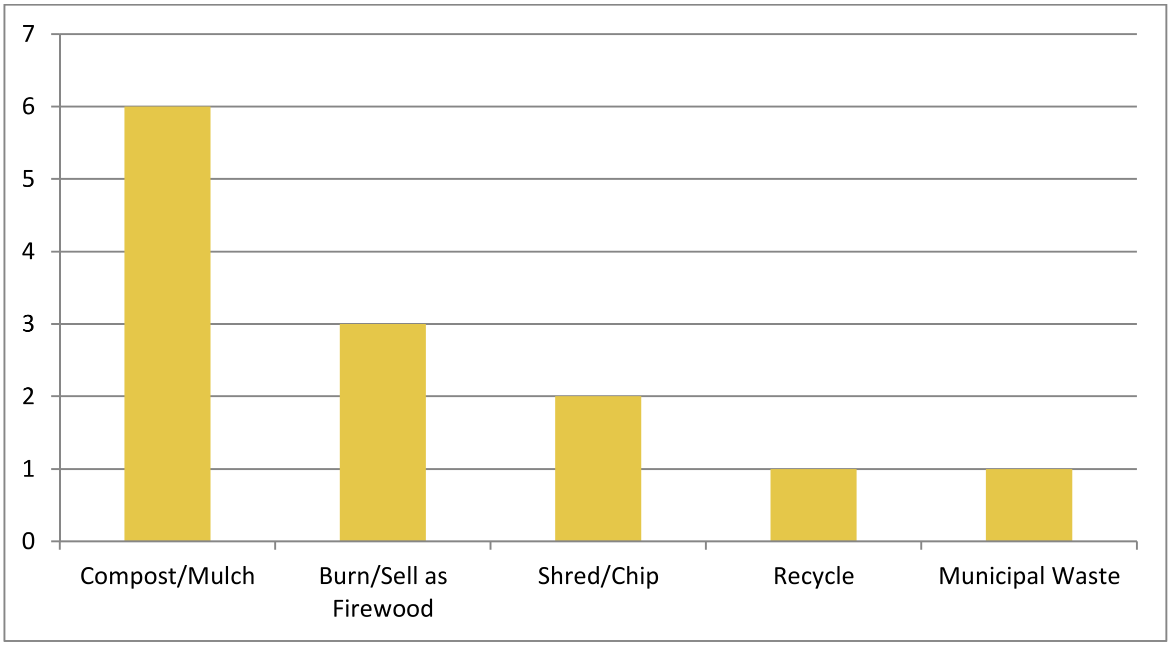
The majority of waste from the Fruit, Tree Nut, and Vine Crop market segment is organic in nature, produced from the plants themselves. When asked what type of solid waste they produced, over half of the growers identified wood/pruning waste as their predominant waste products, as shown in Figure 3.14. Other waste products included pumice, packaging materials, and general "trash." Figure 3.15 illustrates waste disposal methods for this segment. Composting, either for on-farm use or as a product sold to other growers, is the leading method of waste disposal, although growers also burn their waste or sell it as firewood. Respondents also mentioned mulching and chipping. These findings suggest that waste management is not a significant issue for Fruit, Tree Nut, and Vine growers. According to qualitative interview respondents, solid waste regulations do not have a significant effect on their operations overall. Disposal of pruning waste and dead trees was an exception.

Figure 3.14. Fruit, Tree Nut, and Vine Crop Waste Sources



Source: Technical Field Survey, n = 18 - multiple responses allowed, "What kind of solid waste is generated in your operation?"

Figure 3.15. Fruit, Tree Nut, and Vine Crop Waste Disposal Methods



Source: Technical Field Survey, n = 18 - multiple responses allowed, "How do you currently dispose of solid waste?"

Regarding air quality regulations, three of six qualitative interview respondents did not believe that they were subject to air quality regulations or AB 32 as their waste management practices produced no emissions. Those who were subject to the regulations claimed that they did not affect operations. The respondents were, however, aware of burn regulations, trucking regulations, the NorCal air quality board, and some exemptions from the regulations that reduce one's involvement. One farmer claimed that regulations were, "pricing him out of business." Another stated, "Burning is not allowed except on 'good air' days and there are never any of those so they never get to burn. Now [they] have to dispose of waste in other manners like chipping, which increases costs."

3.7 Fruit, Tree Nut, and Vine Crop Segment Conclusions and Recommendations

Conclusion 1: The California fruit, tree nut and vine crop production is steadily increasing over time. If this trend continues, growers will have an increasing capacity to invest in energy efficiency. Demand for California fruit, tree nuts, and vine crops is also increasing; however, growers are chiefly concerned with the cost and availability of labor. Unlike in segments such as mushroom production, there is limited opportunity in the Fruit, Tree Nut, and Vine segment to substitute mechanization for labor. Increases in labor cost, or decline in labor availability, will limit growers' ability to invest in energy efficiency.

Recommendation 1: Navigant also recommends prioritizing delivery of programming based on the level of production. If demand for California produce continues to increase, programs that reduce costs will enhance national and international price competitiveness. Energy efficiency, however, will have limited opportunity within the context of segment stagnation or decline due to labor scarcity. In the latter context, programming focused on other segments may be the best option for utilities and their ratepayers.

Conclusion 2: Operations in this segment are highly diversified in terms of crops grown and on-farm processing methods. While pumping and refrigeration are the dominant end uses, growers in this segment may have the opportunity to employ measures to optimize natural gas use in greenhouses and crop-drying facilities, as well as adopt residential and small commercial measures.

Recommendation 2: Growers would be much more amenable to a consolidated set of incentives and outreach that addresses orchard operations, repair shop consumption, and any on-site, post-harvest processing, as well as residential energy use, than separate offerings from multiple representatives. Utilities should promote a full range of measures to this segment, as part of an integrated program rather than focus solely on irrigation and refrigeration measures.

Conclusion 3: Growers in this segment view their local utility as a primary source of information about energy, yet turn to vendors when deciding which equipment to purchase.

Recommendation 3: Utilities should conduct outreach to both growers and equipment vendors to explain how program incentives can overcome first cost barriers and provide whole-system solutions—including life-cycling costing. Within the context of expanding production, growers and vendors can focus on equipment that will meet increasing demand while minimizing operating costs. This would also enhance the profile of utilities as reference partners among growers in this segment.

4 Vineyards and Wineries

4.1 *Key Findings and Recommendations*

While California's large and small wine grape producers are thriving, its medium-size growers are suffering due to unfavorable distribution infrastructure. Large companies are therefore acquiring the mid-size operations. Because of this trend, **utilities should focus on nurturing relationships with both large and small operations, while paying heed to their inherent operational differences**.

Vineyard and winery operators are currently among the most energy-conscious producers within the agricultural market. **Their increasing use of mechanization is particularly noteworthy, especially with regard to their electrically fueled irrigation techniques**. Because of their affinity for energy management and the attention they pay to monitoring consumption, the Vineyard and Winery market segment would be a favorable segment for utility-sponsored rebate programs. **Industry associations could provide key alliances for utilities, as they are already intent upon educating growers on the benefits of sustainable best practices**.

While utility programs should leverage the outreach and marking efforts of vineyard and winery trade associations to address the needs of all size firms, Navigant recommends that the **priority for programming should be the largest operators who consume the most energy and are most likely to apply mechanization** in an effort to limit labor costs. A secondary priority would be the development of programming to **support the sustainability efforts of smaller vineyards**. Both types of programming should **address financing issues efficiency measures** as this appears to be an issue for all members of this segment.

4.2 *Methodology*

4.2.1 Secondary Research and Literature Review

To understand the information that currently exists on the Vineyard and Winery market segment, Navigant's research team began by conducting secondary research. Sources ranged from industry association article and growers' guides to peer-reviewed publications and California Department of Food and Agriculture's annual reports. Using this array of sources, Navigant conducted an extensive literature review, complete with an annotated bibliography. The findings from this research are located in the Vineyards and Wineries chapter in the *Literature Review for the 2010 – 2012 Statewide Agricultural Energy Efficiency Potential & Market Characterization Study.*

4.2.2 Primary Data Collection

Having gained an understanding of information that currently exists in the market, Navigant was able to identify the knowledge gaps on which to focus primary data collection. As illustrated in Table 4.1, this data collection included technical surveys—both via telephone and in-person—as well as qualitative and subject matter expert interviews.

Table 4.1. Data Collection for the Vineyard and Winery Segment

	Number of Completed Interviews
Subject Matter Expert Interviews	2
Technical Surveys (Telephone/In-Person)	13/12
Qualitative Interviews	6

4.2.2.1 Subject Matter Experts

The research team interviewed two subject matter experts; one from a state trade association and one from the University of California. These interviews covered topics such as market trends, challenges, and drivers within the segment, as well as market structure and energy efficiency.

4.2.2.2 Technical Surveys

The research team conducted technical phone surveys with 13 individuals in the Vineyard and Winery market segment. These surveys included topics such as operation firmographics, energy management and practices, waste and water issues, and business cycles. Each operator responded to an initial phone survey that covered these topics at a high level. If a respondent agreed to participate in a follow-up, in-person survey at their farm, a member of the research team would give one of three subsequent surveys based on their sophistication of energy metrics and history of energy-efficient measure implementation. These follow-ups included a General Technical Survey, an Intermediate Technical Survey, and a Detailed Technical Survey. Twelve of the original 13 Vineyard and Winery telephone respondents agreed to a subsequent technical survey.

Figure 4.1. Map of Vineyard and Winery Technical Survey Respondent Locations

Source: Navigant analysis

4.2.2.3 *Qualitative Interviews*

The research team conducted six qualitative interviews via telephone. The qualitative interviews were designed to complement the technical information, examining agricultural energy usage and efficiency potential. The qualitative interviews focused on market expectations, behaviors, and practices, and potential barriers and opportunities related to increased efficiency.

4.2.2.4 *Firmographics*

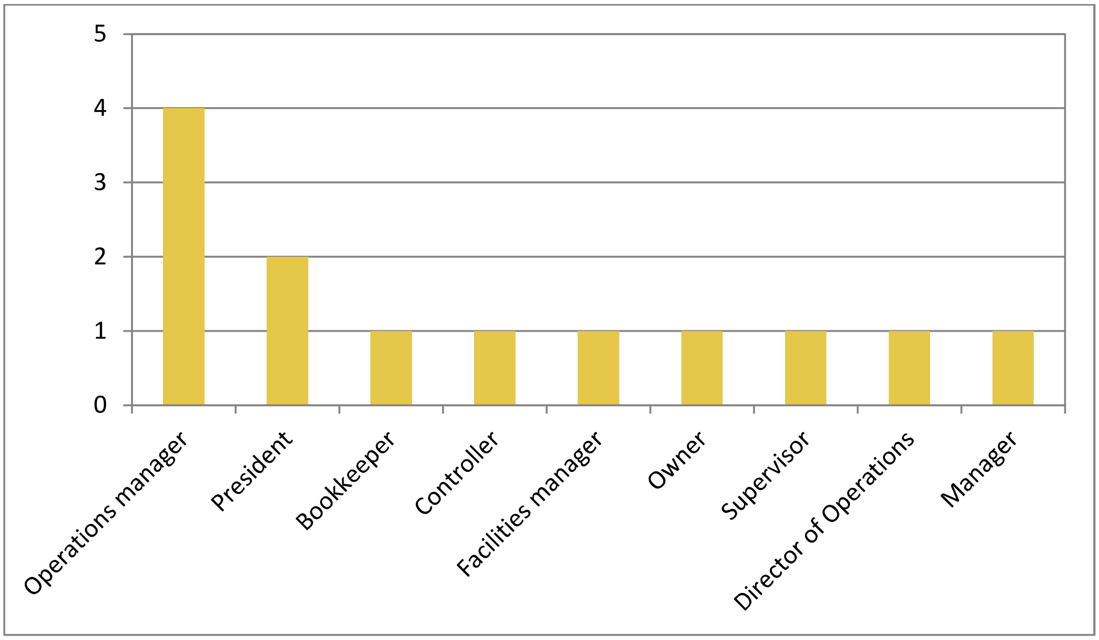
As found through secondary research, California wine grape production typically occurs in the Central San Joaquin Valley, the Central Coast, Napa Valley, and the Northern Coastal Mountain Range regions. Section 4.4.1 details this geographic distribution, while section 4.3.1 outlines the winegrape crush by county.

The state's wine industry consists of large, medium, and small producers, as dictated by volume of production. A handful of large companies produce approximately 75% of California's wine, including Gallo, Constellation, The Wine Group, Bronco, Trinchero, Beringer, and Diageo. These large corporations are reportedly acquiring a number of medium-tier businesses, which produce about one tenth of the volume and include the likes of Mondavi. California's small wineries produce fewer than 5,000 cases per year and typically differentiate themselves in the market by embracing sustainable practices and selling directly to customers. Section 4.3 details the nuances of California winegrowers in greater detail.

California winegrowers typically pump irrigation water from wells and aquifers, and distribute it throughout the winery. Drip irrigation is the most common irrigation method among wine grape growers, particularly for those through the Napa Valley and Central Coast winegrowing region. Growers employ a number of water conservation practices, details of which can be found in Section 4.6.

To verify the findings from secondary research, the research team interviewed a number of California vineyard and winery operators. Of the 13 technical phone survey respondents, most were in management or supervisory roles (see Figure 4.2). Eleven respondents interacted with their local utility representatives as part of their roles, and all but one tracked production costs.

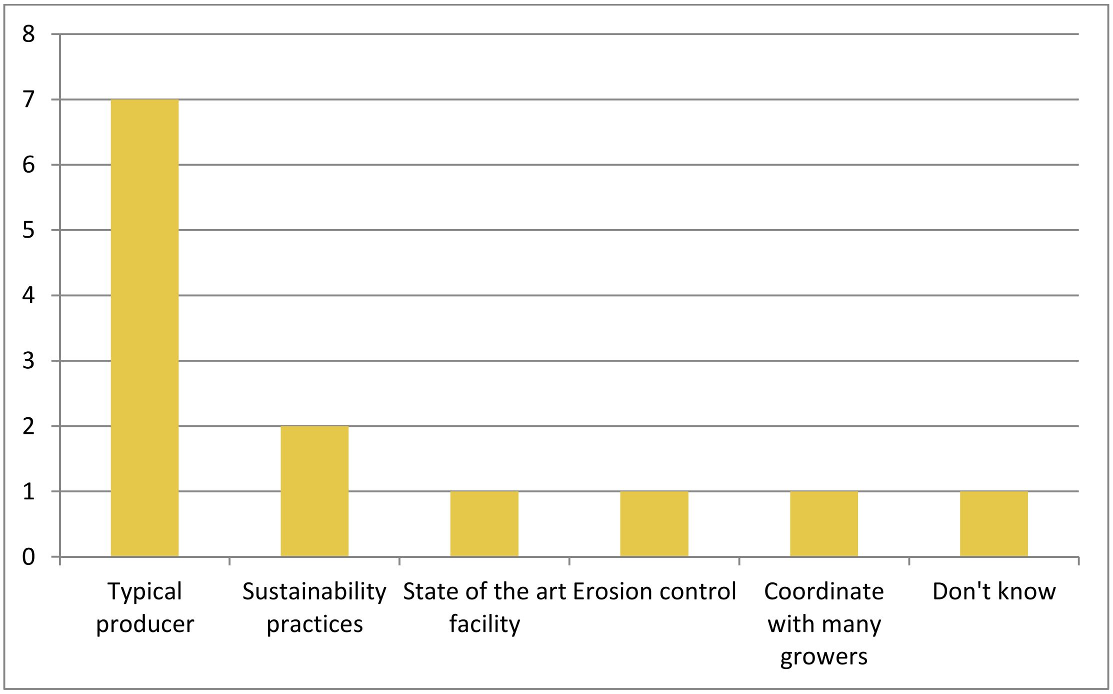
Figure 4.2. Technical Survey Respondent Roles



Source: Technical Phone Survey, n=13, "What is your role in the operation?"

The sample vineyards have been in operation for anywhere between 10 and 150 years, with the average around 50 years of operation. All respondents of the telephone survey listed wine or wine grapes as their primary product. Slightly more than half of the respondents considered themselves typical producers, while five respondents set themselves apart, as seen in Figure 4.3. The average size of the vineyards was around 5,000 acres, but sizes ranged from 100 acres to 45,000. All but one of the respondents who gave meaningful answers irrigated 100% of their vineyard.

Figure 4.3. Respondent Producer Classification



Source: Technical Phone Survey, n=13 - multiple responses, "Are you a typical producer?" and "How do your production practices differ from a typical producer?"

4.3 Structure of Vineyard and Winery Market Segment

4.3.1 Description of Market Segment

The Vineyard and Winery segment is unique from other agricultural segments in that it technically does not fall under the "agricultural" classification system. Grape vineyards. for purposes other than wine, fall under the Fruit, Tree Nut, and Vine Farming segment, covered in Chapter 3. However, the NAICS classifies vineyard cultivation (115112) as "Soil Preparation, Planting and Cultivating," while wineries, which includes the growing of grapes for wine, (312130) fall under "Beverage and Tobacco Product Manufacturing." The primary distinction between the two sub-segments lies in the production of the wine itself; wineries will typically grow their own grapes and subsequently produce wine from their crops, while vineyards' primary product is the grape, which they then sell to wineries for production. Although there is a distinction, it is common practice for wineries to own their own separate vineyards, as well.

4.3.1.1 Segment Overview – Vineyards

Thousands of vineyards grow table, wine, and raisin grape varietals, occupying a combined 789,000 acres of cultivated, irrigated land. In 2010, 489,000 acres of California's total grape acreage was devoted to wine grapes.[8] Raisin and table grape grown varietals at times are added to the wine grape crush. Most vineyards have adopted drip irrigation systems, soil and weather monitoring technologies, and the use of software to adopt Irrigation Scheduling practices. The rate of technology adoption depends on the wine growing region of the state. The Napa Valley and the Central Coast wine growing regions are almost entirely using drip irrigation.[9]

4.3.1.2 Segment Overview – Wineries

In 2010, California's 3,364 bonded wineries[10] crushed 3.7 million tons of fruit,[11] delivering 241.8 million cases of wine to the U.S. market and for export to 125 countries.[12] Many of California's wineries are small businesses that produce fewer than 5,000 cases per year. Demand for these small-batch producers can be strong, sometimes with long waiting periods, and may yield good profit margins for the wineries.[13] However, by volume, a small number of companies produce the vast majority of California's wine. These companies include E.J. Gallo, Constellation Wines (Robert Mondavi, Franciscan, Simi), The Wine Group (Franzia, Glen Ellen, and Canconnon), and Bronco.

Table 4.2 shows the total tons of wine grapes crushed in 2010 by USDA Wine Growing Districts. (Some counties are part of more than one district.) The crush is widely distributed across the state but Districts 13 and 11 are the leaders. Wineries in District 13, which include most of the Ernest and Julio Gallo Wineries, are the single largest crushers of wine grapes in the state. Sacramento and San Joaquin counties (District 11) account for the second largest wine grape crush district, mostly from vineyards associated with the Lodi-Woodbridge Commission.

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8 California Department of Food and Agriculture (CDFA), California Agricultural Production Statistics, Fruit & Nut Crops, 2010-2011. Available: http://www.cdfa.ca.gov/statistics/.

9 Subject matter expert interview, CalPoly SLO, ITRC 2011.

10 Wine Institute, "Number of California Wineries", http://www.wineinstitute.org/resources/statistics/article124

11 CDFA, 2011, Available: http://www.nass.usda.gov/Statistics_by_State/California/Publications/Grape_Crush/Reports/index.asp.

12 Wine Institute, "California Wine Profile 2010".

13 Rachael E. Goodhue et al., *Current Economic Trends in the California Wine Industry*, U.C. Davis Giannini Foundation of Agricultural Economics, 6. Available: http://giannini.ucop.edu/media/are-update/files/articles/v11n4_2.pdf.

Table 4.2: 2010 Wine Grape Crush by County

USDA Wine Growing Districts	Counties	Total Crush (tons/yr)
1	Mendocino	59,617
2	Lake	31,623
3	Marin, Sonoma	212,675
4	Napa	142,752
5	Solano, Sacramento*	19,272
6	Alameda, Contra Costa, San Mateo, Santa Clara, Santa Cruz	26,925
7	Monterey, San Benito	264,848
8	San Luis Obispo, Santa Barbara, Ventura	216,936
9	Butte, Colusa, Glenn, Humboldt, Sacramento*, Shasta, Siskiyou, Sutter, Tehama, Trinity, Yolo*, Yuba	60,142
10	Amador, Calaveras, El Dorado, Mariposa, Nevada, Placer, Tuolumne	18,192
11	Sacramento*, San Joaquin*	770,101
12	Merced, San Joaquin*, Stanislaus	316,063
13	Fresno, Kings*, Madera, Tulare*	1,074,821
14	Kern, Kings*	347,297
15	San Bernardino, Los Angeles	1,078
16	Orange, Riverside, San Diego	3,841
TOTAL	**CALIFORNIA**	**3,702,530**

Source: USDA, NASS. 2011b, California Wine Growing Districts; CDFA, 2011

4.3.2 Description of Supply Chain

Vineyards and wineries constitute a relatively robust supply chain in and of themselves. The two types of operations can handle the majority of the production and distribution process on-site. Primary inputs for the two operations consist of fuel and energy, water, labor, fertilizers and pesticides, and in the case of wineries – grapes. Table 4.3 provides a list of inputs, as found in the qualitative interviews. Utilities source inputs such as energy, while materials ship from suppliers such as equipment suppliers, vineyards (in the case of wineries), fertilizer or pesticide companies, and in some cases, other farms.

Table 4.3. Primary Inputs

Input Type	Number of Mentions
Labor	5
Grapes	5
Electricity	4
Water	3
Fuel	3
Containers	3
Fertilizers	3
Pesticides	2
Natural gas	1
Farm equipment	1

Source: Qualitative Interviews, n = 6, "What are your primary inputs?"

While some of the wineries sell their product on-site, many sell their wines to retail stores, wholesale distributors, grocery stores, and restaurants. Online sales constitute another common means of wine distribution. The qualitative interview respondents reported selling to both national and international markets, as well as those in California. Producers typically ship their products via truck, although one respondent also mentioned trains as a means of shipment.

Wine tourism plays a significant role in the California wine supply chain. The industry trend has led to the development of wine clubs and barrel rooms, and serves as an important connection between producers and consumers.[14] This is particularly true for the Paso Robles and Lake County areas, where many wineries are attempting to open direct shipping channels to the end users.

4.3.3 Description of Market Actors

A small group of privately owned wine distributors controls the majority of California's wine industry. As the intermediaries between producers and end consumers, distributors have significant influence over the market and communication between parties. The market's producers consist of large, medium, and small producers, as dictated by volume of production. A handful of large companies produce approximately 75% of California's wine. These groups include Gallo, Constellation, The Wine Group, Bronco, Trinchero, Beringer, and Diageo. This concentration of production prowess has allowed for fixed pricing, and "lends itself to lack of competition."[15] Indeed, these large corporations are reportedly acquiring a number of medium-tier businesses, which produce about one tenth of the volume and include the likes of Mondavi.

[14] Subject matter expert interview, CSWA Executive Director and Wine Institute Director of Environmental Affairs, May 2012, San Francisco, CA.
[15] Ibid.

In order to compete with large producers, smaller wine companies rely on market differentiators such as sustainability and direct sales to customers. 'Small' wine organizations produce approximately 10,000-50,000 cases of wine per year. These organizations are further removed from distribution issues as compared to their larger counterparts. These wineries are able to sell their product directly to restaurants with a high markup, and their boutique nature attracts tourists to their operations as part of the California wine culture.

4.3.4 Description of Market Reference Partners

The California Vineyard and Winery industry has a number of industry associations devoted to encouraging best practices, including the California Sustainable Winegrowing Alliance, the California Association of Winegrape Growers, and the California Wine Institute. Over the past decade, associations such as these have been making advancements in the education and resources available to wine producers. This included the 2001 development of the California Sustainable Winegrowing Program, a "first-of-its kind, industry-driven, crop-specific sustainability program that helps Industry-Driven Standards for Water Efficiency."[16] Programs such as these focus on the education of growers and vintners on sustainable industry practices.

Membership in the Wine Institute alone represents 70% of California's wine acreage.[17] However, many of these associations target large wine operations. Smaller wineries rely heavily on regional groups such as Napa Green and the Sonoma County Winegrape Commission for representation. These groups offer certifications of their own, in addition to sustainability education.

To gauge the level of these organizations' influence over growers, Navigant's research team asked both qualitative and technical survey respondents about their most common sources of information. Qualitative interview respondents identified the California Association of Winegrape Growers (CAWG), Napa Valley Vintners, and the National Resources Conservation Services (NRCS) as key industry associations. In reviewing each organization's website, the research team noted that neither Napa Valley Vintners nor CAWG makes mention of energy or energy efficiency. The NRCS does devote a section of its website to energy. However, this organization is a section of the USDA, and does not specifically target the wine industry.

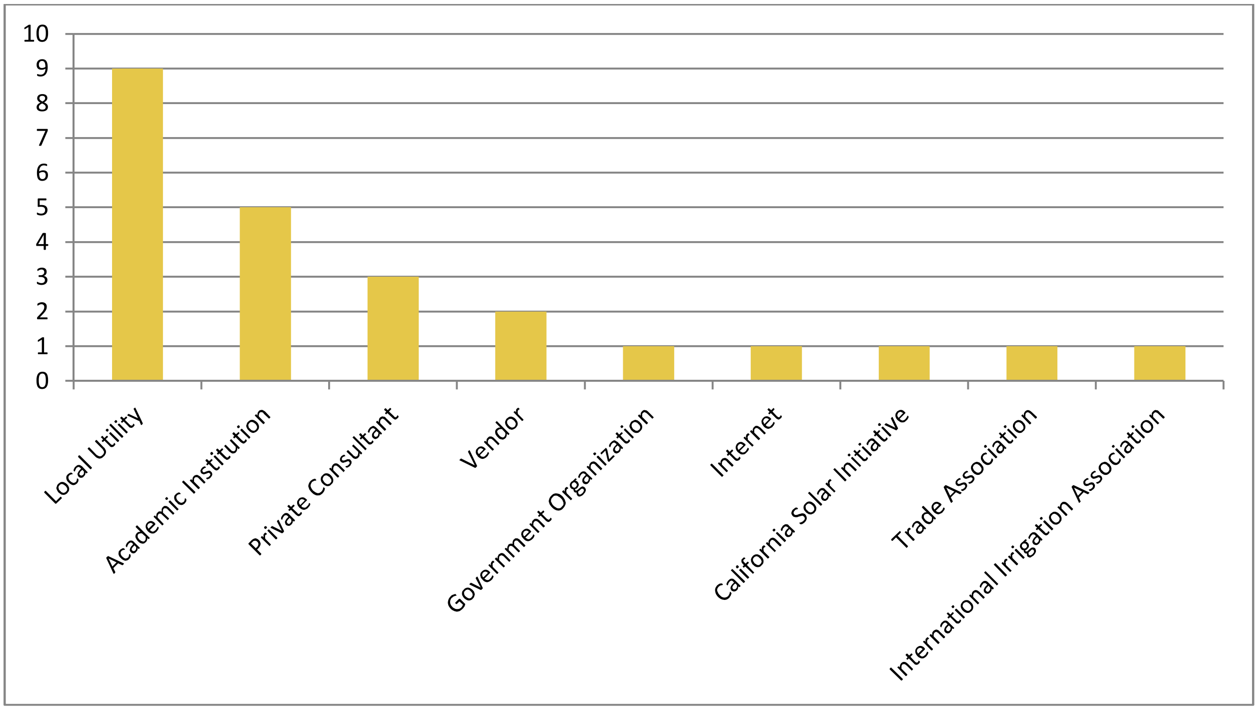
When asked about the information channels that they would use for energy-related issues, nine of 12 technical field survey respondents reported to interact with their local utility representative. Respondents also mentioned academic institutions such as local agricultural colleges and UC Davis. Notably, none of the technical survey respondents mentioned the trade associations identified by the qualitative interview respondents. Furthermore, none of either set of respondents mentioned the associations identified through secondary research (see Figure 4.4). This suggests that although organizations are forming within the industry to educate winegrowers in sustainability and best practices, it is unclear whether these organizations' messages are effectively reaching growers. The high

[16] Courtney Smith, *Industry-Driven Standards for Water Efficiency: The California Sustainable Winegrowing Program*. Pacific Institute. http://www.pacinst.org/reports/success_stories/industry_driven_standards_california_sustainable_winegrowing_program.pdf.

[17] Subject matter expert interview, 2012.

level of influence that utilities seem to have over growers could allow for leverage in cross-promotion of energy programs. Utilities should work with trade associations to develop effective, meaningful streams of information for growers. They should also actively work to ensure that this information is in fact reaching the target audience.

Figure 4.4. California Vineyard and Winery Information Channels



Source: Technical Field Survey, n=12 – multiple responses, "What are your three most likely sources for gathering information about reducing energy use or generating energy?"

Respondents suggested mixed sentiments regarding the level of perceived knowledge that suppliers have surrounding energy efficiency options. Two of the five respondents who offered a response felt that suppliers were knowledgeable about energy efficiency options and developments. One claimed that they were not knowledgeable, and two were unsure. Only one of these respondents indicated that their supplier kept them informed about energy efficiency developments, suggesting that suppliers are not a regular source of information for the vineyards and wineries operators. As vineyards and wineries interact with their suppliers on a regular basis, educating suppliers about energy efficiency could be an opportunity for utilities to influence supply choice.

4.4 Status of Vineyard and Winery Market Segment

California produces 90% of American wine and holds the fourth spot in global wine production (behind France, Italy, and Spain).[18] In 2009, the retail value of California's domestic wine sales was $18.5 billion with export revenue reaching $1.14 billion.[19] California's emergence as a major force on the national and

[18] Wine Institute, "California Wine Profile 2010", http://www.wineinstitute.org/files/CA_EIR_Flyer_2011_Apr15.pdf

[19] Wine Institute, "California Wine Profile 2010".

international wine is a recent phenomenon: in 1960, the state had about 250 wineries, in 1990, there were around 800 and by 2010, over 3,360.20. In turn, international competition is a growing challenge that U.S. producers must face. By volume, the U.S. is the largest wine consuming country in the world.[21] Because of this, international growers tend to target the U.S. This can be detrimental to domestic growers, as foreign governments often subsidize their wine exports. While the USDA matches funds for some export markets, California producers must increasingly compete with national and international players.

4.4.1 Market Trends

The rise of California's profitable wine industry is the story of a successful partnership between vineyards and wineries. Independent grape growers and winery-owned vineyards supply fruit to regional wineries. Wineries crush and ferment grapes and produce and store wine in tanks, barrels, and cold storage facilities. Wine grapes production typically occurs in the Central San Joaquin Valley, the Central Coast, Napa and the Northern Coastal Mountain Range regions. (See Figure 4.5 for the geographical distribution and aggregation of California's winegrape growing districts.)

[20] Wine Institute, "California Wine Profile 2010".
[21] Subject matter expert interview, 2012.

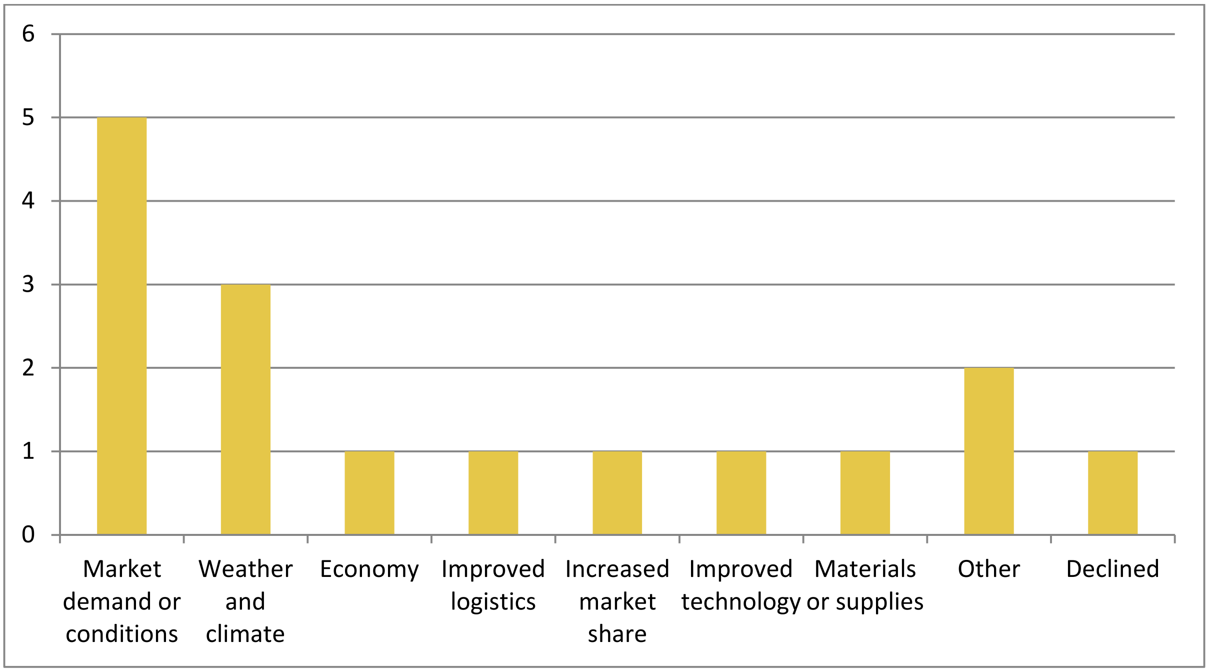
Figure 4.5. California Wine Growing Districts[22]

Source: USDA, NASS. 2011b, California Wine Growing Districts

California wine grape production dropped by 3% from 2010 to 2011. However, most respondents of the technical surveys reported to have steady or increasing production over the last two years. Reasons for this included constant or increasing market demand, weather or climate factors, improved technology or business logistics, and a number of other factors (see Figure 4.6). When asked what their greatest production costs have been over the last two years, most respondents listed labor rates (11/13 respondents) and electricity (10/13 respondents) among their top costs (see Figure 4.7). The qualitative interviews revealed similar findings; five of six respondents listed labor and three of six listed energy among their top costs.

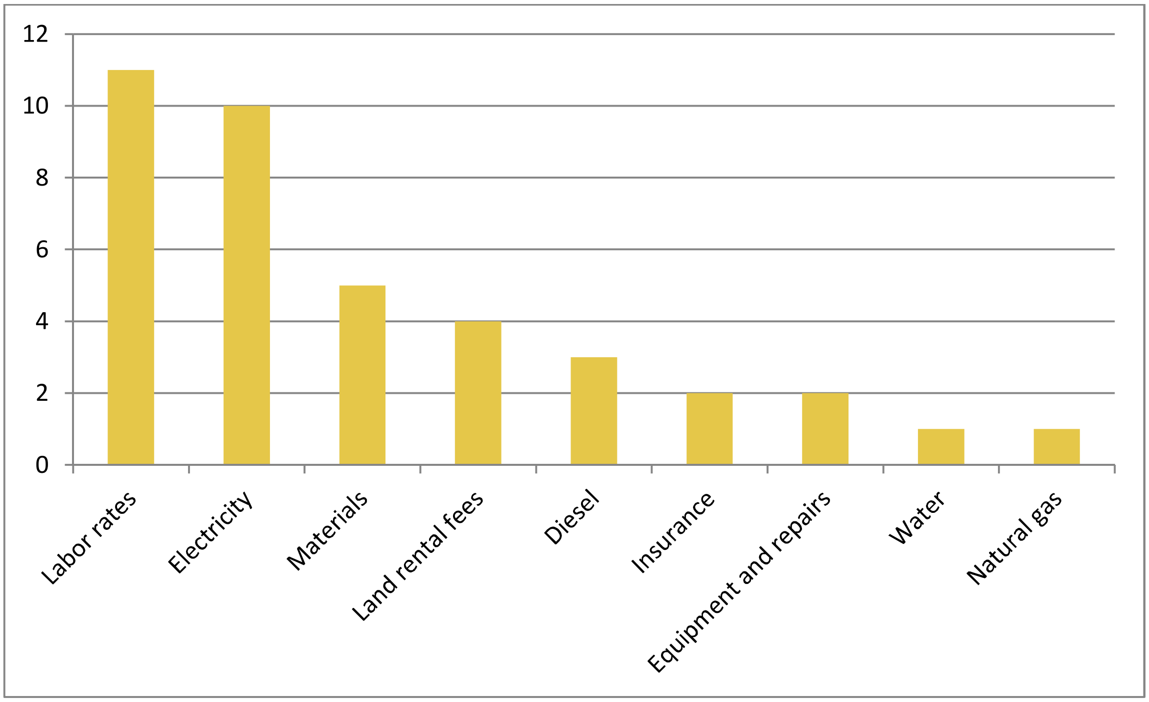
[22] USDA, NASS. 2011b, California Wine Growing Districts. Available: http://www.nass.usda.gov/Statistics_by_State/California/Publications/Grape_Crush/Prelim/2010/201002gcbtb00.pdf.

Figure 4.6. Reasons for Vineyard and Winery Production Increase or Decrease



Source: Technical Survey, n =13- multiple responses, "What have been the primary reasons your production has increased, decreased, or remained the same?"

Figure 4.7. Greatest Production Costs for Vineyards and Wineries



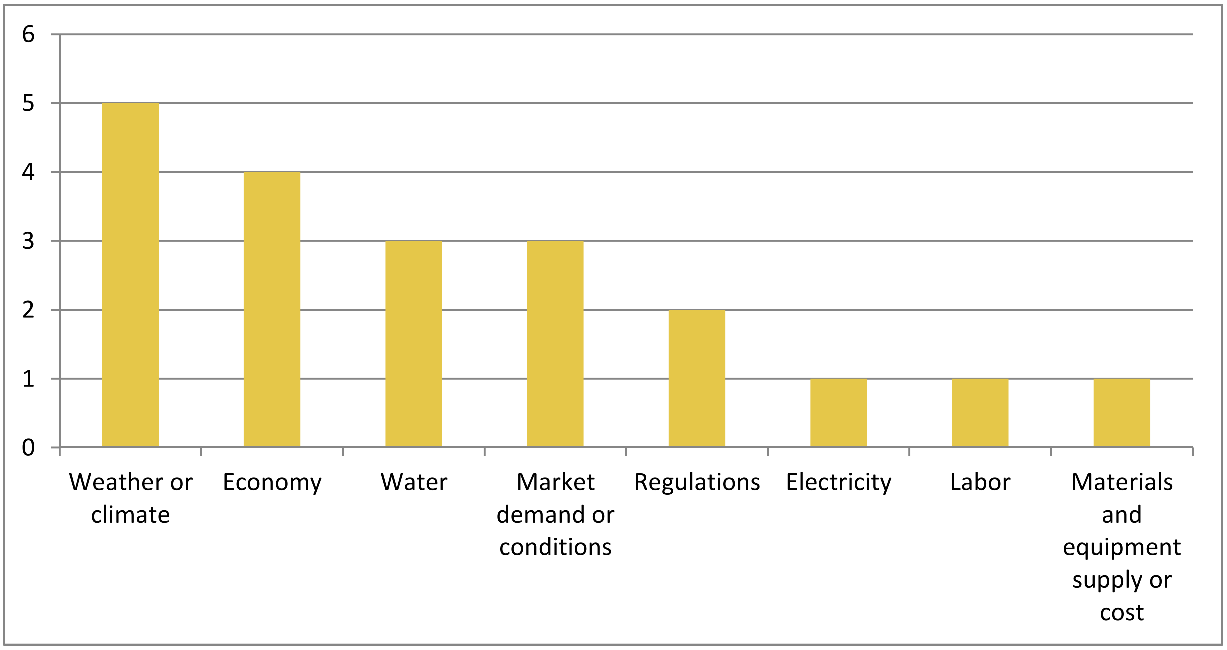
Source: Technical Survey, n = 13 – multiple responses, "What are your top three production costs?"

Natural gas was relatively insignificant for both sets of respondents. Eight of the 13 technical survey respondents were not natural gas users. Only two of the five who did use natural gas in their operations considered it to be a significant operating cost. While natural gas may have been included in the 'energy' response for the qualitative interview respondents, it is unlikely, as natural gas did not exceed 20% for any of the respondents. Assuming electricity was the majority of energy use, and considering energy was a top cost, opportunities for future program design should focus on electricity.

4.4.2 Future Prospects

When asked about factors that will influence production in the future, technical survey respondents pointed primarily to weather or climate factors, the economy, water, and demand or market conditions (see Figure 4.8). Qualitative respondents suggested that they anticipated strong future demand as the economy improves. However, many respondents suggested that they were wary of national and international competition. One respondent pointed to the acquisition of smaller firms into larger operations as a factor in national competition. Another respondent claimed that new vineyards are opening, and that the Chinese market is becoming a major player in the international market segment. The changing dynamic of the market segment could significantly affect individual operations in the California wine industry.

Figure 4.8. Factors Influencing Future Production



Source: Technical Phone Survey, n = 13 – multiple responses, "What factors do you think will most impact your future production?"

4.5 *Energy Use and Efficiency in Vineyards and Wineries Segment*

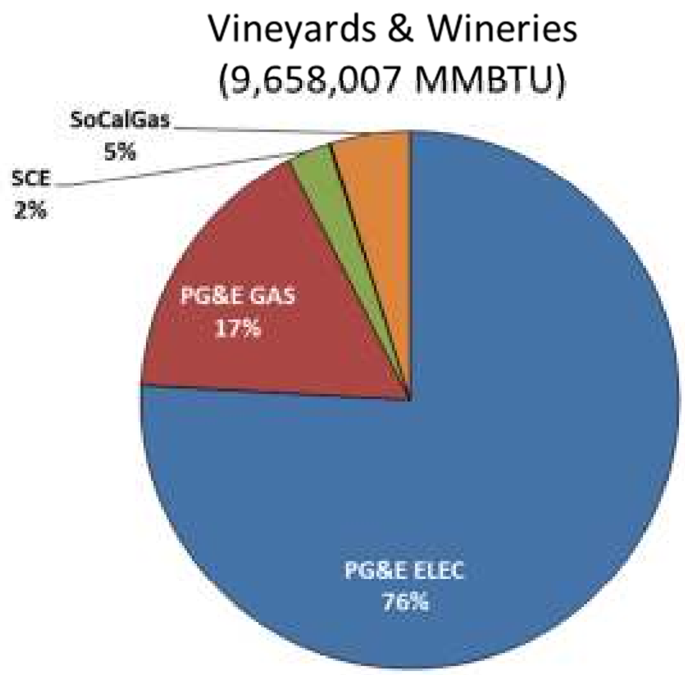
Vineyards and wineries represented 12.9% of total energy sales within the agriculture sector in 2010 (see Table 4.4). In the Vineyards and Wineries segment, gas sales are larger than electricity sales, and SCG is the largest gas supplier (see Figure 4.9).

Table 4.4. 2010 Vineyards and Wineries Segment Energy Sales Compared to All Agriculture Sales

Category	Sub-Segment	Total MMBTU	% of Electric MMBTU	% of Gas MMBTU	% of Total MMBTU	MMBTU by Category	% of Total MMBTU
Vineyards & Wineries	Vineyards	2,195,421	3.4%	0.5%	2.9%	9,658,007	12.9%
	Wineries	7,462,586	8.7%	16.1%	9.9%		
Total		75,032,670	100%	100%	100%	75,032,670	100%

Source: Navigant analysis of CPUC electric consumption data

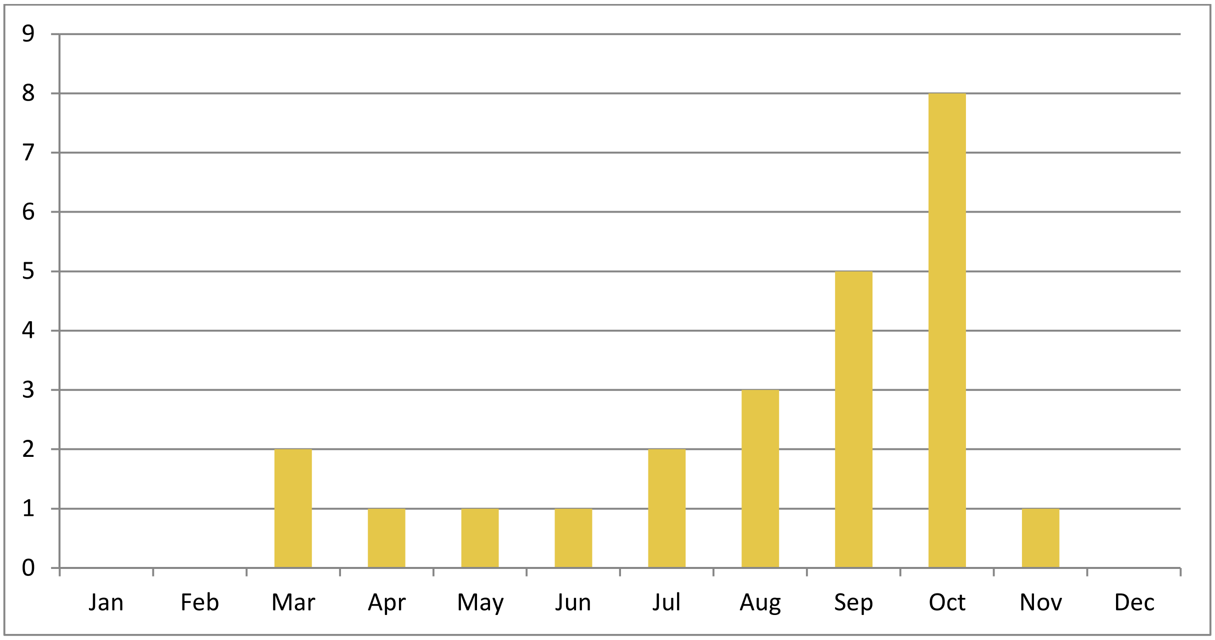
Figure 4.9. 2010 Vineyards and Wineries Energy Sales by IOU



Source: Navigant analysis of CPUC electric consumption data

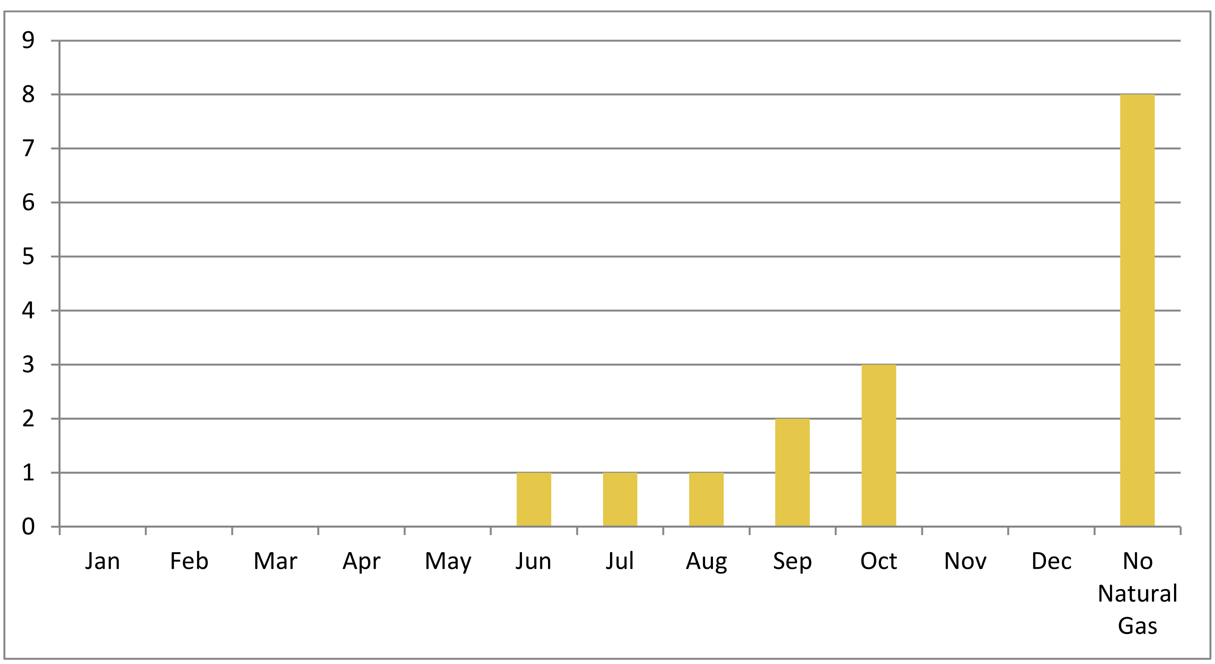
Wineries are industrial facilities utilizing process energy to wash, clean, and crush wine grapes, and to process grape juice to create wine products. Operators use electricity to power pumps to extract well water and to discharge and treat wastewater residues, usually using pond aerators. Operators also use both electricity and natural gas building conditioning and lighting, motors for crushers and presses, process heat for the fermentation vats, motor-driven bottling equipment, and post-bottling cooling storage and refrigeration. California's winemaking industry uses 400 gigawatt-hours (GWh) of electricity every year, in addition to the consumption of natural gas and propane. Figure 4.10 and Figure 4.11 illustrate the usage patterns for each fuel type.

Figure 4.10. Vineyard and Winery Electricity Usage by Month



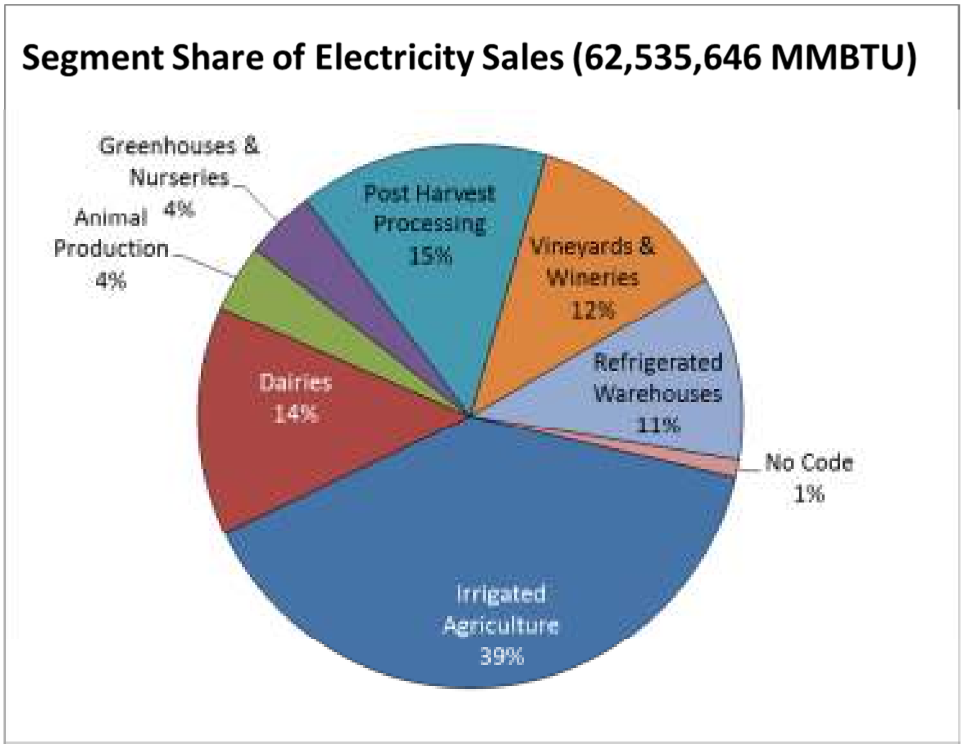
Source: Technical Field Survey, n =13 - multiple responses, "In which month do you think your electricity usage is greatest?"

Figure 4.11. Vineyard and Winery Natural Gas Usage by Month



Source: Technical Field Survey, n =13 – multiple responses, "In which month do you think your natural gas usage is greatest?"

Figure 4.12. 2011 California Agriculture Consumption of Electricity (IOUs Only)

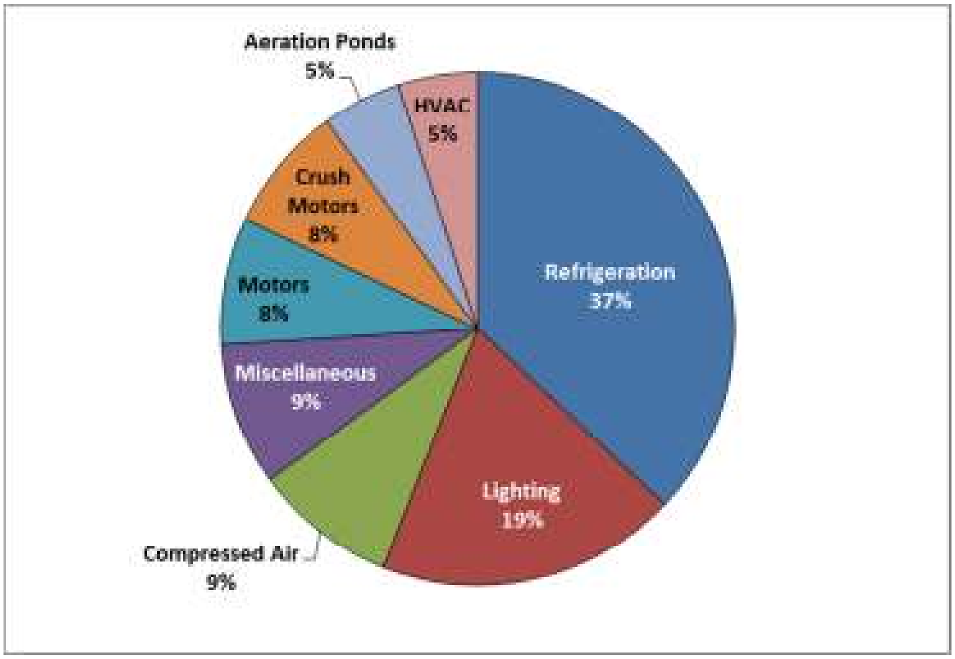


Source: Navigant analysis of CPUC electric consumption data

4.5.1 Energy End Uses

Secondary research has shown that vineyard and winery operations use the majority of their electricity for cooling and cold storage refrigeration, as well as compressors, pumps, and motors. Hot water usage consists of heating red wine in fermentation vats, heating yeast generator tanks, and for washing and cleaning storage barrels. The washing and cleaning of equipment, bottling lines, cellars, and crushing areas also use fresh water. Figure 4.13 shows the distribution of energy resources for the production of wine: refrigeration and lighting combined utilize 56% of total energy in a typical winery, and motors represent an additional 16% of total electricity use.

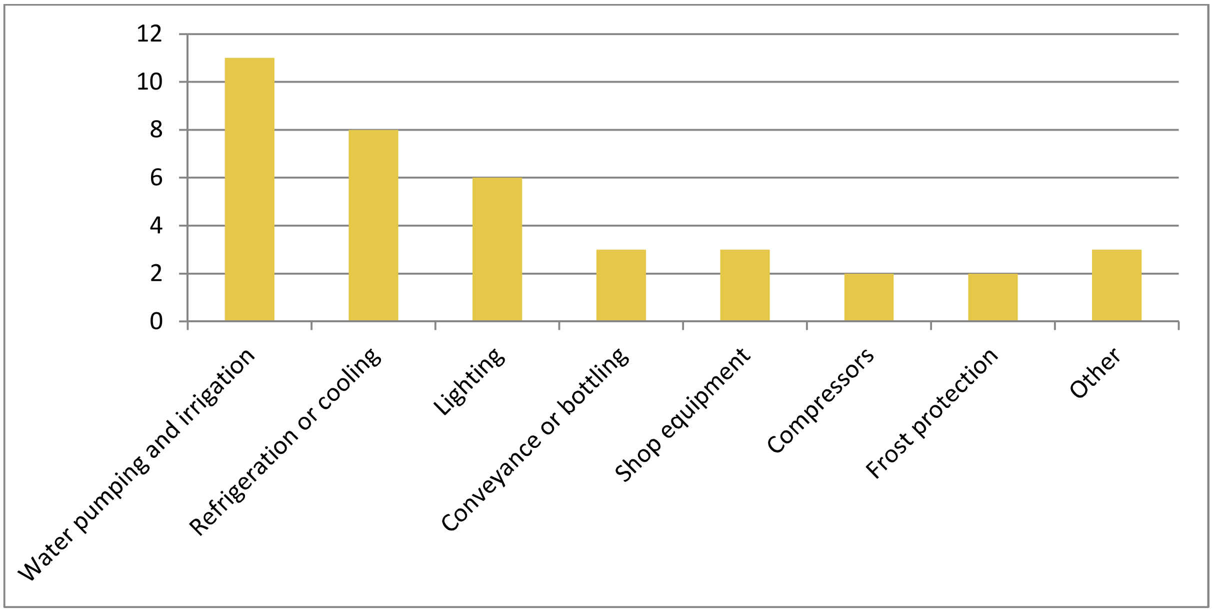
Figure 4.13. Typical Winery Energy Use



Source: Clem Lee, Reducing Wineries' Climate Impact: How PG&E's Energy Efficiency Programs Assist, presentation at Eco-winegrowing Symposium, July 19, 2011, Available: http://www.mendowine.com/files/Lee%20EcoWinegrowing%20Symposium_PGE%20Presentation.pdf

Generally, Navigant's technical field surveys supported the secondary research findings. However, respondents also listed water pumping, an end use that was absent from the literature review findings (see Figure 4.14). When asked about their on-site energy use, respondents identified refrigeration, water pumping, and lighting as their primary electrical end uses. Refrigeration reportedly consumed an average of 48% of respondents' electricity usage, while water pumping consumed an average of 46% and lighting another 13%. In instances where respondents used both refrigeration and pumping, pumping consumed an average of 30% of the operation's electrical load, while refrigeration consumed 45%. However, in operations that did not involve refrigeration as a top energy consumer, the average amount of electricity used for water pumping increased to 75%. No instances occurred in which operations used refrigeration but not water pumping. This suggests that water pumping is a significant electrical end use in all vineyard and winery operations; however, in operations that require refrigeration, the latter end use consumes incrementally more energy. Utilities should therefore note that pumping programs may reach a broader base of vineyard and winery customers, yet refrigeration programs may achieve more savings within individual operations. For a full list of electricity end uses, see Table 4.5.

Figure 4.14. Processes/Equipment Using the Most Electricity



Source: Technical Field Survey, n = 12- multiple responses, "Which processes or equipment use the most electricity?"

Over half of the technical survey respondents did not use natural gas in their operations. For those who do use natural gas, it constituted less than 10% of operations' production costs. Those who did use natural gas used the fuel in a number of ways. There did not appear to be a strong trend in terms of natural gas usage, indicating that the purpose of natural gas varies with the operation. Responses included boilers, space heating, sterilization, and tank heating. For a full list of responses, see Table 4.6.

Table 4.5. Self-Reported Estimates of Electric End Use among Vineyard and Winery Operators

End Use	Number of Mentions	Range of Consumption Estimates	Average Consumption Estimate	Secondary Research Estimates
Water pumping and irrigation	11	10-90%	46%	Not Mentioned
Refrigeration or cooling	8	30-80%	48%	37%
Lighting	6	5-25%	13%	19%
Bottling	3	5-10%	8%	Not Mentioned
Shop equipment	3	10-20%	13%	Not Mentioned
Compressors	2	5-20%	13%	9%
Frost protection	2	30-30%	30%	Not Mentioned
Other	3	20-25%	22%	N/A

Source: Technical Field Survey, n = 12- multiple responses, "Which processes or equipment use the most electricity?"

Table 4.6. Self-Reported Estimates of Natural Gas End Use among Vineyard and Winery Operators

End Use	Number of Mentions	Average Percent of Natural Gas Use, When Mentioned
No Natural Gas	7	N/A
Boilers	2	100%
Space heating	1	40%
Sterilization	1	60%
Heating tanks	1	90%
Restaurant purposes (water heating)	1	10%
Irrigation	1	90%
Homes	1	10%

Source: Technical Field Survey, n = 12 – multiple responses, "Which processes or equipment use the most natural gas?"

4.5.2 Energy Management

California wineries have adopted numerous energy management practices to increase efficiencies and reduce the energy intensity of winemaking. To reduce energy use during harvest, producers are embracing more mechanization, and are harvesting at night to improve wine grape quality and reduce the need for cooling. To date, there is no documentation to establish an industry-wide comparison for efficiency improvements achieved.

Of the 13 technical phone interview respondents, ten used metrics or performance measures to gauge energy costs in their operations. All but one of these respondents used kilowatt-hours (kWh) or British thermal units (Btu) per unit of production to gauge performance, and some of these respondents have been using these metrics since the 1970s-1980s due to corporate requirements. Nine of the 12 respondents who agreed to follow-up interviews used metrics that they had developed internally, primarily with the help of facilities managers and/or chief financial officers (CFOs). The prevalence of internally developed metrics among respondents suggests that vineyard and winery operators are conscious of and knowledgeable about their energy usage. Utilities may therefore be able to approach this segment on a more technical level than they would with other producers.

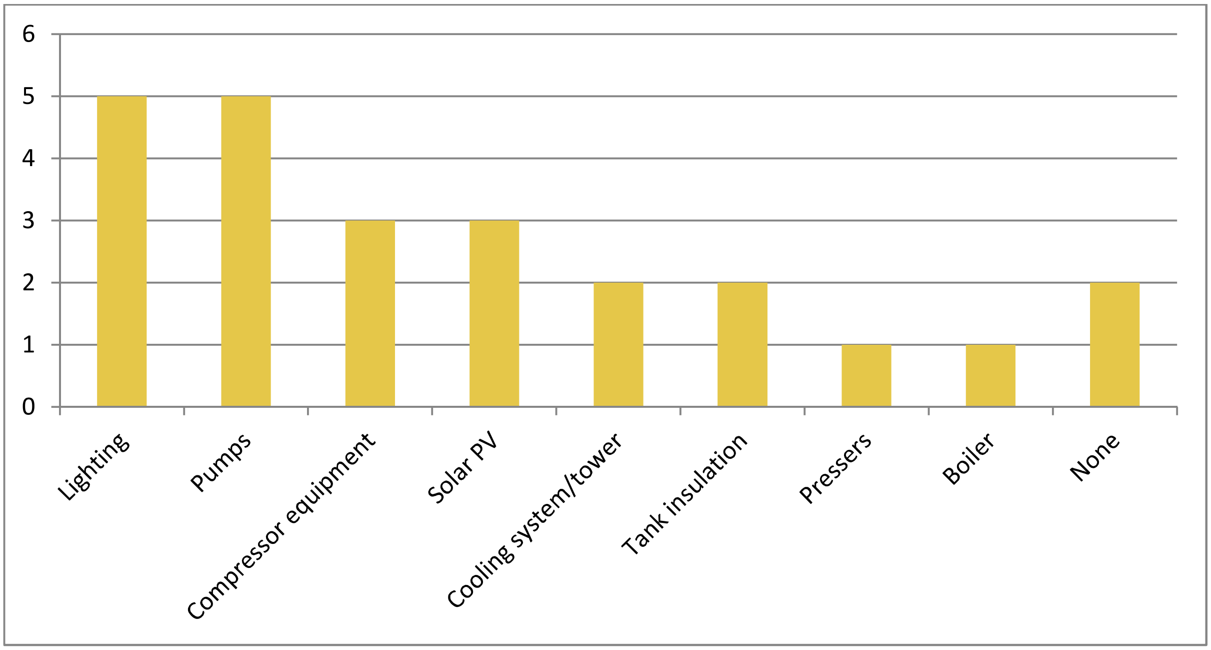
All but two of the technical field interview respondents had installed at least one measure to save energy. The majority of these included lighting measures and pumps, although some respondents also mentioned compressor equipment and solar photovoltaics (PV) (see Figure 4.15). Most respondents had installed these measures within the last five years to achieve a cost reduction. Respondents installed these measures with expected energy savings between 10 and 30%, most of which had been achieved. In addition to technology installations, respondents incorporated a number of system changes to their operations, as shown in Table 4.7. When asked what the barriers were to implementing further energy-saving measures, all respondents cited financial issues as their primary concern. Respondents also mentioned lack of awareness, maintenance, and safety concerns.

Table 4.7. Systemic or Procedural Changes for Vineyard and Winery Energy Efficiency

System/Procedure	Number of Mentions
Green committee	2
Irrigation controller	1
Motor sensors	1
Energy management system	1
Cooling tower controller	1
Tank temperature controls	1
Track Utility Bills	1

Source: Technical Field Survey, n = 7 – multiple responses, “What systems/procedures do you use to manage energy costs?”

Figure 4.15. Energy-Efficient Equipment Installations



Source: Technical Survey, n = 12 – multiple responses, "What equipment or devices have you installed to reduce energy use?"

4.5.3 Equipment Installations and Utility Involvement

The California IOUs currently offer programs devoted to energy efficiency in the Vineyard and Winery market segment. For instance, the PG&E Wine Industry Efficiency Solutions (WIES) program has identified the following technologies to qualify for the rebate program: wine tank insulation, strip curtains, fluorescent lights, occupancy sensors, steam or water process boilers, pipe insulation for boiler systems, attic and roof insulation, wall insulation, and commercial and industrial steam traps.[23] Additional customized retrofit measures include energy-efficient motors, VFD cooling and heating circulation pumps, glycol pumps, air handler and condenser fans, controls floating head pressure and suction pressure, aerators for wastewater ponds, dissolved oxygen, sensors for wastewater ponds, air compressor upgrades and replacements, and glycol pipe insulation.

PG&E's WIES program offers a comprehensive menu of energy management services to medium-size and small wineries. These services include pricing plans, energy audits, energy efficiency rebates, new construction, retrofit, retro-commissioning, agricultural pump testing and repair, demand response, solar and other self-generation rebates, education and training, and the Climate Smart Program. Program offerings for the 2010-2012 program cycle include financial incentives for on-site audits.[24] This program no longer offers wine tank insulation to the detriment of many small and medium-size wineries

[23] PG&E, Clem Lee, 2011.

[24] PG&E WIES program information available here: http://www.pge.com/includes/docs/pdfs/mybusiness/energysavingsrebates/incentivesbyindustry/agriculture/AgFood-EM_Wineries_Fact_Sheet.pdf.

that have yet to insulate storage tanks. The lack of insulation may have direct energy implications in the performance of the refrigeration system load.

In addition to these services, PG&E has identified specific energy efficiency rebates and incentives for the purchase of variable frequency drives, qualified higher-efficiency motors, wine tank insulation, high-bay lighting, refrigeration, and compressed air system controls. A 2009 program evaluation by The Cadmus Group reported 3,739 megawatt-hours (MWh) of electricity savings and 105,660 therms of natural gas savings.[25] The Cadmus Group's recent evaluation of PG&E's wine industry program shows that since 2006, some 150 wineries have received energy efficiency rebates. Over 85 wineries have installed PV solar power generating renewable energy. Wineries participated almost 60% of the time upgrading motor and pumping systems, including wastewater facilities. Tank insulation is the second largest with 16% of the electric-powered measures available for IOU rebates. The use of control systems reaches 7%, with the rest distributed among variable frequency drives, lights and sensors, compressed air, and chiller refrigeration. Chiller and refrigeration systems have a low 2% participation in the 2010 review.[26]

In the mid-2000s, the California Energy Commission's (CEC's) Public Interest Energy Research (PIER) program conducted a field demonstration project showcasing the use of electrodialysis for wine processing. Since then, the use of ion exchange membrane technology for both tartrate stabilization and pH adjustment became a viable private-sector business offering. Winesecrets demonstrated an energy-efficient tartrate stabilization system without refrigeration that resulted in energy savings of 139,200 kWh per year for a 600 gallon per hour unit operating 4,000 hours. At the time of the evaluation, these savings represented $13,200 saved per year.[27] There is no evidence that this technology is eligible to participate in the PG&E winery program. Table 4.8 provides detail on the rebates currently offered to vineyards and wineries by PG&E and SDG&E. The Navigant research team found no SCE or SCG programs targeting this segment.

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[25] Cadmus, 2009, Process Evaluation of PG&E's Agricultural and Food Processing Program, July 27, 2009, Final Report, CALMAC Study ID PGE0276.01.

[26] Cadmus, 2009.

[27] California Energy Commission, Emerging Energy Technologies http://www.energy.ca.gov/process/agriculture/loan_solicitation/02_ETabstracts.PDF.

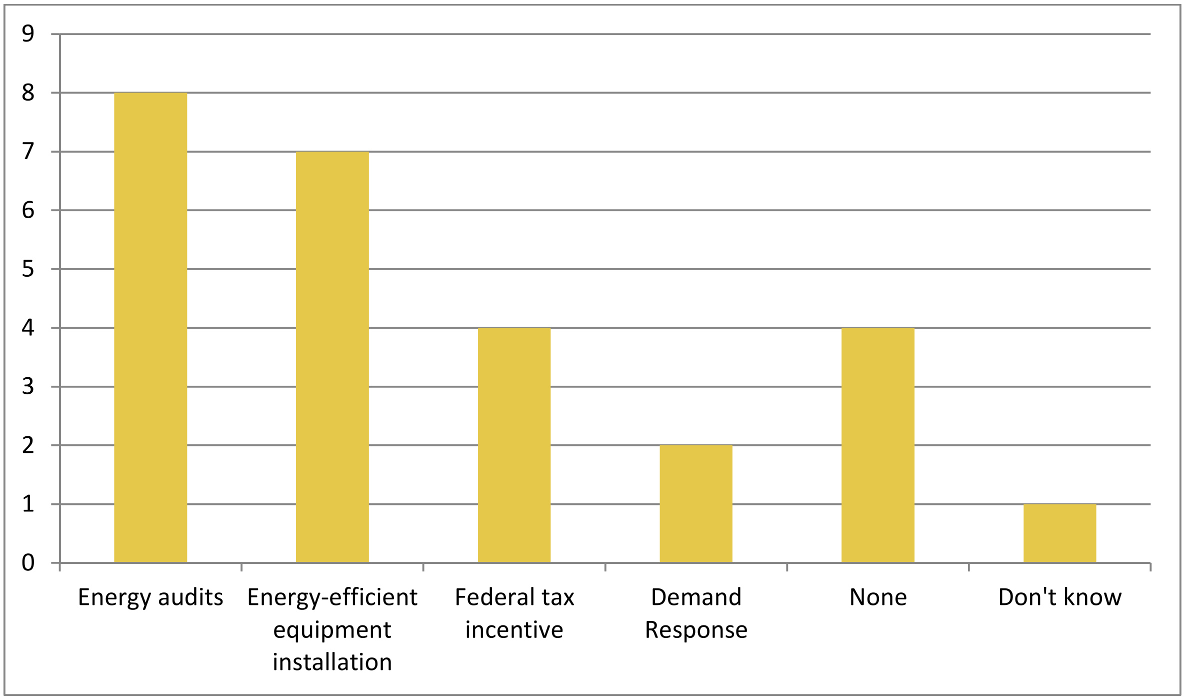
Table 4.8. Measures Offered by IOUs

Measure Name	Measure Type	Rebate Amount	IOU	Segment
Low-Pressure Sprinkler Nozzle	Electric	$1.15/nozzle	PG&E SDG&E	Vineyards
Sprinkler to Drip Irrigation	Electric	$44.00/acre	PG&E SDG&E	Vineyards
Wine Tank Insulation	Insulation	• $2.25/sq ft Indoor Tank • $3.00/sq ft Outdoor Coastal Tank • $3.75/sq ft Outdoor Inland Tank; Outdoor Coastal Valley	PG&E SDG&E	Wineries

Source: Pacific Gas & Electric, Agriculture and Food Processing Rebate Catalog, http://www.pge.com/includes/docs/pdfs/mybusiness/energysavingsrebates/rebatesincentives/agricultureandfoodprocessing_catalog.pdf

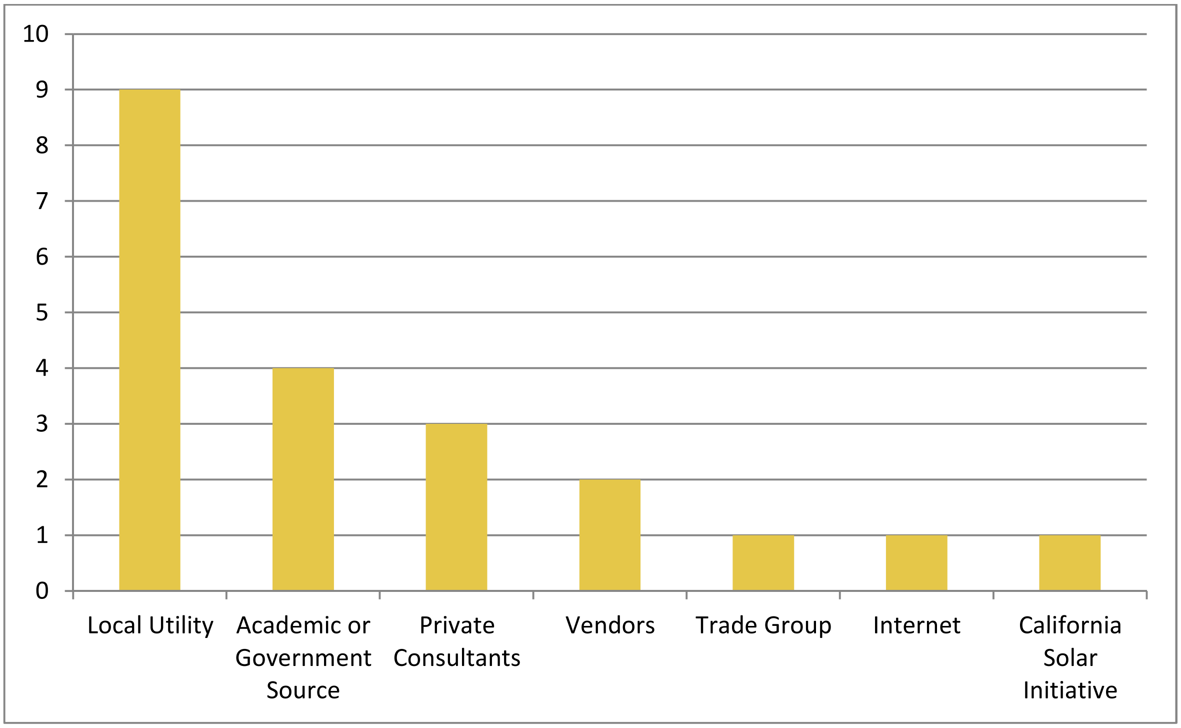
When asked about utility rebate programs, approximately half of the technical phone survey respondents claimed to have accepted incentives from their electric utility. All had conducted energy audits, and most had installed equipment (see Figure 4.16). Many of the respondents interact regularly with their utility, and nine of the 12 technical field interview respondents identified their local utility as a likely source for gathering information (Figure 4.17). However, only three of these respondents claimed to rely on their utility to help identify cost savings. This suggests that while producers recognize their utility as a resource, there is an opportunity for utilities to create stronger bonds with their Vineyard and Winery customers and help them to identify savings potential.

Figure 4.16. Vineyard and Winery Participation in Incentive Programs



Source: Technical Survey, n = 13 – multiple responses, "Has your operation accepted incentives or rebates from your local utility or a government agency for energy efficiency work"?

Figure 4.17. Vineyard and Winery Energy Efficiency Reference Partners



Source: Technical Field Survey, n = 12- multiple responses, "What are your three most likely sources for gathering information about reducing energy use or generating energy?"

4.6 *Vineyard and Winery Water Management*

Operators in the Vineyard and Winery industry have shown advancements in water management practices beyond those of other agricultural sectors. This is, in part, due to the unique nature of their crop; while some irrigation is necessary to grow wine grapes, the quality of the crop can improve if supplied with less water than the full potential requirement of the vineyard.[28] When employed regularly, this particular practice is called deficit irrigation and is one of many water-related best practices employed by the Vineyard and Winery industry.

4.6.1 Sensitivity of Vineyards and Wineries to Water Issues

Although producers in California's Vineyard and Winery segment are adept at water conservation, water is still a critical element of their operations. When asked how sensitive they were to interruptions in their water supply, all but one technical phone survey respondent claimed they were extremely sensitive (10/10 score). Notably, only three of 13 technical phone respondents listed water availability as a key influencer on future production, and only one respondent listed water as a major production cost. Rather, respondents most frequently mentioned labor and electricity as the greatest production costs (see Figure 4.7). While water is a critical component to the Vineyard and Winery segment, utilities often

[28] Terry L. Prichard, *Winegrape Irrigation Scheduling Using Deficit Irrigation Techniques*. UC Davis Department of Land, Air and Water Resources, Davis, CA.

subsidize water prices due to historical agreements made with water utility companies.[29] Additionally, producers are also honing their water management practices by instituting water-saving irrigation techniques. Coupled with the inherent drought tolerance of wine grape vines, these factors render water availability and cost lower concerns than they would be for other agricultural market segments. In designing agricultural programs, utilities should bear in mind the existing technological and managerial advancements of wine product operations, particularly in terms of broad, agricultural programs.

4.6.2 Water Regulations

Vineyards and wineries are subject to a number of regulations, including state and local water quality and groundwater laws. Qualitative interview respondents also noted that they were subject to discharge capping in the Central Valley, and state and regional storm-water runoff regulations. According to one subject matter expert, compliance with water regulations can be a greater challenge for small growers as opposed to larger operations. When asked how water regulations affect their operations, approximately half of the qualitative interview respondents claimed that these water regulations had a negative effect on their operations, while the other half were unsure. Reasons for concern included expensive groundwater testing and a water rights dispute that has been continuing for years. Results did suggest that operators' past actions have an effect on an operation's ability to comply with regulations today. One respondent claimed that, years ago, his local water quality board had banned any wastewater runoff. These strict regulations forced this particular grower to implement a wastewater recycling system, which is still in use today. This grower claimed that current regulations are less stringent than they had been before, so it is easier for his vineyard to comply with them since he had paid the capital cost of his system years ago.

4.6.3 Sources and Uses

Wells act as the primary access point for water for many California winegrowers.[30] Pumps typically extract water from aquifers and distribute it throughout the winery. The majority of respondents from the technical field interview surveys utilize wells as their primary water source, although three respondents also mentioned their water utility. Ten of 12 respondents used water for irrigation, while five of 12 respondents listed cleaning/washing and production/bottling, respectively (see Table 4.9). Navigant found no trend in the level of influence of the business cycle on water usage, suggesting that this level of influence depends on the individual operation. These findings suggest that water use among the Vineyard and Winery market segment is extremely variable with the producer, although irrigation remains the most water-intensive step in the production practice.

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[29] Subject matter expert interview, 2013.
[30] California Sustainable Winegrowing Alliance 2009. *California Wine Community Sustainability Report*. http://www.sustainablewinegrowing.org/2009sustainabilityreport.php.

Table 4.9. Water End Uses for Vineyards and Wineries

End Use	Number of Mentions
Irrigation	10
Cleaning or washing	5
Production or bottling	5
Frost protection	2
Landscaping	2
Cooling	1
Reconstituting	1

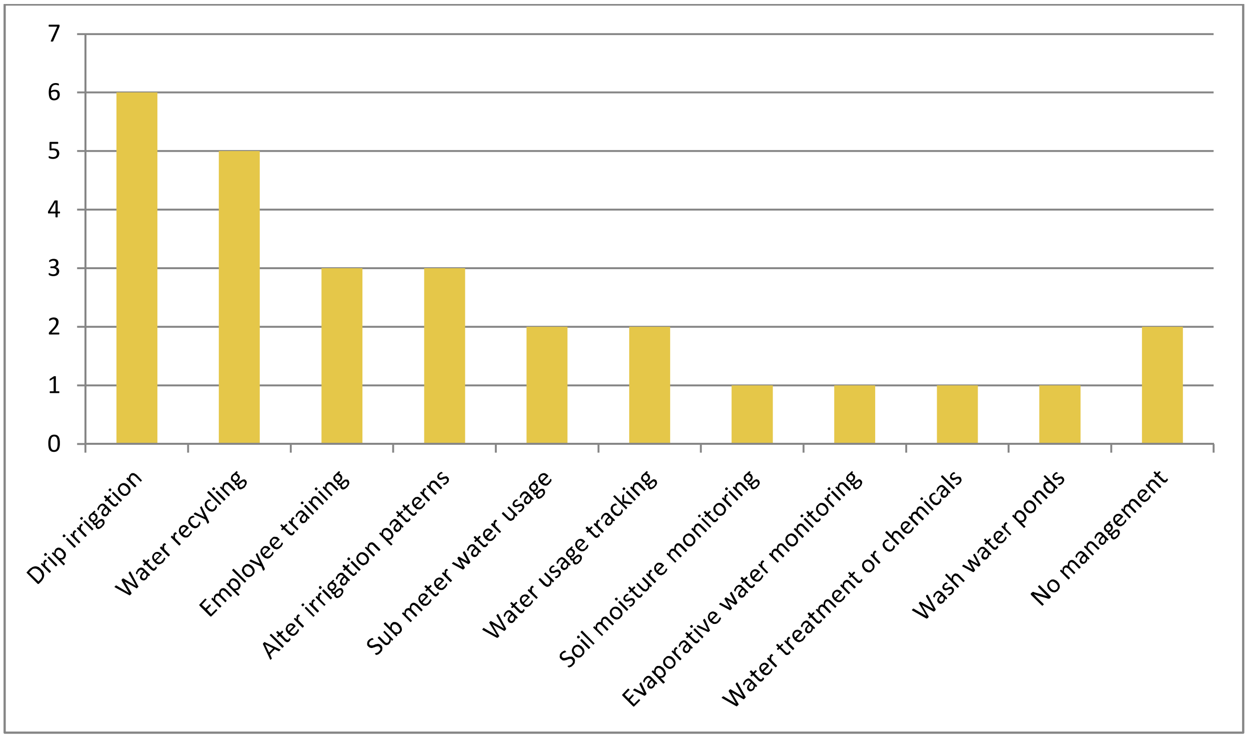
Source: Technical Field Survey, n = 12 – multiple responses, "What are the major production and process applications that require water?"

4.6.4 Management and Equipment

Water management is both critical to and common in the Vineyard and Winery market segment. Most California wine grape growers practice some form of conservation methods. The most common of these practices is drip irrigation, which not only conserves the flow of water, but also allows for precise irrigation and eliminates unnecessary evapotranspiration.[31] Indeed, ten of 12 field interview respondents employed formal water conservation methods in their operation, six of which included drip irrigation. Water recycling was also common among respondents.

[31] L. Ann Thrup, 2008. *Reducing Risks through Sustainable Winegrowing: A Grower's Guide*. California Sustainable Winegrowing Alliance, United States Department of Agriculture.

Figure 4.18. Systems and Procedures Implemented for Water Reduction by Vineyards and Wineries



Source: Technical Field Survey, n = 12- multiple responses, "What systems or procedures have you implemented to reduce water usage?"

A number of water management and conservation technologies exist for the Vineyard and Winery market segment. These can range from basic tools such as tensiometers to expansive monitoring systems. Table 4.10 includes a list of such technologies and includes tools for monitoring water conditions, as promoted by the California Sustainable Winegrowing Alliance.[32] Although many vineyards use innovative technologies to monitor water usage, the use of these tools is equally important. For instance, correct spacing of drip irrigation emitters can be as crucial to winegrape production as the amount of water that is used. In designing programs for the Vineyard and Winery segment, utilities should be sure to accompany incentives with training in the proper use of each incented technology.

[32] http://www.sustainablewinegrowing.org/docs/Risk-Management-Guide-Chap-1-Conserving-Water.pdf.

Table 4.10. Tools for Monitoring Water/Moisture Conditions in Vineyards

Tool or Method	Function Est. 2008	Purchase Price (per tool)	Comments: Pro & Con
Soil Measurement Tools			
Moisture Block	Measures soil water potential	$50 per sensor plus logging / telemetry costs	Inexpensive and may be monitored continuously. Requires good soil contact.
Tensiometer	Measures soil water potential	$200	Inexpensive technology, but requires much maintenance and is not effective in the drier soil range.
TDR, Dielectric, Sensors-Permanent	Measures soil water potential	$100-$300 per sensor plus logging/ telemetry	Some require no soil contact. May be monitored continuously. Higher sensor costs.
Dielectric (capacitance) Sensor – Portable	Measures soil water potential	$6,000	Less expensive and not regulated like neutron probe, but can be measured only occasionally
Neutron Probe	Measures soil water potential	$10,000	Large measurement volume for very good representation, but can practically be measured only occasionally
Vine Measurement Tools			
Porometer	Measures vine response to water stress – stomatal conductance	$2,500	Highly portable. Vine water status is valuable information and stomatal conductance is a measurement of the vine's response to stress. Instrument is more fragile than the pressure chamber and sample area is smaller.
Pressure Chamber	Measures leaf water potential	$2,900	Highly portable and rugged. Vine water status is valuable information, but leaf water potential can sometimes be misleading.
Other			
Automated Weather	Measures weather parameters for ETo and may be used to log and deliver soil moisture measurements	$2,500-$5,000	Evapotranspiration (ETo) may be used to assist irrigation scheduling. Other useful information is also provided and most vendors provide soil moisture connectivity. Cost is high with telemetry solutions.

Source: California Sustainable Winegrowing Alliance, 2008

4.7 Vineyard and Winery Waste Management

The crushing of wine grapes and production of wine generate both liquid and solid residues. These waste products are generally organic in nature, comprised mainly of plant residue. Common by-products include pomace and lees. Pomace is an industry term for residual grape skins, seeds, and stems. It serves as a compostable soil amendment and animal feed supplement, but can also be used in anaerobic digesters to extract biogas. Lees are the dregs of dead yeast that remain at the bottom of wine vats after fermentation. Wineries also discharge wastewater to aerated holding ponds and on land using land discharge permits from their Regional Water Quality Districts. The use of solar-powered aeration pumps on wastewater discharge lagoons also emerged in the early 2000s. There is insufficient information to determine the extent to which wineries are purchasing solar pumps to replace electric power aeration pumps. A few very large wineries discharge wastewater to local wastewater treatment facilities.

All but two of the 12 technical field survey respondents compost their organic waste. A few respondents reported to have installed waste management equipment in the last two years, consisting mainly of recycling bins, new filtering systems, palette grinders, decanters, and a wastewater pond. Although this waste could be used for energy generation, none of the respondents used the waste in this manner.

The waste that is not an organic by-product can include paper, plastic, metal, glass, and wood. While some of these materials are recycled, there is much room for improvement. For instance, only 50% of paper disposed at wineries is recycled, only 4% of wood waste is recycled, and an even smaller amount of glass is recycled.[33] When targeting waste reduction in the Vineyards and Wineries segment, conventional recycling would be the most viable starting point.

The qualitative interview results found little to no effect of business cycles on waste management costs. Statewide regulations were the only waste disposal requirements that respondents identified. These included solid and hazardous waste regulations, and, to some extent, pesticide and chemigation laws. Slightly more than half the respondents claimed that these waste disposal laws had a somewhat negative effect on their operations, while the other half were neutral to the subject. These findings suggest that waste management is a lower priority issue as compared to energy management and labor costs. There would be little opportunity for utilities to impact waste reduction or reuse.

4.8 Vineyard and Winery Conclusions and Recommendations

Conclusion 1: While California's large and small producers are thriving, its medium-size growers are suffering due to unfavorable distribution infrastructure. Because of this, large companies are acquiring the mid-size operations, thus further reducing competition in California's wine economy.

Recommendation 1: Utilities should focus their efforts on both large and small producers, and program design should account for their differences in operational energy use. Mid-size producers should be a secondary concern as their market share is continually decreasing.

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[33] California Sustainable Winegrowing Alliance, 2009. *Sustainability Report*. http://www.sustainablewinegrowing.org/docs/cswa_2009_report_chapter_12.pdf.

Conclusion 2: Many wine growers in California are already engaging in energy management practices. Growers are increasingly mechanizing their irrigation processes, primarily by means of drip irrigation. As this trend continues, electrical load will likely increase into the future.

Recommendation 2: Utilities should engage wine grape growers as they begin to mechanize. This will allow utilities to influence equipment-purchasing decisions at an early stage of this trend. Utilities should first identify the most efficient irrigation technologies to promote within the industry.

Conclusion 3: Winegrowers are active in their energy management, and are generally open to new, energy-saving equipment. However, the primary barriers that prevent winegrowers from implementing energy-saving measures are financial in nature. Lack of awareness is also a key obstacle.

Recommendation 3: Utilities should be more proactive in educating the wine industry in energy-efficient equipment options. Because financial constraints are the most significant barrier to energy efficiency, utilities are in a prime position to influence energy savings in the Vineyards and Wineries segment.

Conclusion 4: Industry alliances exist for both larger and smaller operations. Many of these groups promote sustainability among winegrowers; however, the practices that these organizations promote may differ from organization to organization.

Recommendation 4: Utilities should work with industry associations at all levels to promote energy efficiency. They should also ensure that marketing and educational materials are consistent across the segment.

5 Dairies

5.1 Key Findings and Recommendations

Future demand for milk products will likely remain stable. As a result, factors such as growing export markets, increasing production costs, stringent regulatory requirements, and limited price flexibility may lead to **a challenging environment for dairy operators**. **Larger operations with greater energy management sophistication will likely prosper at the expense of smaller dairies** that are unable to differentiate their offerings or achieve economies of scale.

While dairy operators recognize their local utilities as sources of energy-related information, **equipment vendors have a greater influence in equipment-purchasing decisions**. Further, the reference partners for this segment do not emphasize energy in their communications to or about this segment.

Even dairy operators with energy management metrics still see first cost as a barrier to energy efficiency. Moreover, animal feed and labor costs are more immediate concerns than promoting energy efficiency.

Navigant recommends that utility programs should **tailor their offerings to meet the relative sophistication of large and small dairies**. Programs to develop energy management metrics and developed staged efficiency improvements would be most appropriate for smaller operations. Programs to **leverage existing metrics for broader, integrated efficiency projects would be more appropriate for larger dairies**. Using traditional trade ally programs, utilities should emphasize the opportunity to alleviate first cost issues and maximize return on their conservation efforts. **Collaborating with reference partners to promote energy efficiency measures** within the dairy segment would improve conservation efforts and further sustainability efforts. These industry associations could in turn **promote improvements in segment sustainability to improve overall demand**.

5.2 Methodology

5.2.1 Secondary Research and Literature Review

To understand the information that currently exists on the dairy market segment, Navigant's research team began by conducting secondary research. Sources ranged from agricultural statistical surveys, such as the 2007 Census of Agriculture, to peer-reviewed publications and IOU program evaluations. Using this array of sources, Navigant conducted an extensive literature review, complete with an annotated bibliography. The findings from this research are located in the Dairies chapter in the *Literature Review for the 2010 – 2012 Statewide Agricultural Energy Efficiency Potential & Market Characterization Study.*

5.2.2 Primary Data Collection

As Table 5.1 shows, the primary sources for data collection were technical surveys (both telephone and in-person) and qualitative interviews (telephone only). In addition, the research team reviewed relevant trade association websites for energy-related content, and examined data from the USDA.

Table 5.1. Data Collection for the California Dairy Sector

Acknowledgments	Number of Completes
Subject Matter Expert Interviews	1
Technical Surveys (Telephone/On-Site)	13/10
Qualitative Interviews	6

5.2.2.1 *Subject Matter Expert Interviews*

The research team contacted the University of California Cooperative Extension Service and held a telephone interview with one of the organization's dairy advisors. This interview helped Navigant to determine current market structure and trends among dairy producers, as seen from the perspective of an organization that has served California dairies for over 50 years.

5.2.2.2 *Technical Surveys*

The research team conducted technical phone surveys with 14 individuals in the Dairy market segment. These surveys touched on topics such as operation firmographics, energy management and practices, waste and water issues, and business cycles. Each operator responded to an initial phone survey that covered these topics at a high level. If a respondent agreed to participate in a follow-up, in-person survey at their farm, a member of the research team gave a subsequent survey. For the follow-up discussions, a member of the research team gave each respondent one of three surveys, based on their sophistication of energy metrics and history of energy-efficient measure implementation. These interviews included a General Technical Survey, an Intermediate Technical Survey, and a Detailed Technical Survey. Ten of the 14 telephone respondents agreed to a subsequent technical survey.

Figure 5.1. Map of Dairy Technical Survey Respondent Locations

Source: Navigant analysis

5.2.2.3 *Qualitative Interviews*

The research team conducted six qualitative interviews via telephone. The qualitative interviews were designed to complement the technical information, examining agricultural energy usage and efficiently potential. The qualitative interviews focused on market expectations, behaviors and practices, and potential barriers and opportunities related to increased efficiency.

5.2.2.4 *Firmographics*

The majority of California dairies are located in the Central Valley, with 71% of state production occurring in the counties of Tulare, Merced, Kings, Stanislaus, and Kern. Some smaller, niche dairies can be found in the coastal and northern regions of California. Section 5.3.2.1 further details this geographic distribution.

To verify the findings from secondary research, the research team interviewed a number of California Dairy operators. For the technical survey respondents, the size of their dairy production operations ranged from 210 to 7,400 milking cows, with an average of 2,761 milking cows per operation. Thirteen of the 14 respondents grew silage and/or fodder for their milking cows, of which 817 average acres were reportedly irrigated.

Of the 14 technical survey respondents, 10 were owners, three were operations managers, and one was a bookkeeper. Thirteen of these respondents tracked energy costs as part of their job. The average length of time in their current roles for these respondents was 25 years. As shown in Figure 5.11, the majority of respondents participated in utility energy efficiency programs.

5.3 *Structure of Dairy Market Segment*

5.3.1 Description of Market Segment

The dairy-related processes included in this study fall under NAICS 11212, Dairy Cattle and Milk Production. This classification is a subcategory of the more general Cattle Ranching and Farming (1121), which is a part of Animal Production (112). Generally, NAICS 11212 includes establishments primarily engaged in milking dairy cattle.[34] Raising the cattle, whether for beef or for dairy replacements, technically falls under NAICS 11211, Beef Cattle Ranching and Farming. However, dairy farms rarely engage in the practice of milking cows without first raising the cows, themselves.

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[34] North American Industry Classification System, 2007, http://naics-code-lookup.findthedata.org/l/684/Dairy-Cattle-and-Milk-Production.

5.3.2 Description of Supply Chain

5.3.2.1 Dairies as Suppliers

California's milk production is mostly concentrated in five counties—Tulare (27%), Merced (14%), Kings (10%), Stanislaus (10%), and Kern (9%)—which together represent 71% of state production.[35] The top counties in the state account for the vast majority of the cow population and dairy product production as well (see Table 5.2).

Table 5.2. Dairy Cows and Dairy Product Production in California (Top Counties)[36]

County	Farms with Dairy Cows	Cows	Commodity Value of Dairy Products (in $1,000)
California Total	**2,165**	**1,840,730**	**$6,569,172**
Top Counties Total	1,349	1,562,018	$5,609,219
Tulare	289	474,497	$1,685,257
Merced	280	273,242	$969,019
Stanislaus	268	191,729	$690,029
Kings	140	163,600	$551,827
Kern	52	124,756	$464,985
San Joaquin	132	109,336	$407,432
Fresno	93	114,768	$436,486
San Bernardino	95	110,090	$404,184
Top Counties as Percentage of Total	**62%**	**85%**	**85%**

Source: NASS 2007 Census, 2009

Large and small dairy producers sell to dairy processors, who then distribute market-ready products such as pasteurized liquid milk, cheese, and ice cream. In some cases, dairy operators act as food processors and produce these products, themselves. However, their primary source of income and consumption of energy is devoted to the care and milking of their cows, thus rendering them dairy cow operations rather than food processors.

For all sales of fluid milk, the California Department of Food and Agriculture (CDFA) sets the minimum price, which diary operators can then change. As stated on the CDFA's website:

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[35] California Agricultural Production Statistics, California Agricultural Statistical Review, 1. Available: http://www.cdfa.ca.gov/statistics/.

[36] NASS 2007 Census, 2009.

The Dairy Marketing and Milk Pooling Branch are involved with the economic and fiscal regulation and oversight of the dairy industry. Activities and responsibilities of the ***Dairy Marketing Branch*** *include oversight of the production and marketing of milk and dairy products, which includes the regulation of minimum milk farm prices and dairy trade practices in the marketplace. Activities and responsibilities of the* ***Milk Pooling Branch*** *include the administration of the Milk Pooling Act, which provides standards for distributing monthly statewide market milk revenues to all California dairy producers.*[37]

In this role, CDFA determines dairy revenue. In years of depressed prices, such as 2012, dairies have limited opportunity to reinvest profits into the health of their livestock or their equipment. Both technical survey and subject matter expert interview respondents commented that this regulation was the most limiting factor in their ability to do business. Utilities should therefore be aware that regulated milk prices may have a substantial impact on the success of their programs, and that they should be particularly active in promoting programs during years of stimulated segment economy.

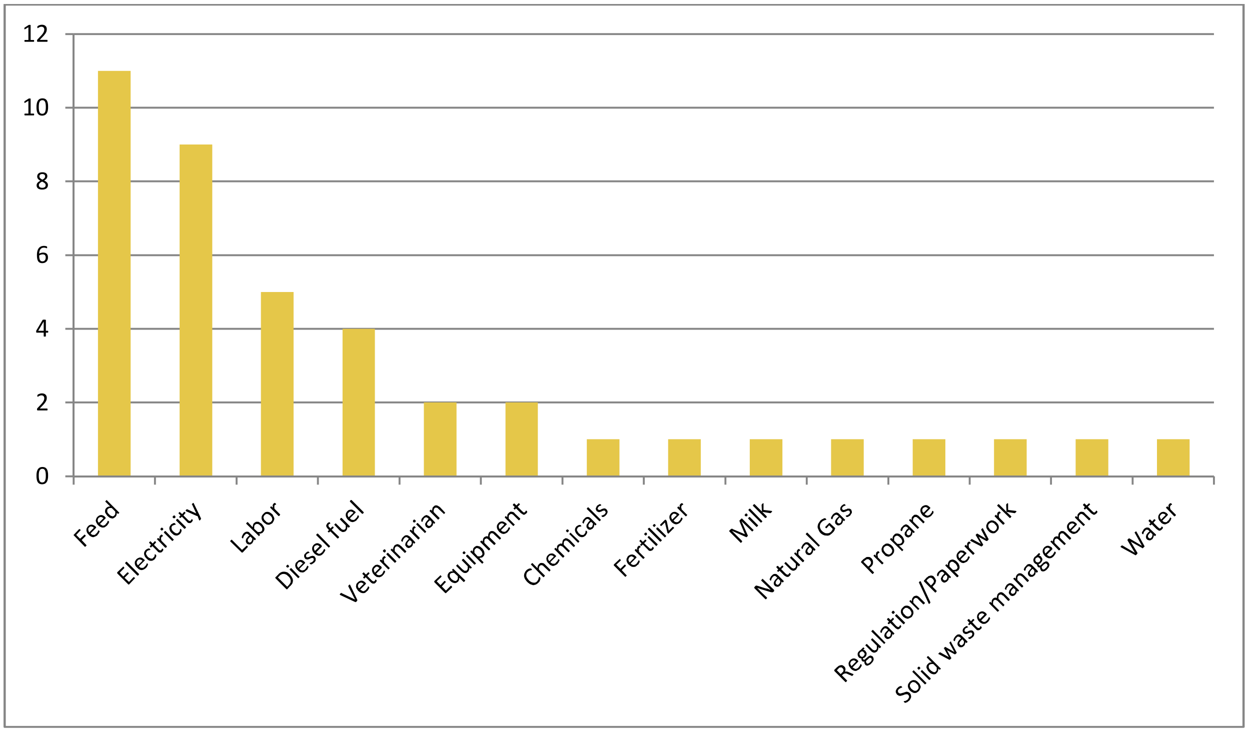
5.3.2.2 Dairies as Customers

Dairies purchase a variety of goods and services for their operations, ranging from new milking cows to veterinary services, and energy in the form of electricity, natural gas, propane, and gasoline. The supply chain to dairy operations can include local distributors of national and international products, as well as service providers in close proximity to their farms. Commonly these distributors and service providers serve as trusted advisors dairy operators, making them ideal trade allies for utility programs.

In both the subject matter and technical surveys, respondents indicated feed as one of their highest cost components. Figure 5.2 shows the range of cost components mentioned by technical survey respondents. As shown, electricity is the second most frequently mentioned cost, followed by labor.

[37] http://www.cdfa.ca.gov/dairy/index.html accessed December 20, 2012.

Figure 5.2. Greatest Costs for Dairy Operators



Source: Technical Phone Survey, n = 14– multiple responses, "What are your three highest costs?"

While Figure 5.2 does show electricity as the second most mentioned high-cost component by technical survey respondents, the subject matter expert did not mention it as a significant cost, and four of the six qualitative interview respondents stated that electricity constituted less than 5% of total operational costs. These different perceptions are likely the result of the technical survey respondents including the consumption of electricity to pump water irrigation, while the subject matter expert and qualitative interviewees appear only to focus on dairy-specific operations (e.g., milking, refrigeration, and motorized transportation). In the latter context, feed and labor would remain the highest cost components, with electricity constituting a minor element.

Natural gas, by contrast, does not share this mixed perception. All qualitative interview respondents stated that this input constituted less than 5% of their operational costs, and the subject matter expert made no mention of natural gas as cost of concern. Only one technical survey respondent identified natural gas as a high cost, indicating that natural gas should not be a main focal point of programs targeting dairies.

5.3.3 Description of Market Actors

Four major dairy cooperatives control the majority of California's milk production. These include California Dairies, Inc., Land O'Lakes, Dairy Farmers of America, and Humboldt Creamery, which was formerly independent but is now part of Foster Farms Dairy. In 2004, these producers represented over

80% of fluid milk production in California.[38] Of these cooperatives, only California Dairies, Inc., has its headquarters in state, while the others are national organizations.

California boasts a number of reputable lobbying groups and trade organizations for the Dairy segment. The subject matter expert identified the California Milk Advisory Board and Western United Dairymen, a lobbying organization for California dairies, as associations that held great credibility with dairy operators in the state. Western United Dairymen is a trade association for California dairy operators that focuses on a wide range of issues, with a particular emphasis on milk pricing, labor, and environmental issues. Energy does not appear to be a topic of particular urgency for this organization. The California Milk Advisory Board is an instrumentality[39] of the CDFA that conducts marketing, research, and education on behalf of the state's dairymen. While this organization does promote the sustainability of dairy farms, energy and energy efficiency are not a part of their primary messaging. With utility cooperation, however, it is possible that energy efficiency could be included in the organization's research and education offerings. Utilities would need to look further into this alliance to gauge potential developments.

5.3.4 Description of Market Reference Partners

Qualitative interview respondents identified the California Dairy Campaign, the Milk Producers Council, and Western United Dairymen as entities with great credibility among California dairy operators. In reviewing each organization's website, Navigant's research team noted that none of the groups devotes a particular section to energy efficiency or energy inputs. The California Dairy Campaign provides regular news articles, some of which have made mention to energy issues in the segment. The Milk Producers Council has a politically driven section on the Coalition Efforts to Stop Ethanol Subsidies, and Western United Dairymen devote a portion of their 'Environmental' section to methane digesters. However, there is virtually no reference to on-farm energy usage or mitigating energy consumption in dairy operations. Utilities should engage these organizations to determine whether there is room for cooperation and promotion of energy efficiency within their education offerings.

When asked what information channels they used for energy-related information, technical survey respondents consistently identified the University of California's Cooperative Extension Service and the U.S. Department of Agriculture, as shown in Figure 5.3. These services are available in every county throughout the state and offer information and advice on a range of subjects, such as animal health and niche product marketing. These services also offer technical assistance regarding dairy operations. Extension agents provide educational opportunities and may visit dairies for specific consultations.

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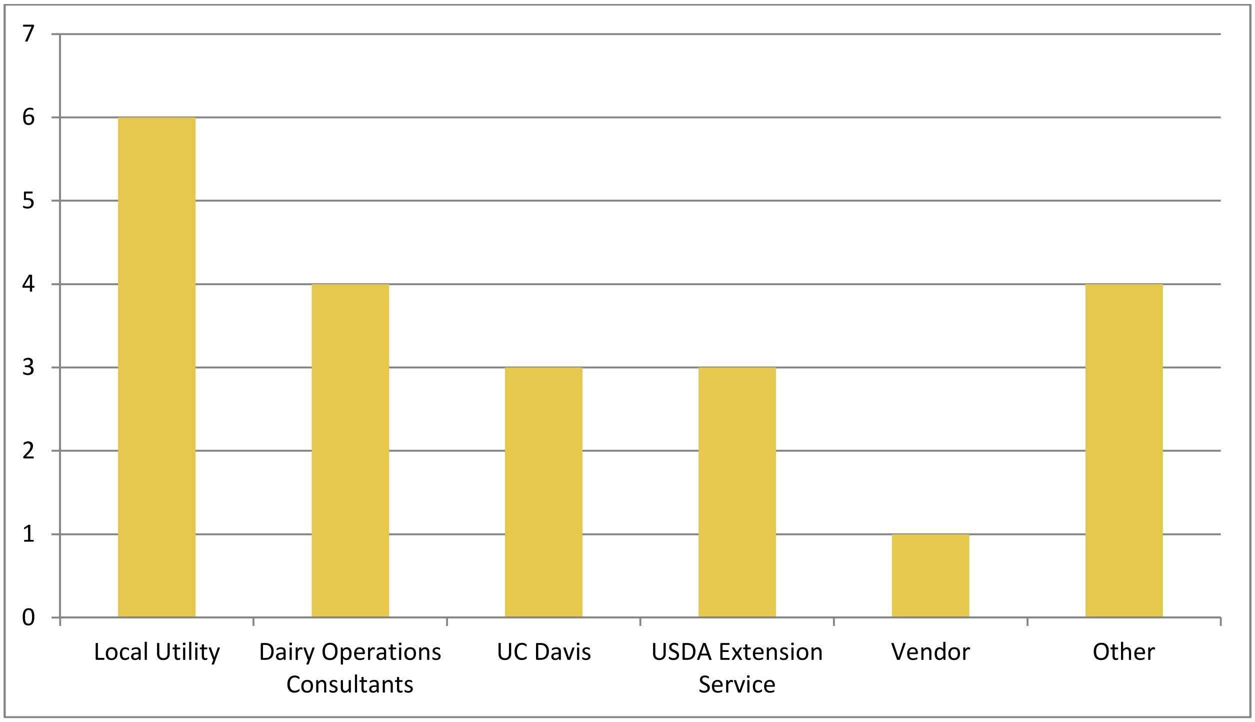
[38] California Institute for Food and Agricultural Research. 2004. *Technology Roadmap: Energy Efficiency in California's Food Industry*. California Energy Commission, PIER Energy-Related Environmental Research. CEC-500-2006-073.

[39] In this context, an instrumentality is an organization created by legislation and funded by an assessment per unit of production (e.g., gallon of milk). An instrumentality is not a state agency but a trade association with funding guaranteed by statute.

Figure 5.3. California Dairy Energy Efficiency Information Channels



Source: Technical Field Survey, n = 10 - multiple responses, "What are your three most likely sources for gathering information about reducing energy use or generating energy"

The subject matter expert also noted that consultants have become an increasingly important service provider and an exception to the general preference for local suppliers. These consultants offer a combination of operational and financial advice to farm operators of all sorts. This trend has emerged because, as the subject matter expert stated,

> *One of the necessities of doing business under regulation of this level* [State of California], *complexity, and evolution is that consultants must be hired to deal with all of the regulations. This has come to mean that consultants have become specialists in working with dairies and now do all of the sampling, prepare the reports, etc. and this is an added cost of doing business in California.*

This trend has not translated into a desire to hire energy efficiency consultants, although both the technical survey respondents and subject matter expert did acknowledge the advisory role of utility energy efficiency programs in pump testing and the introduction of new technologies. As the trend toward utilizing private consulting services continues, utilities should remain aware of incoming market actors and should work with these entities to educate dairymen about energy-saving potential. If private consultants are aware of and further encouraging energy efficiency, this may alleviate some of the utilities' outreach efforts while achieving the end goal.

5.4 *Status of Dairy Market Segment*

5.4.1 Current Trends and Issues

Dairies have long been an important part of California's agricultural economy. In the early 1990s, California surpassed Wisconsin as the largest producer of fluid milk, and has since gone on to produce about 22% of the national milk supply. This equated to approximately 40.6 billion pounds of milk in 2007.[40] California dairy production has increased over the last ten years, both in terms of number of animals and overall milk production (see Table 5.3). Technical survey respondents confirmed these trends, with eight respondents having reported stable production over the last two years, and six stating that their production had increased over that same period.

Table 5.3. California Milk Cow and Milk Production 2000-2011

Milk Cows, Milk Production and Value, 2000-2011								
	Milk Cows		Production Per Milk Cow		Production		Value	Total
Year	January 1	Annual Average	Milk	Milk Fat	Milk	Milk Fat	Per Unit	Value 1/
	1,000 Head	*1,000 Head*	*Pounds*	*Pounds*	*Million Pounds*	*Million Pounds*	*$/Cwt.*	*$1,000*
2000	1,490	1,526	21,130	778	32,245	1,187	11.50	3,704,035
2001	1,580	1,589	20,904	771	33,217	1,228	15.94	4,823,451
2002	1,620	1,648	21,277	785	35,065	1,294	10.94	3,832,501
2003	1,670	1,688	20,993	770	35,437	1,301	11.38	4,032,731
2004	1,700	1,725	21,139	776	36,465	1,338	14.73	5,371,295
2005	1,740	1,755	21,404	786	37,564	1,379	13.92	5,228,909
2006	1,770	1,780	21,815	803	38,830	1,429	11.58	4,496,514
2007	1,790	1,813	22,440	826	40,683	1,497	18.05	7,343,282
2008	1,835	1,844	22,344	822	41,203	1,516	16.82	6,930,345
2009	1,840	1,796	22,000	805	39,512	1,446	11.49	4,539,929
2010	1,760	1,754	23,025	843	40,385	1,478	14.69	5,932,557
2011	1,780	1,769	23,438	872	41,462	1,542	18.54	7,687,055

1/ Milk valued at averaged returns per 100 pounds in combined marketings of milk and cream. Includes value of milk fed to calves.

Source: California Agriculture Statistics, Crop Year 2011

The value of milk production per unit, however, has fluctuated over these years. The CDFA's Marketing Services Division regulates this fluctuation by setting prices for dairy products within the state; however, this does not always mitigate extreme fluctuations. For instance, between spring 2008 and 2009, national milk prices dropped to the point at which they were equal to or below production costs, which rose sharply in a short period of time.[41] Skyrocketing feed prices were largely to blame, and over 100 California dairies closed in 2009.[42] When asked about the variation in milk prices, both technical and qualitative interview respondents indeed pointed to the CDFA's milk pricing, which declined from 2011 to 2012 in all regions.[43] These price trends signify that per-unit revenue from dairy operations is stagnant

[40] USDA, National Agricultural Statistics Service (NASS), 2007 Census of Agriculture – California State and County Data, Volume 1, Part 5, 2009.

[41] Justin Ellerby, *Challenges and Opportunities for California's Dairy Economy*, California Center for Cooperative Development, 2010, pg. 5.

[42] Ellerby, pg. 5.

[43] http://www.cdfa.ca.gov/dairy/prices_main.html accessed on December 20, 2012.

or declining, while costs are increasing over time. This revenue "pinch" may reduce the ability of dairy to fund energy efficiency opportunities.

Across the country, the Dairy segment is trending toward vertical integration,[44] and California is no exception. Since 1987, the total number of California dairy farms has declined steadily while the milk cow population has increased.[45] Dairy cooperatives have played a major role in the segment's consolidation; as noted earlier, a small number of dairy cooperatives control the majority of both milk production and marketing, in California and across the United States. This is in part because of their exemption from anti-trust laws,[46] which enables them to serve as marketers of raw milk as well as processors and manufacturers of dairy products.[47] There is even consolidation amongst these large cooperatives; two former large California dairy cooperatives, the California Cooperative Creamery and Cal-West Dairymen, Inc., have become part of the Dairy Farmers of America (DFA) cooperative in the past decade.

From 2000 to 2007, the segment saw a growth in the number of small dairy operations. The number of larger operations remained the same, although larger dairies accounted for an increasing proportion of the state's inventory of dairy cows (see Table 5.4). Over this same period, mid-size operations declined in both number and share of dairy cow inventory. This trend will continue as small, specialty dairies emerge to service specific local markets and large operations absorb mid-size operations. Elaborating on this trend, the subject matter expert stated:

> *Something that has been going on for many years, and seems to be accelerating, is a movement toward fewer and larger herds. More of the smaller dairies are getting out of the business and selling their cows to bigger dairies that either become even larger or even multi-site dairies.*

This consolidation will likely lead to dairies that are less family farms and more family corporations or multi-family cooperatives, with professional management staff and increasingly sophisticated approaches to operations. This development may present an opportunity for utilities to impact a large portion of the market through a limited number of operations.

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[44] Lowe and Gereffi, 2009, pg. 5.

[45] USDA, 2009.

[46] James J. Miller and Don P. Blayney, *Dairy Backgrounder, LDP-M-145-01*, United States Department of Agriculture Economic Research Service, July 2006, pg. 6.
http://www.ers.usda.gov/publications/ldp/2006/07Jul/ldpm14501/ldpm14501.pdf.
The exemption is through the Capper-Volstead Act, passed in 1922, which provides specific exemptions from anti-trust laws to associations of agricultural producers. U.S. Code Title 7, Sections 291 & 292.
http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=browse_usc&docid=Cite:+7USC291.

[47] Miller and Blayney, pg. 6.

Table 5.4: California Milk Cow Operations 2000 - 2007

Milk Cow Operations and Inventory by Size Groups, 2000-2011 1/ 2/										
	1 - 49 Head		50 - 99 Head		100-199 Head		200-499 Head		500+ Head	
Year	Operations *Number*	Inventory *Percent*	Operations *Number*	Inventory *Percent*	Operations *Number*	Inventory *Percent*	Operations *Number*	Inventory *Percent*	Operations *Number*	Inventory *Percent*
2000	370	0.3	70	0.3	230	3.3	730	16.50	1,100	80.00
2001	370	0.3	80	0.3	250	2.9	700	15.00	1,100	82.00
2002	380	0.3	80	0.3	200	2.4	640	13.50	1,100	84.00
2003	390	0.3	80	0.3	210	1.9	620	12.50	1,100	85.00
2004	365	0.2	80	0.3	180	1.9	575	12.00	1,100	86.00
2005	390	0.2	80	0.3	180	1.5	550	11.00	1,100	87.00
2006	330	0.2	70	0.3	170	1.5	530	11.00	1,100	87.00
2007	490	0.1	50	0.2	110	0.8	450	7.90	1,100	91.00
2008	—	—	—	—	—	—	—	—	—	—
2009	—	—	—	—	—	—	—	—	—	—
2010	—	—	—	—	—	—	—	—	—	—
2011	—	—	—	—	—	—	—	—	—	—

1/ An operation is any place having one or more head of milk cows, excluding cows used to nurse calves, on hand at any time during the year. Percent of inventory reflect average distributions of various surveys conducted during the year.

2/ Data will only be published during the Census of Agriculture which is conducted in five-year intervals.

Source: California Agriculture Statistics, Crop Year 2011

The size of individual dairy operations is increasing at the expense of mid-sized operations, yet, the overall size of California's herds is relatively stable. The subject matter expert reported that some of California's largest dairy operators have begun to expand their operations to other states rather than increase their local production. Reasons for this include operators' perception of onerous environmental regulations in California and the idea that other states have more open markets. The expansion of these dairies to other states could limit the California-based impact of utility programs. However, so long as these operations remain in California, this would be a secondary concern for utilities.

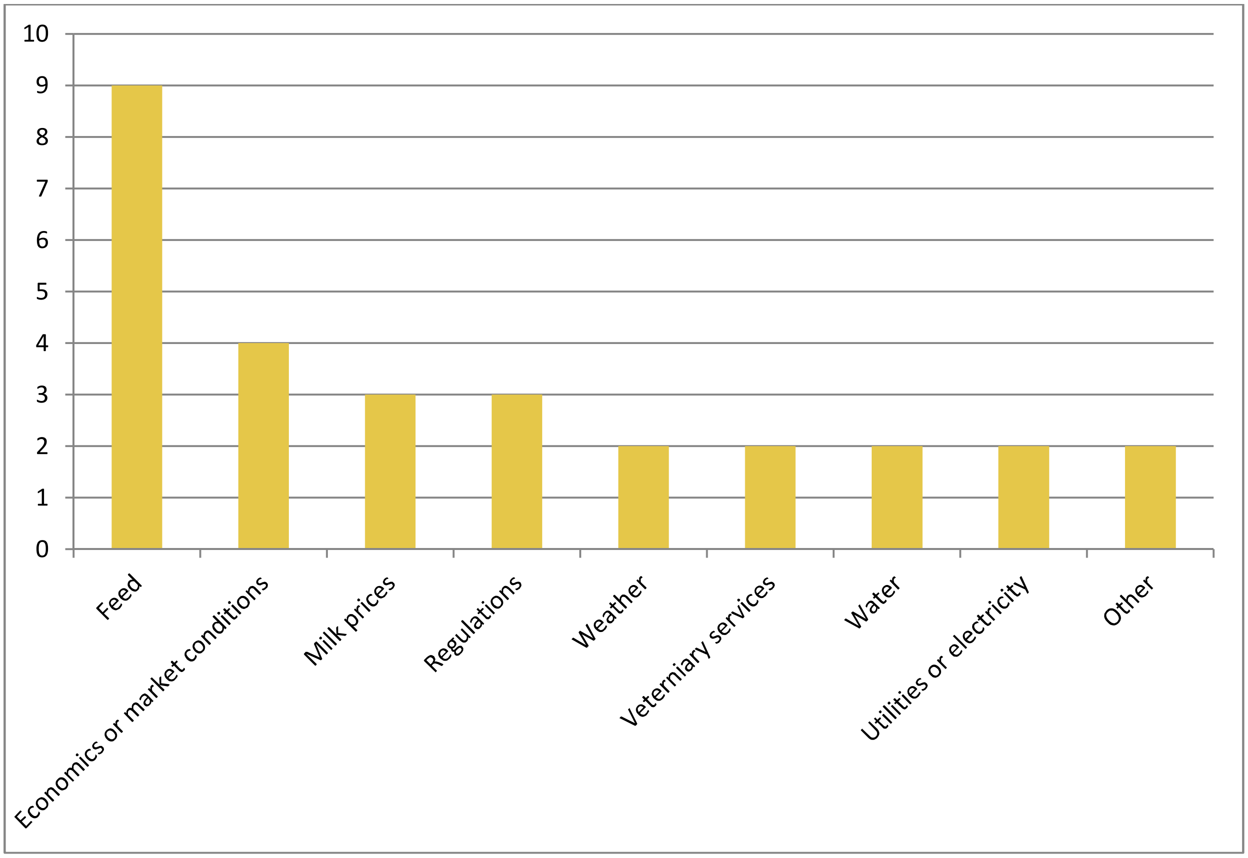
5.4.2 Future Prospects

Qualitative interview respondents suggested that they expect a future increase in demand for their service. Reasons for this belief included population increases and a growing export demand from China's emerging consumer class. Dried milk products are also increasingly in demand as ingredients in snack products.

Qualitative interview respondents also observed that, as marginal operators go out of business due to increased costs and constrained prices, the remaining dairies will be able to expand to service existing demand. As one dairyman put it, "There is a big issue now because there are two pricing systems, the California prices, which pay less to dairies, and the federal prices. Dairy farmers get paid based on what the processors costs are. If energy prices go up if, processors just pay dairies less". These respondents also mentioned that there is a movement in the Dairy segment to go organic to meet the growing demand.

Technical survey respondents also listed milk prices among their top anticipated future costs. However, for these respondents, feed was a much higher concern. Eight of 14 respondents mentioned feed as one of their top future costs, while only three mentioned milk prices. Respondents listed a number of other costs, as well, as shown in Figure 5.4. Only two respondents mentioned energy costs as a major concern, suggesting that utilities may have to compete with feed and milk prices when promoting energy efficiency in this particular market segment.

Figure 5.4. Anticipated Future Costs for Dairy Operators



Source: Technical Phone Survey, n = 14 – multiple responses, "What factors do you think will most impact your future production?"

5.5 *Energy Use and Efficiency in Dairy Segment*

5.5.1 Energy Consumption

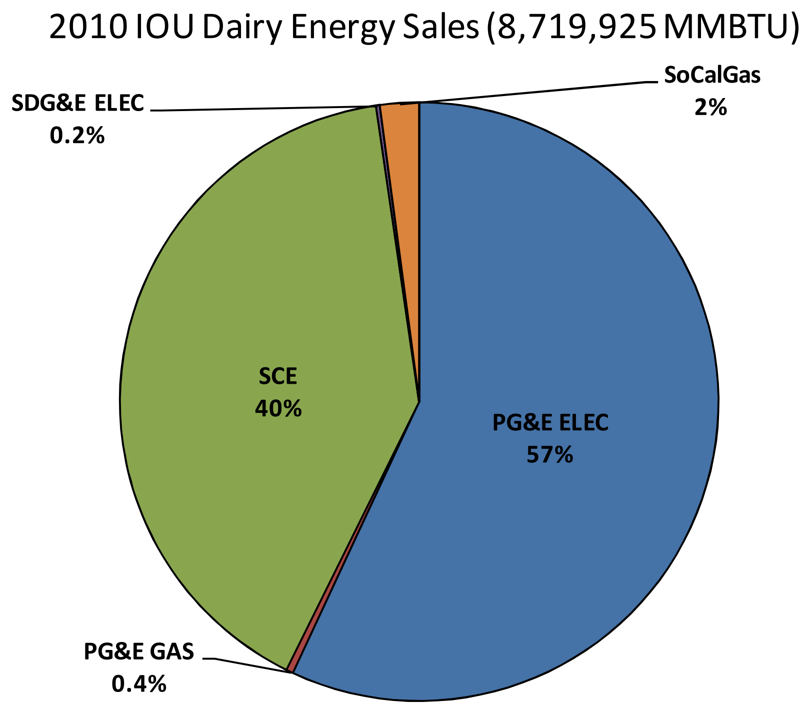
In 2010, dairy energy sales represented 11.6% of the California IOUs' total agricultural energy sales (see Table 5.5). PG&E and SCE supplied a combined total of 97% of IOU energy sales to dairy farms in that year (see Figure 5.5). When asked about on-farm energy usage, the subject matter expert stated that the energy cost "to produce milk is not huge, but because of the size of some of these operations, the bills are large."

Table 5.5. 2010 Dairy Segment Energy Sales Compared to All Agriculture Sales

Category	Total MMBTU	% of Electric MMBTU	% of Gas MMBTU	% of Total MMBTU	MMBTU by Category
Dairies	8,719,925	13.6%	1.7%	11.6%	8,719,925
All Segments	75,032,670	100%	100%	100%	75,032,670

Source: Navigant analysis of CPUC electric consumption data

Figure 5.5. 2010 Dairy Energy Sales by IOU



Source: Navigant analysis of CPUC electric consumption data

When asked about their perceptions of energy efficiency, three of the four qualitative interview respondents stated that they believed energy efficiency is "important" in the way they operated their business. However, these respondents did identify two common barriers to increasing energy efficiency for dairies: first cost and the time investment to research equipment options. This is especially true of small dairies that are just trying to stay in business with little or no additional capital for improvement. As one interviewee stated, "There are air quality issues for using diesel pumps; [we] will maybe switch to electric. Many of the programs talk about saving energy, but they do not save a lot of money. [Small dairies] are just so worried about trying to stay in business that they don't have a lot of time to look into spending more money and make any changes."

When asked what barriers prevented improvement of energy efficiency of their operations, these respondents identified improvement costs, timing, and other general business concerns as the reasons for not moving forward. As mentioned earlier, dairy operators recognize the value of energy efficiency but tend to weigh it against more immediate needs such as feeding their cows and providing veterinary services.

Technical survey respondents provided similar answers regarding electricity. Electricity was the second most frequently mentioned cost component of production and 12 of 14 telephone respondents stated that their electric costs had increased over the last two years. Only two respondents did not think electricity was a significant production cost.

5.5.2 Energy Consumption

In a recent analysis of energy consumption by IOU agricultural customers, Navigant found that dairies were the second largest segment for electrical consumption, but one of the three smallest for natural gas consumption, as shown in Figure 5.6 and Figure 5.7, respectively. A 2000 UC Cooperative Extension study[48] calculated that, in that year, dairies were using an average of 42 kWh per cow/per month, or the equivalent to over 504 kW hours per year.[49] SCE's 2004 Dairy Energy Management guide[50] offered a wider range of consumption estimates, ranging from 300 to 1,500 kWh per cow per year. PG&E audit data, published in 2006, estimated that farms used 700 to 900 kWh per cow per year.[51] These data points reveal an increase in electricity consumption per cow/per year at dairy farms from the mid-1990s to the mid-2000s. This increase could be the result of an increase in milk production per cow from 16,405 pounds per cow in 1995 to 18,204 pounds per cow in the year 2000.[52] If production continues to increase – and with it, energy consumption through the milk harvest – energy use on dairy farms could become progressively more energy intensive. As milk production gradually increases, utilities should focus their efforts on promoting energy-efficient milk harvest equipment, as this end use can make up a significant portion of dairies' energy consumption.

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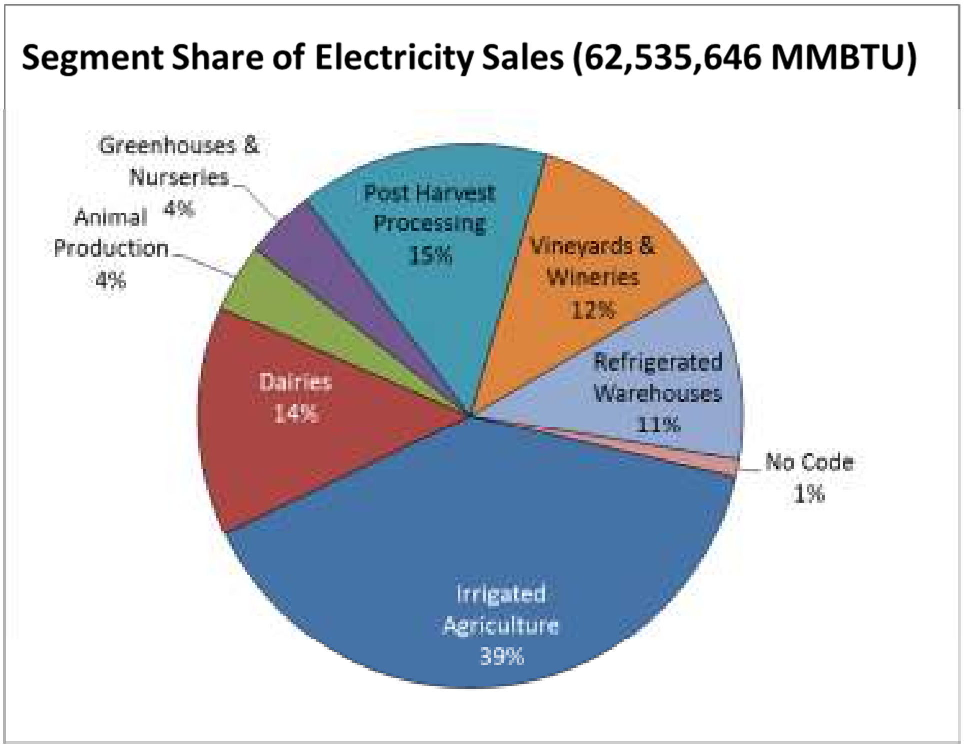
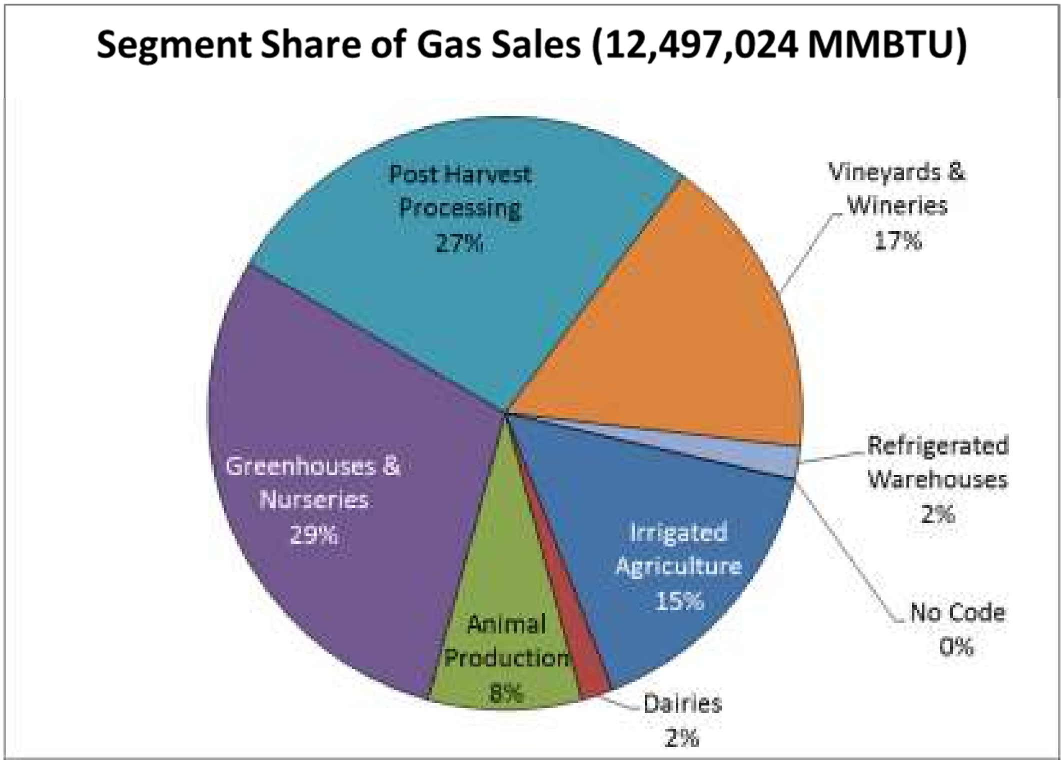
[48] C. Collar et al., *Dairy and Livestock,* California Dairy Energy Project, 2000.
[49] C. Collar et al., 2000.
[50] Southern California Edison, *Dairy Farm Energy Efficiency Guide*, http://www.sce.com/b-sb/design-services/dairy-farm-energy-efficiency-guide.htm.
[51] FX Rongere, PG&E, Tulare, November 9, 2006 presentation.
[52] USDA, 2002 Statistical Bulletin Number 978, http://www.ers.usda.gov/publications/sb978/sb978.pdf.

Figure 5.6. 2011 California Agriculture Consumption of Electricity (IOUs Only)



Source: Navigant analysis of CPUC electric consumption data

Figure 5.7: 2011 California Agricultural Natural Gas Consumption (IOUs Only)



Source: Navigant analysis of CPUC gas consumption data

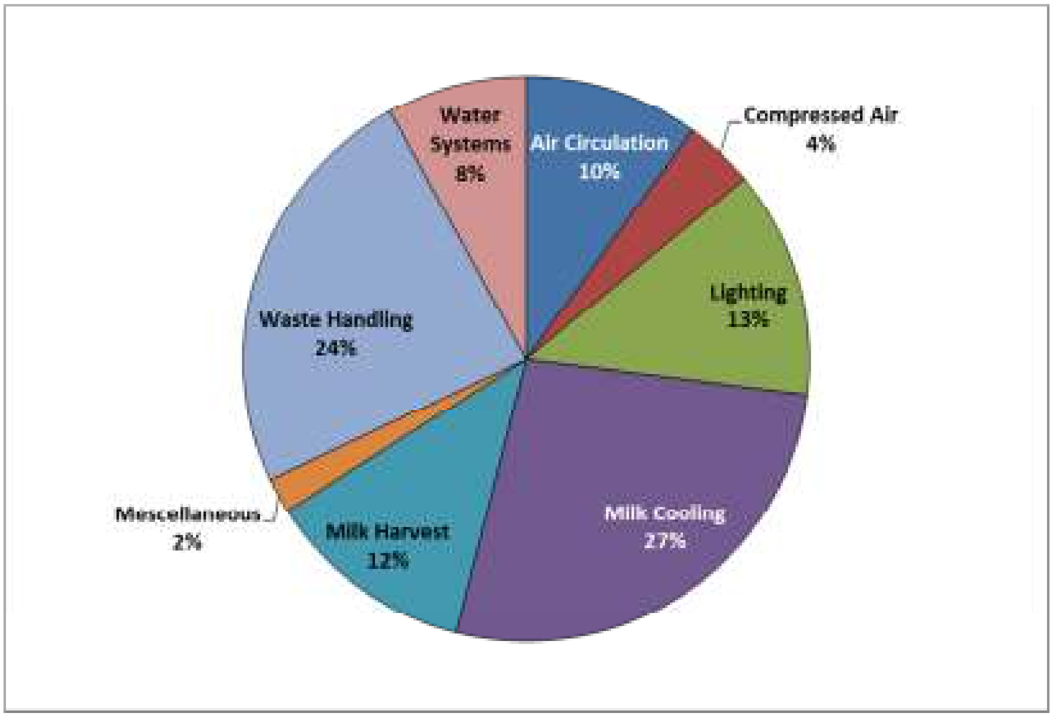
Navigant found no clear consensus as to the distribution of energy among end uses. As shown in Figure 5.8, SCE's 2004 *Dairy Farm Energy Management Guide*[53] shows milk cooling and harvest constitute two of the three most energy-intensive end uses.[54] This guide deems electricity to be the main energy source for nearly all these end uses, while dairies use gas primarily for water heating. Figure 5.9 provides an alternative allocation of electrical end uses for the Dairy segment. The relative percentage of each end use from this study differs significantly with both SCE's guide and the self-reported estimates from the in-person technical surveys shown in Table 5.6. One reason for these differences is likely the categorization schemes for each assessment. While SCE's management guide provided explanations for dairy processes,[5], there is still no standard definition for dairy end uses. Therefore, some processes identified in one study may not appear in another.

Another reason for these differences may be the scope of the dairies in review. For instance, 10 of the 14 technical survey respondents used irrigation to raise crops for fodder or silage. This application was not accounted for in the IOU study. Regardless of the individual definitions, it is clear that pumping to move water, milk or waste is a primary consumption of electricity on California dairies. As such, pump optimization, VFDs, and similar measures are the most obvious opportunities for utility efficiency programs. Refrigeration and process cooling are the next most prevalent forms of electricity

[53] Southern California Edison, *Dairy Farm Energy Efficiency Guide.*
[54] C. Collar et al., *Dairy and Livestock,* California Dairy Energy Project, 2000. http://www.energy.ca.gov/process/agriculture/ag_pubs/calif_dairy_energy.pdf .

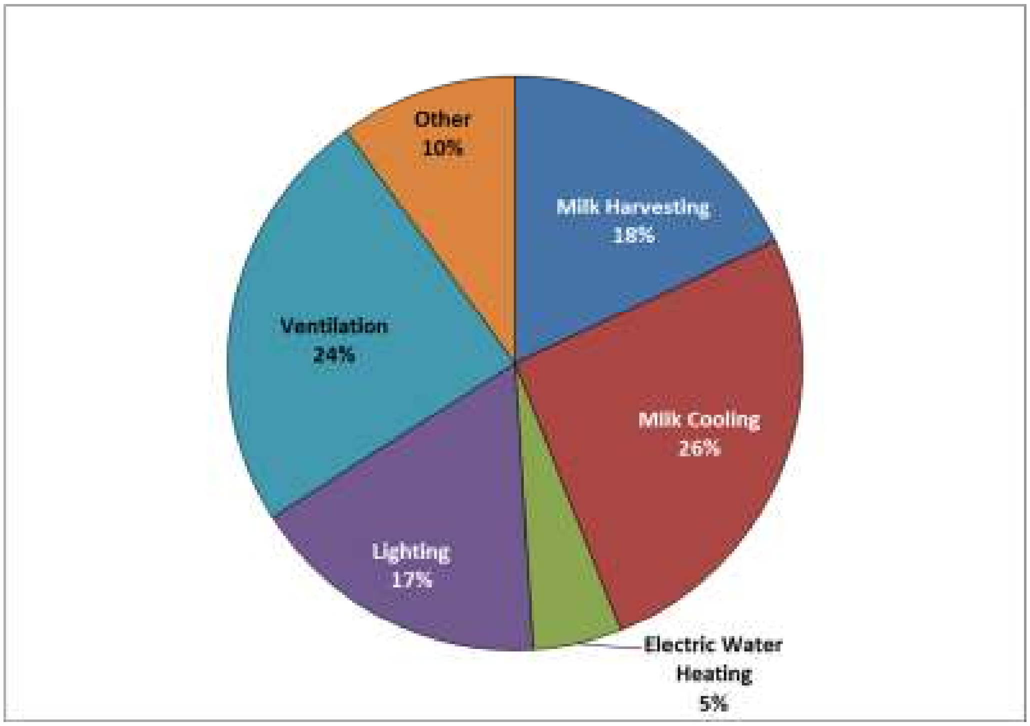
consumption, followed by air conditioning and ventilation. Dairies are not significant consumers of natural gas, as shown in Figure 5.7. Only three of the 14 telephone respondents used natural gas in their operations with water heating the only end use mentioned. Therefore, utilities should focus dairy-related programs on electricity, with natural gas as a secondary concern.

Figure 5.8. Electrical Energy Use on a Representative California Dairy Farm



Source: Southern California Edison, Dairy Farm Energy Efficiency Guide, http://www.sce.com/b-sb/design-services/dairy-farm-energy-efficiency-guide.htm

Figure 5.9: Electrical Energy Use on a Representative Dairy Farm



Source: ATTRA Dairy Farm Energy Efficiency

Table 5.6: Self-Reported Estimates of Electric End Use among California Dairy Operations

End Use	Number of Mentions	Range of Consumption Estimates	Average Consumption Estimate
Milking/Milk Pumping	8	10% - 40%	26%
Water Pumping	7	20% - 85%	53%
Refrigeration	5	7% - 80%	41%
Fans	3	5% - 20%	12%
Lighting	3	30% - 20%	11%
Solid Waste Management	2	10% - 20%	15%
Air Conditioning	1	20%	20%
Facilities Cleaning	1	5%	5%
Process Cooling	1	20%	20%

Source: Technical Field Survey, n = 10 – multiple responses per grower allowed, "Which processes or equipment use the most electricity?"

5.5.3 Energy Management

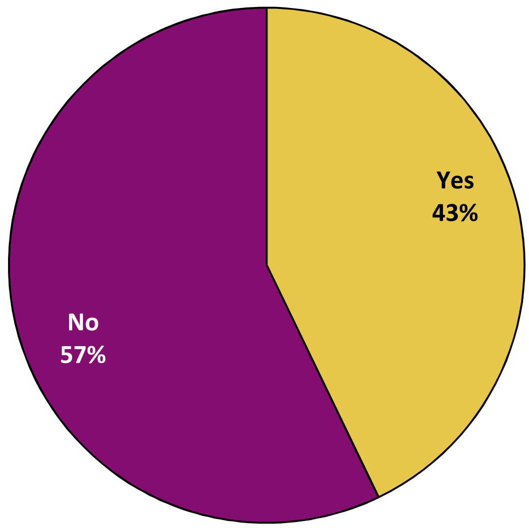
California IOUs have conducted a number of studies researching on-farm energy use and technologies available for conservation. Furthermore, IOUS have previously targeted programs toward this segment to help dairy farm customers reduce their energy consumption. Numerous efficient technologies and systems are available to mitigate energy use on dairy farms, as shown in Table 5.7. However, only six of the 14 telephone respondents to the technical survey indicated that they had metrics for managing their energy use, as shown in Figure 5.10. As mentioned previously, the establishment of these metrics correlates to the size of dairy with larger operations more likely to have such metrics.

Table 5.7. Examples of Energy Efficiency Technologies for Dairy Farms

End Use	Purpose	Efficient/Emerging Equipment	Benefits/Barriers
Refrigeration	Milk cooling	• Refrigeration heat-recovery systems • Water-cooled pre-coolers	• Recover waste heat from milk-cooling condensers, which can be used to preheat water for washing milk equipment • Improve efficiency of heat-exchangers
Pumping for vacuum pumps and milking pumps	Milk harvest	• Variable-speed drives	• May not be cost-effective for smaller farms (fewer than 8 hours of milking per day)
Ventilation	Temperature control for herd	• High-efficiency fans	• Improves direct cooling of cows
Anaerobic digesters	Waste management		• Waste management system • Energy-conversion system • Do not currently meet existing NO_x restrictions in California

Source: Madison Gas & Electric, http://www.mge.com/business/saving/BEA/_escrc_0013000000DP22YAAT-2_BEA1_CEA_CEA-10.html

Figure 5.10. Proportion of Energy Metrics among California Dairies



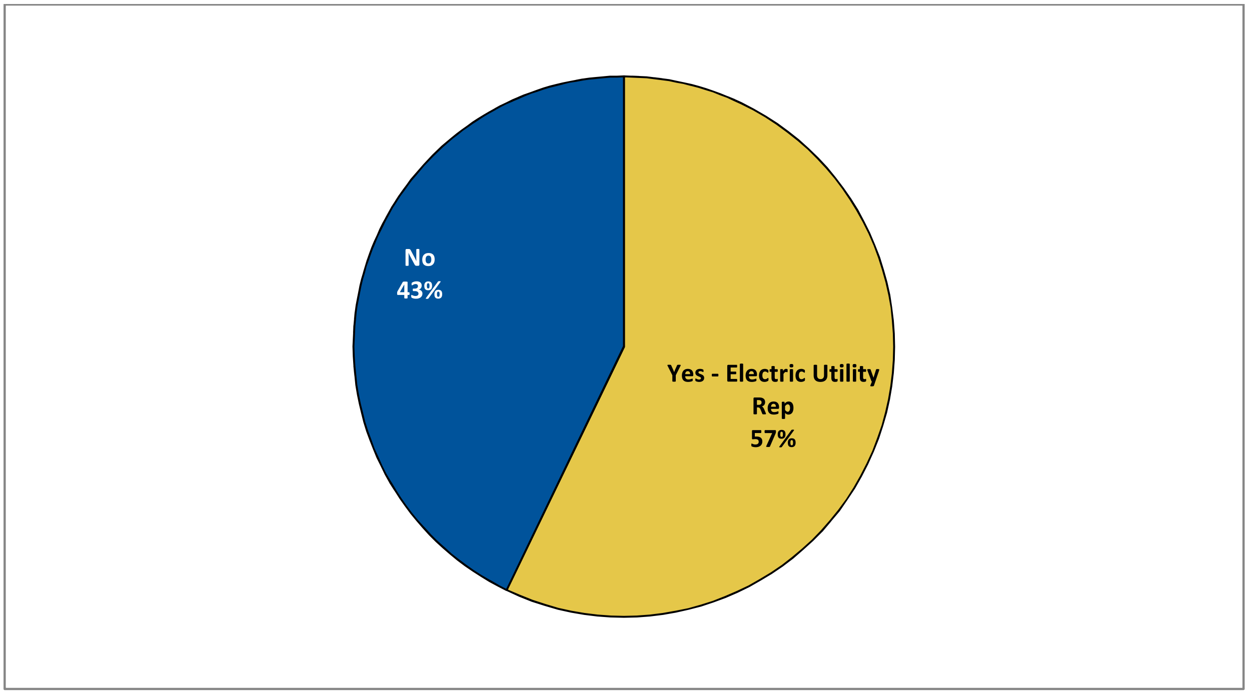
Source: Technical Survey, n = 14, "Do you have metrics or performance measures for energy costs?"

5.5.3.1 *Efficient Measures and Savings*

When asked about installed efficiency measures, the eight in-person technical survey respondents identified 17 equipment installations that took place from 2006 to 2012. Individual measures included lighting measures (seven); VFD installations (six – three of which were on pump motors); cooling systems (three); and ventilation fans (one). Respondents could recall only six of the original savings estimates ranging from 5% for ventilation fans to 25% for VFD installations. The average expected savings for these measures was 10%.

Given the high level of electricity devoted to pumping as compared to that of lighting, the prevalence of energy efficiency measures for the latter is initially counter-intuitive. However, the relatively low first cost of lighting compared to that of pumps could explain why dairy farmers have favored this equipment. On this subject, nine of the ten in-person technical survey respondents identified first cost as the primary barrier to implementing energy efficiency measures in dairies. Indeed, Figure 5.11 shows that the majority of techncial survey respondents had taken part in energy efficinecy programs offered by their electric utility. (None had taken part in natural gas programs.) This indicates that dairy farmers are open to utility assistance for achieving energy efficiency on their farms. Further financial assistance from utilities could increase farmers' willingness to install efficient pumping measures as well as lighting.

Figure 5.11. Dairy Participation in Incentive Programs



Source: Technical Phone Survey, n = 14 – multiple responses, "Has your operation accepted incentives or rebates from your local utility or a government agency for energy efficiency work?"

When asked if they had achieved the promised savings from their efficient installations, the respondents stated that they achieved the expected savings for 6 of the 17 measures. Two said that they did not achieve the savings and the remaining six did not know if they had achieved the savings at all. When asked how they knew that they had achieved these savings, the four respondents that said they had achieved savings came to this conclusion by "tracking their utility bills." Seven of the ten dairymen who installed measures, relied on simple payback over one to five years to determine return on investment. One dairyman relied on a net present value to assess return on investment. Based on these responses, it appears that dairy operators—even those with energy management metrics—have the means to assess accurately the impact of equipment installations.

When asked where they learned of the installed equipment, for seven of the 17 measures, the dairy operator relied on information from their vendor. For only four did the dairy operator rely on information from their local utility. This is a stark contrast to the responses described in Figure 5.3, in which respondents identified their local utility as a primary reference partner. This may indicate that although dairy operators rely on their utility for information, information sharing between the utility and the operators may not be as effective as possible. Based on the responses from Navigant's interviews, energy efficiency in California dairies is characterized by limited energy management metrics, first cost barriers to energy efficiency measures, a focus on simple, short-term payback, and significant influence by vendors in energy-efficient equipment-purchasing decisions. Given that utilities already have programs in place for this market segment, representatives should be more proactive in direct promotion of these programs and measures to the dairy farmers.

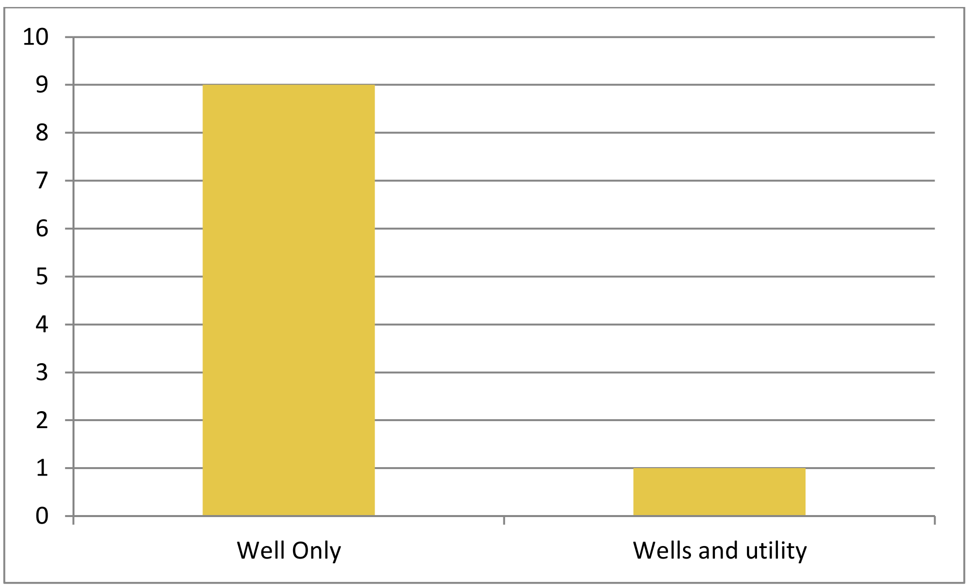
5.6 Dairy Water Management

Water is a necessary input for both the survival of dairy herds as well as milk production. In addition, California dairies rely upon irrigation to raise hay and silage to feed their herds. The technical survey respondents' sensitivities to disruptions of water and electric service were 9.6 and 8.9, respectively.[55]

5.6.1 Sources and Uses

As shown in Figure 5.12, all but one of the technical in-person survey respondents sourced their water solely from wells. Only one respondent reported sourcing water from a local utility in addition to the respondent's well. Figure 5.13 illustrates water end uses in this segment, showing that dairymen use water primarily for watering their herds; irrigating the crops used to feed their herds; and other cleaning/processing end-uses.

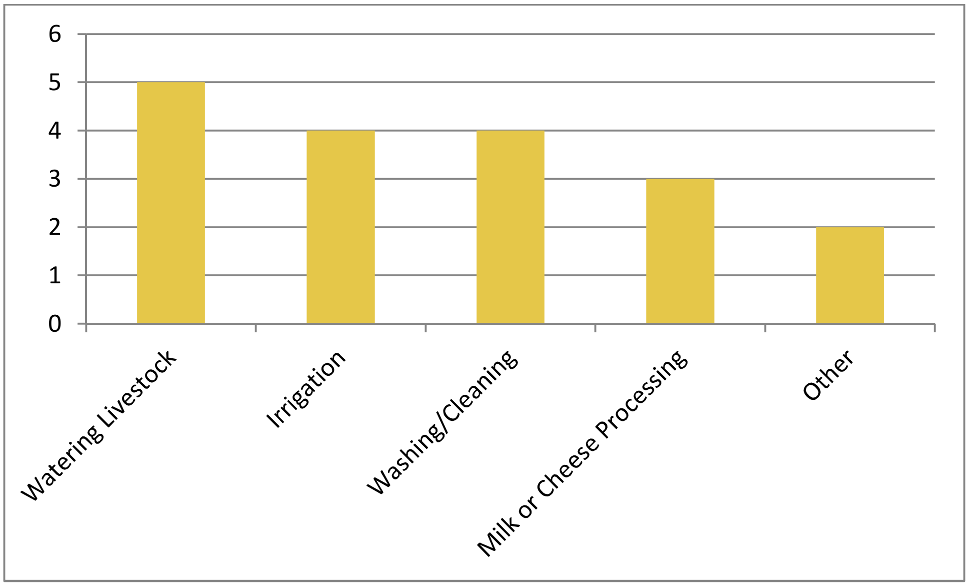
Figure 5.12. Dairy Water Sources



Source: Technical Field Survey, n = 10, "From what source do you receive your water?"

[55] On a scale of 1 to 10, how sensitive is [your operation] to interruptions in your water/electric supply?

Figure 5.13. Dairy Water Uses



Source: Technical Field Survey, n = 10 - multiple responses allowed, "What are the major production or process applications that require water in your operation?"

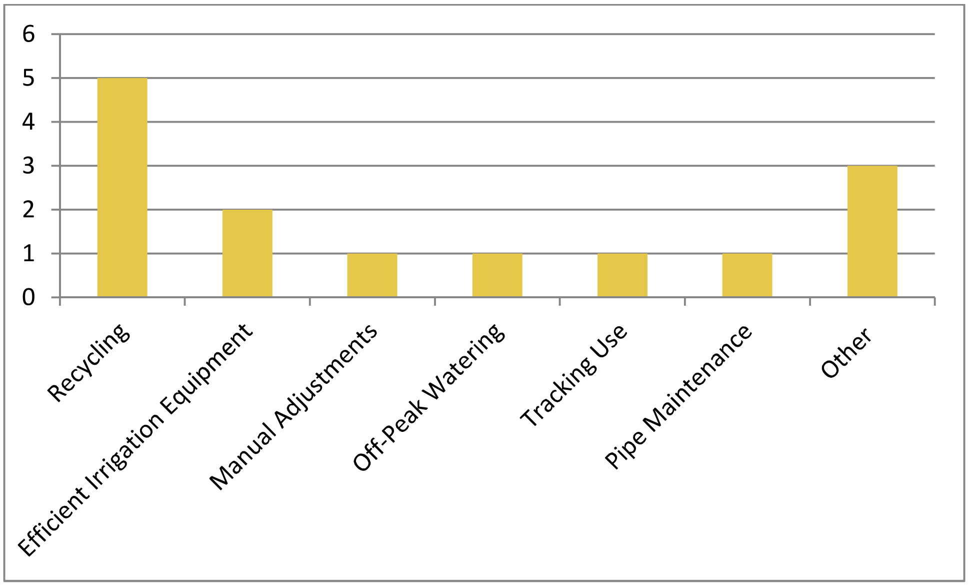
5.7 Dairy Waste Management

As perhaps the least surprising finding of this report, all ten respondents reported manure as the primary waste of their dairies. Four of the technical survey respondents stated that they used manure as a fertilizer for their production of hay for their cows. The only technologies mentioned for this use were pumps and manure separators. The remaining respondents indicated that they sold manure to organic farms or composters.

5.7.1 Management and Equipment

Dairies rely primarily on recycling to manage water use with some effort directed towards efficient irrigation equipment, as shown in Figure 5.14. Other mentions include manual adjustments to irrigation pipes and irrigation pipe maintenance. Respondents mentioned very little effort towards holistic water management for overall dairy and irrigated pasture water use.

Figure 5.14. Dairy Water Management Approaches



Source: Technical Field Survey, n = 18, multiple responses, "How do you manage water usage in your operation?"

5.8 Dairies Conclusions and Recommendations

Conclusion 1: While demand for milk products will likely remain stable or may increase due to growing export markets, increasing production costs and regulatory requirements combined with limited price flexibility will lead to a challenging environment for dairy operators. Larger operations with greater energy management sophistication will likely prosper at the expense of smaller dairies that are unable to differentiate their offerings or achieve economies of scale.

Recommendation 1: Utility programs should tailor their offerings to meet the relative sophistication of large and small dairies. Programs to develop energy management metrics and developed staged efficiency improvements would be most appropriate for smaller operations. Programs to leverage existing metrics for broader, integrated efficiency projects would be more appropriate for larger dairies.

Conclusion 2: While dairy operators recognize their local utilities as valuable sources of energy-related information, equipment vendors have a greater influence in equipment-purchasing decisions. Further, the reference partners for this segment do not emphasize energy in their communications to or about this segment.

Recommendation 2: Because of concerns regarding initial capital outlays, utilities should emphasize that their programs can help alleviate first cost issues and maximize return on their conservation efforts. This emphasis should address both the energy savings and non-energy benefits of efficient equipment. Coordination with equipment vendors and reference partners will add credibility and overall uptake of programs measures.

Conclusion 3: Even dairy operators with energy management metrics still see first cost as a barrier to energy efficiency. Given that feeding their animals and paying for labor are concerns of much greater immediacy, promoting energy efficiency measures will remain a challenge for utilities.

Recommendation 3: While some reference partners such as the California Farm Bureau and UC Davis do provide information about on-farm energy use, other organizations such as the Western United Dairymen and the California Milk Advisory Board do not. Collaborating with these organizations to promote energy efficiency measures within the dairy segment would improve conservation efforts and further sustainability efforts. These industry associations could in turn promote improvements in segment sustainability to improve overall demand.

6 Greenhouses and Nurseries

6.1 Key Findings and Recommendations

The Greenhouses and Nurseries segment is a **stable segment concentrated among a relatively small number of growers**. Grower-to-grower communication is prevalent within the segment, and **grassroots communication networks often disseminate information about new technologies**. However, a number of factors cause greenhouse and nursery operators to be wary of new technologies. Namely, lack of awareness, lack of financing, and lack of confidence in functionality can all be barriers to adopting innovative energy savings technologies.

Utility rebates and large-scale, sponsored demonstrations can help to alleviate some of these concerns. Trade associations are available and willing to educate producers in this market segment. However, because these associations have extremely limited budgets, they are often unable to devote sufficient funds to education and energy efficiency training. **Utilities should therefore partner with these trade associations to promote and demonstrate innovative technologies that could help producers to lower their energy consumption**.

California greenhouse and nursery operations tend to be **geographically clustered and closely networked**. Navigant recommends that utilities **leverage the close connections of this community to demonstrate and promote programming** that includes efficient equipment (particularly natural gas-fired equipment) as well as energy management systems. The connectivity of this segment would **facilitate the diffusion of technologies and techniques** by early adopters and segment leaders throughout the state's commercial greenhouses and nurseries.

These demonstrations would also address a **trend towards mechanization** in this segment as a response to labor costs. As these costs increase or labor simply becomes less available, the tendency to introduce machines to replace people will build electrical load. Navigant recommends that utilities use demonstration projects to **identify the most energy-efficient automation options** and work with vendors and trade allies before the greenhouses and nurseries make their investments and thereby **minimize the impact** of this trend.

6.2 Methodology

6.2.1 Secondary Research and Literature Review

To understand the existing information on the Greenhouses and Nurseries market segment, Navigant's research team began by conducting secondary research. Sources ranged from growers' guides to peer-reviewed publication, trade industry reports, and scientific research papers. Using this array of sources, Navigant conducted an extensive literature review, complete with an annotated bibliography. The findings from this research are located in the Greenhouses and Nurseries chapter in the *Literature Review for the 2010 – 2012 Statewide Agricultural Energy Efficiency Potential & Market Characterization Study.*

6.2.2 Primary Research and Data Collection

After extensive secondary research, the research team conducted primary research in order to gain a more comprehensive view of the Greenhouses and Nurseries market segment. As shown in Table 1, sources for primary data collection included technical surveys (both telephone and in-person), qualitative interviews (telephone only) and interviews with subject matter experts.

Table 6.1: Data Collection for the California Greenhouses and Nurseries Segment

	Number of Completed Interviews
Subject Matter Experts	2
Technical Surveys (Telephone/In-Person)	7/7
Qualitative Interviews	6

6.2.2.1 Subject Matter Expert Interviews

To gain a high-level understanding of the Greenhouses and Nurseries market segment, the research team interviewed two greenhouse and nursery subject matter experts at the University of California, Davis. These interviews covered topics such as market trends, challenges, and drivers within the segment, as well as market structure and energy efficiency.

6.2.2.2 Technical Surveys

The research team conducted technical phone surveys with seven individuals in the Greenhouses and Nurseries market segment. These surveys included topics such as operation firmographics, energy management and practices, waste and water issues, and business cycles. Each operator responded to an initial phone survey that covered these topics at a high level. If a respondent agreed to participate in a follow-up, in-person survey at their farm, a member of the research team would give one of three subsequent surveys based on their sophistication of energy metrics and history of energy- efficient measure implementation. These follow-ups included a General Technical Survey, an Intermediate Technical Survey, and a Detailed Technical Survey. Seven of the original seven Greenhouses and Nurseries segment telephone respondents agreed to a subsequent technical survey.

Figure 6.1. Map of Greenhouse and Nursery Technical Survey Respondent Locations

Source: Navigant analysis

6.2.2.3 *Qualitative Interviews*

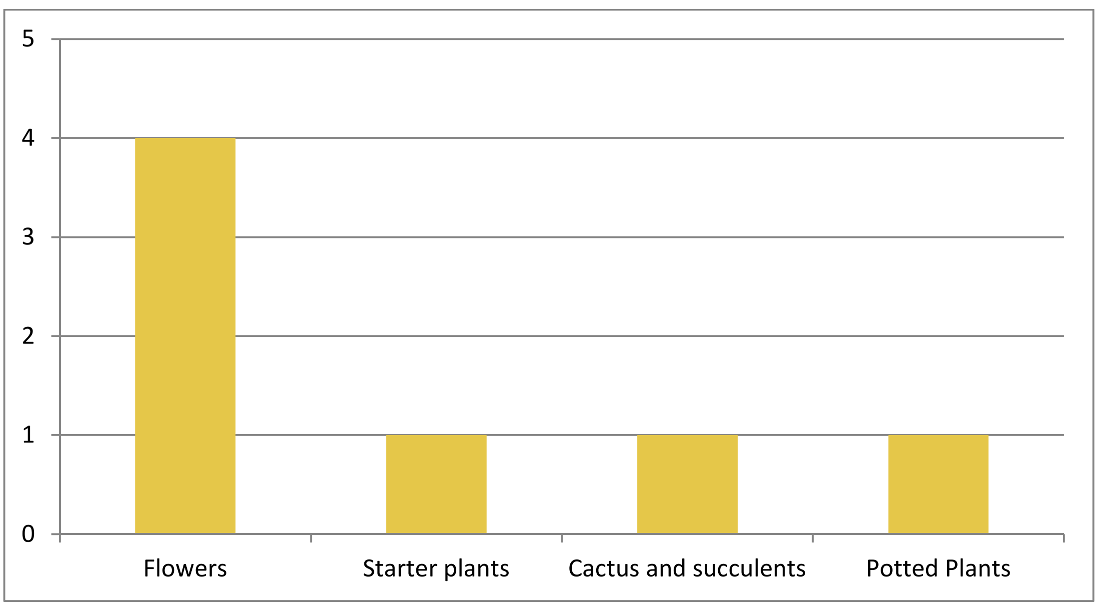
The research team conducted six qualitative interviews via telephone. The qualitative interviews were designed to complement the technical information, examining agricultural energy usage and efficiency potential. The qualitative interviews focused on market expectations, behaviors and practices, and potential barriers and opportunities related to increased efficiency.

6.2.2.4 *Firmographics*

As found through secondary research, California greenhouse and nursery operations tend to be geographically clustered and closely networked. The majority of greenhouse and nursery growers are located in Southern California, with the counties of San Diego, Riverside, Los Angeles, Ventura, and Orange having the greatest number of operations and the highest sales.[56] Irrigation and plant watering are significant uses of water in greenhouses and nurseries. Many Greenhouse and Nursery growers irrigate their farms with well water, as outlined in section 6.6.1.

To verify the findings from secondary research, the research team interviewed a number of greenhouse and nursery operators. Production by technical survey respondents primarily included flowers and starter plants, although respondents also mentioned cacti/succulents and potted plants (as seen in Figure 6.2). Four of the seven respondents considered themselves typical producers. Of the three who claimed to be atypical, two reported to use a European system and one used hydroponics.

Figure 6.2. Distribution of Respondents by Primary Products

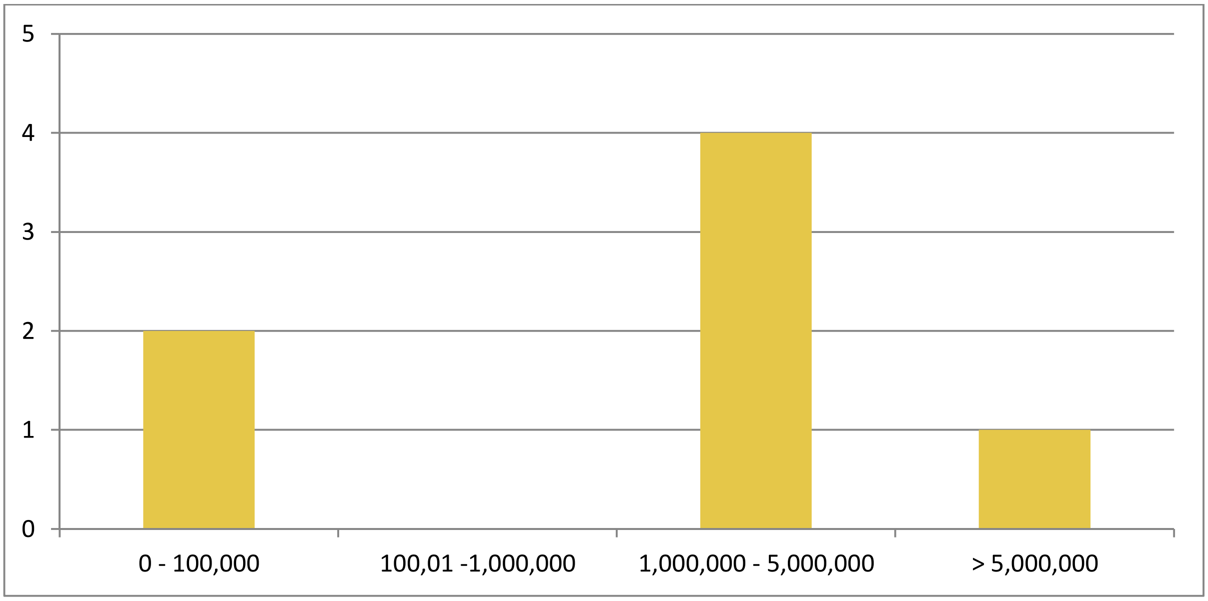


Source: Navigant analysis. n = 7, "What do you consider your primary product?"

[56] NASS, 2007 Agricultural Census.

The square footage of greenhouse space managed by technical survey respondents ranged from 87,000 to over 10,800,000 square feet, as seen in Figure 6.3. The age of the greenhouses ranged from 14 to 100 years, with an average age of 37 years. Four of the six respondents also had nursery stock under cultivation, which ranged from 2 to 800 acres.

Figure 6.3. Distribution of Respondents by Square Footage of Greenhouse Space



Source: Technical Survey, n = 7, "How many square feet of greenhouse space to you operate?"

The technical survey respondents held a variety of roles on their respective farms. One respondent was the CFO, one owned the operation, one was in inside sales, one was in accounting, one was in marketing, and two were in management positions. These respondents had been in their positions for anywhere from 1 to 40 years, all tracked production costs as a part of their positions, and all but one interacted regularly with their local utility representatives.

6.3 Structure of Greenhouses and Nurseries Market Segment

6.3.1 Description of the Market Segment

Greenhouses, nurseries, and floriculture fall entirely under the NAICS code 1114. This industry group refers primarily to operations growing nursery stock and flowers, or crops grown under covers such as greenhouses, cold frames, cloth houses, or lath houses.[57] Nursery stock includes short-rotation woody crops with growth cycles of ten years or less. Covered crops can be removed from their coverings at any point in their maturity, and typically have perennial life cycles.

This chapter is devoted mainly to floriculture within this market segment. Mushroom production and other food crops grown under cover are also included in this NAICS category. However, Chapter 7

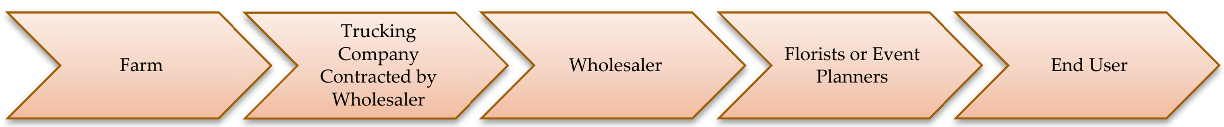
[57] North American Industry Classification System, 2007. http://naics-code-lookup.findthedata.org/l/124/Greenhouse-Nursery-and-Floriculture-Production.

covers mushroom production in greater detail, and covered food crops are only discussed at a high level within this study.

6.3.2 Description of Supply Chain

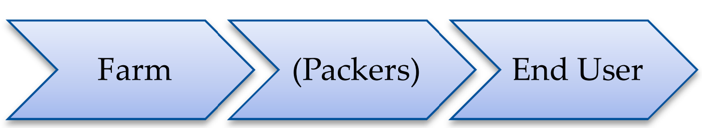
Greenhouse and nursery operators fall into the beginning of the overall supply chain. For sub-segments such as floriculture, flower growers will often transport and sell their products to wholesalers for further sale. However, some also sell directly to end users such as event planners and florists. Qualitative respondents outlined the following three distinct variations on the "supply chains" for the floriculture sub-segment:

Specialty Flowers



Mass-Market Flowers

Online Orders



6.3.3 Description of Market Actors

The Greenhouses and Nurseries market segment consists of a handful of companies that can be broken into three tiers based on the acreage of production. Two companies, Monrovia and Hines Horticulture, represent approximately one third of the Greenhouses and Nurseries market segment. While Monrovia is performing well within the segment, Hines has been working through their second potential bankruptcy, having avoided the first by acquiring new business. The following five companies on the list constitute approximately 15% of the overall market share. The final, smallest tier is composed of approximately ten companies that constitute about half of the overall market share. These companies operate within about 20 acres each.[58]

6.3.4 Description of Market Reference Partners

A number of industry associations exist for the Greenhouses and Nurseries market segment, although their influence may be waning in recent years. As identified through secondary research, particular organizations include the following:

- **Container Nursery**
  - California Associations of Nurseries and Garden Centers
  - Nursery Growers' Association (Southern California)
- **Cut Flowers**
  - International Growers' Association
  - American Nursery and Landscape Association
  - American Floral Endowment
  - Minor associations such as those for specialty flowers

Of these associations and those like them, only a small amount make connecting with growers their primary work; others operate with an alternative function, such as research. Those who do incorporate a research section with training or workshops for growers are better positioned to make an impact on the segment. However, funds may be limited for offerings such as these, and members frequently let their memberships lapse due to the inability to afford membership fees. Indeed, associations may now see an attendance of 25 people at meetings and workshops when once there were 250.[59] Other associations have foregone communication with growers in favor of independent research due to the overbearing costs of holding such industry meetings. Research in this field can cost hundreds of thousands of dollars, whereas industry associations may have only ten thousand or so to devote to operations. Researchers must therefore find funding from sources such as the USDA, and devote the majority of their finances to research purposes. This indicates that while there is ample enthusiasm in the segment for technological advancements and efficiency, financial restraints serve as a main barrier in the corroboration between market actors. This represents a significant opportunity for utilities to influence growers in the Greenhouse and Nursery segment, as well as to fund research of nascent technologies.

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[58] Subject matter expert interview, February 2012.
[59] Subject matter expert interview, 2012.

When asked about their primary sources of information, technical field survey respondents identified their local utility as a key source, as well as vendors and the Internet. Qualitative respondents identified the California Cut Flower Commission, the UC Davis Nursery and Floriculture Alliance, the San Diego County Flower and Plant Association, and the CFBF as key sources of information. While the CFBF offers high-level publications on farms' energy-using systems and a brief section on fuel efficiency, the other three organizations make no mention of energy on their websites. This suggests that there is an opportunity to engage these groups and further promote energy efficiency through these avenues.

6.4 *Status of Greenhouses and Nurseries Market Segment*

California leads the nation in sales of greenhouse and nursery products, and is a dominant producer of cut flowers and greens (58% of national sales) and nursery transplants (74% of national sales).[60] The Greenhouses and Nurseries segment plays a prominent role in California's agricultural industry as producers of food crops, key suppliers of landscaping plants, major producers of flowers, and suppliers of plugs, garden and household plants, and vegetable transplants.[61] Sales of nursery, greenhouse, and floriculture products accounted for 7.8% of California's total agricultural revenue in 2011.[62]

Overall, the number of producers is small compared with the total value of production of floriculture and nursery products, ranging from a high of $2.4 million average sales per producer in 2010 to a low of $2.0 million in 2006. This supports the finding that large companies dominate the Greenhouses and Nurseries segment.[63]

6.4.1 Current Trends and Issues

Of the seven technical survey respondents, three had seen an increase in production over the past two years. Three said their production had remained stable, and only one said their production decreased. However, in terms of sales, the Greenhouses and Nurseries segment is seeing a number of influences on both a domestic and international scale. Domestically, many of the companies in the Greenhouses and Nurseries market segment sell to big-box-style stores with garden centers. Often, these stores operate with a "Pay by Scan" system, in which stores do not pay growers until their product is purchased from the shelf. While this type of system has little effect on larger companies, the smaller firms often suffer, as stores lower prices to the point at which growers receive little profits.

From an international standpoint, the U.S. cut flower industry is seeing increasing competition from the South American import market. While cut flower production will likely not decrease, the market may have peaked in terms of international exports. Much of this is due to the poor economy in recent years, although generational turnover has also contributed to greenhouse and nursery firms going out of

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[60]Based on sales by sub-segments provided in the 2007 U.S. National Agriculture Census, sales used to allow comparison across Greenhouse and Nurseries sub-segments, which are highly diverse. http://www.agcensus.usda.gov/Publications/2007/Full_Report/Volume_1,_Chapter_2_US_State_Level/st99_2_035_035.pdf.

[61] Literature review for the 2010-2012 Statewide Agriculture Energy Efficiency Potential & Market Characterization Study, Navigant Consulting, Inc., October 2011.

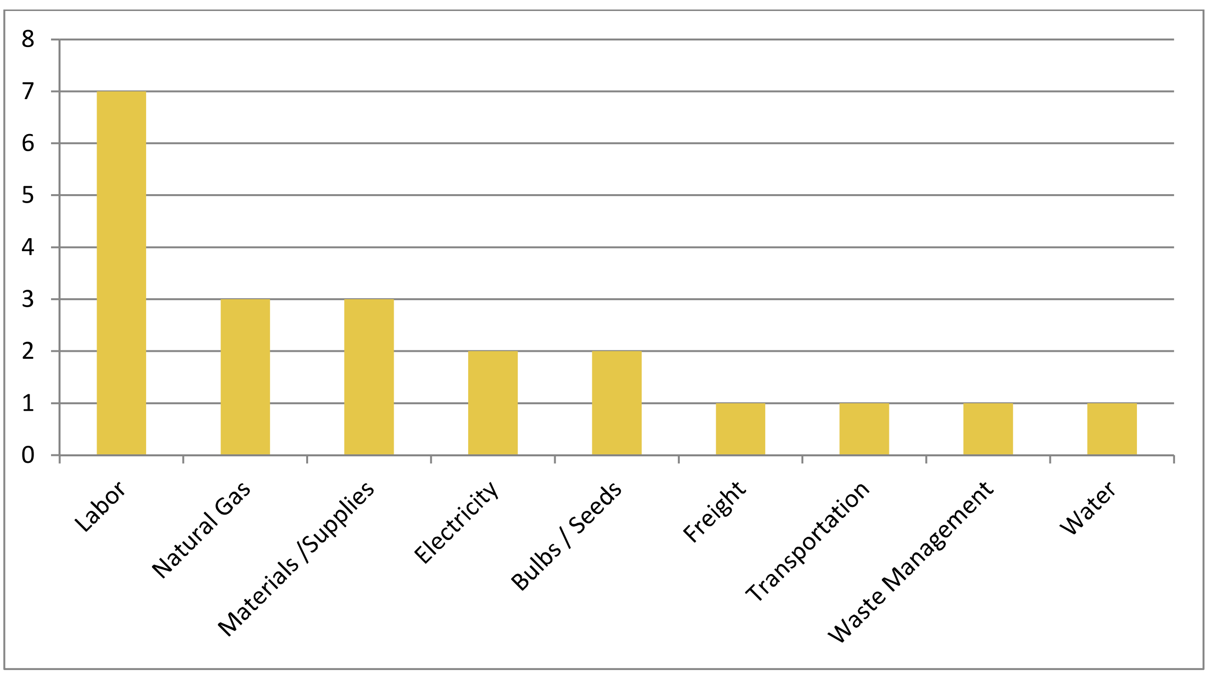
[62] California Agricultural Statistics, Crop year 2011 (October 31, 2012), page 5.

[63] USDA, *Floriculture and Nursery Crops Yearbook. FLO-2007*, Economic Research Service, September 2007. http://www.ers.usda.gov/Publications/Flo/2007/09Sep/FLO2007.pdf.

business. The container nursery sub-segment is seeing slightly differing trends, as production is still largely domestic. However, the primary issue for this sub-segment is regulations, and because much of this market is devoted to landscaping, the downturn of the housing market has created a downturn for this market, as well. In order to cope with this, some major producers are moving out the country to places where they can produce more cost effectively. Additionally, smaller companies are losing traction within the segment, as they are either going out of business or being swallowed by the major producers. Because of this, growers are increasingly cost-conscious. This could present an opportunity for utilities to encourage energy efficiency by educating growers about the potential savings that they might gain.

Illegal immigration is also a concern within the segment, as many growers hire undocumented workers to reduce labor costs. The segment consistently looked into penalizing operations that employ illegal immigrants. In particular, E-Verify—an Internet-based system that verifies the legality of workers—has caused issues for some growers. One market expert explained that the federal government has taken it upon itself to "make examples" out of these operations, having parked U.S. Immigration and Naturalization Service vans outside of some California operations. According to this expert, approximately 60% of staff would not show up to work on these days, regardless of whether they were legal citizens. This is a significant problem for these growers, as labor already constitutes their primary production cost for both technical and qualitative interview respondents (see Figure 6.4). As labor becomes scarcer, farmers will need to mechanize or to close down portions of their operations. If mechanization occurs, this would create an opportunity for utilities to work with growers to make energy-efficient equipment decisions.

Figure 6.4. Greatest Production Costs for Greenhouse and Nursery Operators



Source: Technical Phone Survey, n = 7 – multiple responses, "What are your top three production costs?"

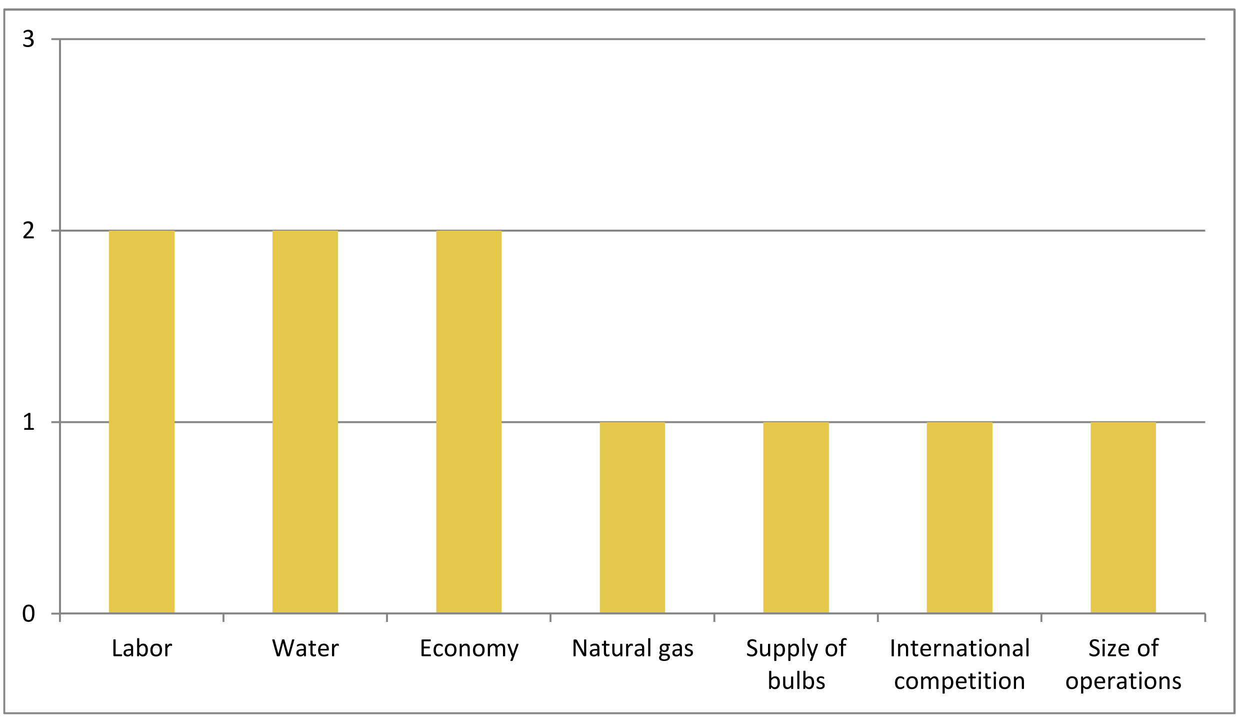
A final concern is the spread of pests and invasive species. With the increasing prevalence of globalization, the spread of invasive species between countries is a growing concern. Regulators are actively trying to prevent this spread, often to the detriment of growers as they are finding it more difficult to move their product. To combat these restrictions, National Compliance Agreements are being made to ease distribution regulations at the state level. However, the future impact of these regulations and subsequent agreements remains to be seen.

6.4.2 Future Prospects

When asked about future trends, industry experts stated that growers are increasingly organizing among themselves to voice their concerns at the state and federal levels. Qualitative interview respondents claimed that they anticipate demand to increase while production remains constant. Reasons for the expected demand growth include an improving U.S. economy and an increasing population. One respondent added that as this demand increases, there will also be a greater focus on locally grown flowers.

When asked what will most impact production in future years, technical survey respondents frequently mentioned labor supply and water. Other factors included the supply of bulbs, the economy, international competition, and natural gas. Electricity was not a major impact, presumably because it plays a small role in greenhouse and nursery operations as compared to other factors.

Figure 6.5. Factors Influencing Future Production



Source: Technical Phone Survey, n = 6 – multiple responses, "What factors do you think will most impact your future production?"

6.5 *Energy Use and Efficiency in Greenhouse and Nursery Segment*

6.5.1 Energy Consumption

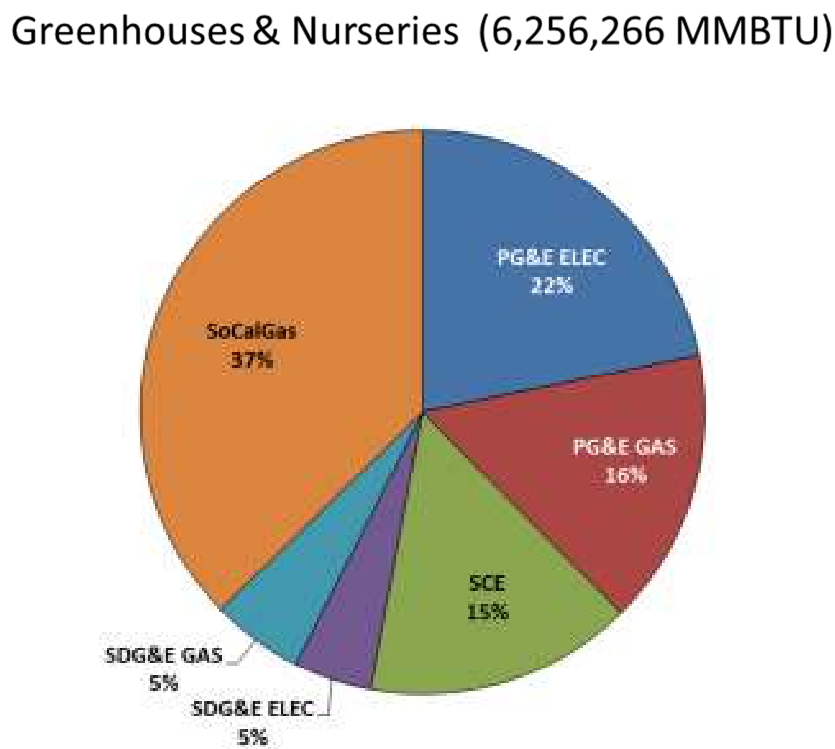
The Greenhouses and Nurseries segment can be an energy-intensive segment. In 2010, greenhouses and nurseries represented approximately 8.3% of total energy sales within the agriculture sector (see Table 6.2). In the Greenhouses and Nurseries segment, gas sales are larger than electricity sales, and SCG is the largest gas supplier (see Figure 6.6).

Table 6.2. 2010 Greenhouses and Nurseries Segment Energy Sales Compared to All Agriculture Sales

Category	Sub-Segment	Total MMBTU	% of Electric MMBTU	% of Gas MMBTU	% of Total MMBTU	MMBTU by Category	% of Total MMBTU
Greenhouses & Nurseries	**Floriculture**	2,920,061	0.9%	19.0%	3.9%	6,256,266	8.3%
	Mushroom Production	1,820,045	1.7%	5.9%	2.4%		
	Nurseries & Trees	959,835	1.2%	1.7%	1.3%		
	Misc. Greenhouses & Nurseries	556,326	0.4%	2.7%	0.7%		
Total (All Agriculture Sales)		75,032,670	100%	100%	100%	75,032,670	100%

Source: Navigant analysis of CPUC electric consumption data

Figure 6.6. 2010 Greenhouses and Nurseries Energy Sales by IOU



Source: Navigant analysis of CPUC electric consumption data

Due to their space-conditioning and cold storage requirements, greenhouse crops and floriculture generally use more energy than nurseries.[64] Seasonal usage patterns for electricity and natural gas are located in Figure 6.7 and Figure 6.8. For floriculture and greenhouse food crops, key energy end uses include lighting, space conditioning (cooling, heating, and humidification), sorting, packing, cold storage, and irrigation-related (pumping, sprinklers). The Cadmus Group's 2009 process evaluation of the PG&E Agricultural and Food Processing Program indicated that natural gas-fired heating (primarily from boilers) is the largest end use in greenhouses, despite increases in insulation quality. According to the study, process cooling and circulation are also significant.[65] The subject matter experts supported these findings, having emphasized heating costs as a significant concern for some growers within the Greenhouses and Nurseries segment. The energy costs associated with heating and boilers have been crippling for some growers over the past ten years. This is particularly true in the northern United States, where winter temperatures can be extreme. However, space heating is presumably less of an issue for California growers, who are subject to a milder climate. Utilities should explore the heating-related energy use specific to California's greenhouse and nursery heating technologies. There may be

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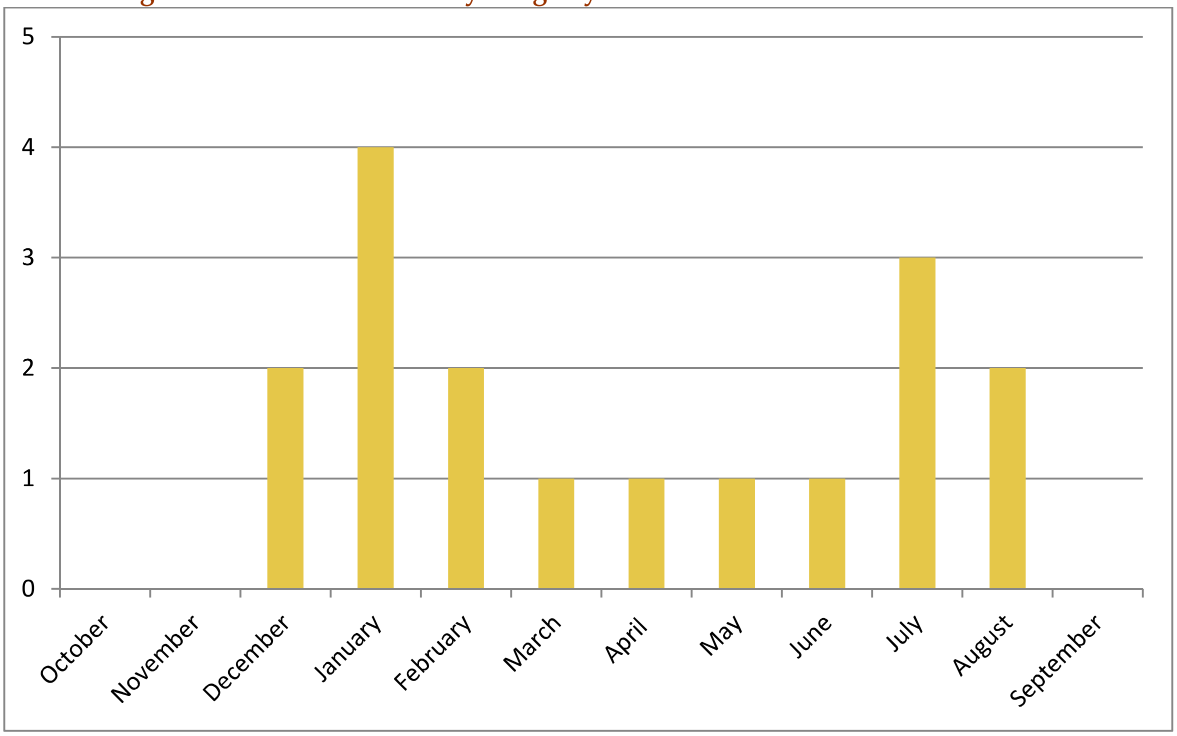
[64] Mushroom production has similar requirements to greenhouse crop production; however, since mushroom production is not aggregated in any of the data sets, this is not an issue for that sub-segment.

[65] Kerstin Rock and Crispin Wong (The Cadmus Group), 2009, *Process Evaluation of PG&E's Agriculture and Food Processing Program*. Portland, Oregon: Pacific Gas and Electric Company. CALMAC Study ID PGE0276.0, 50.

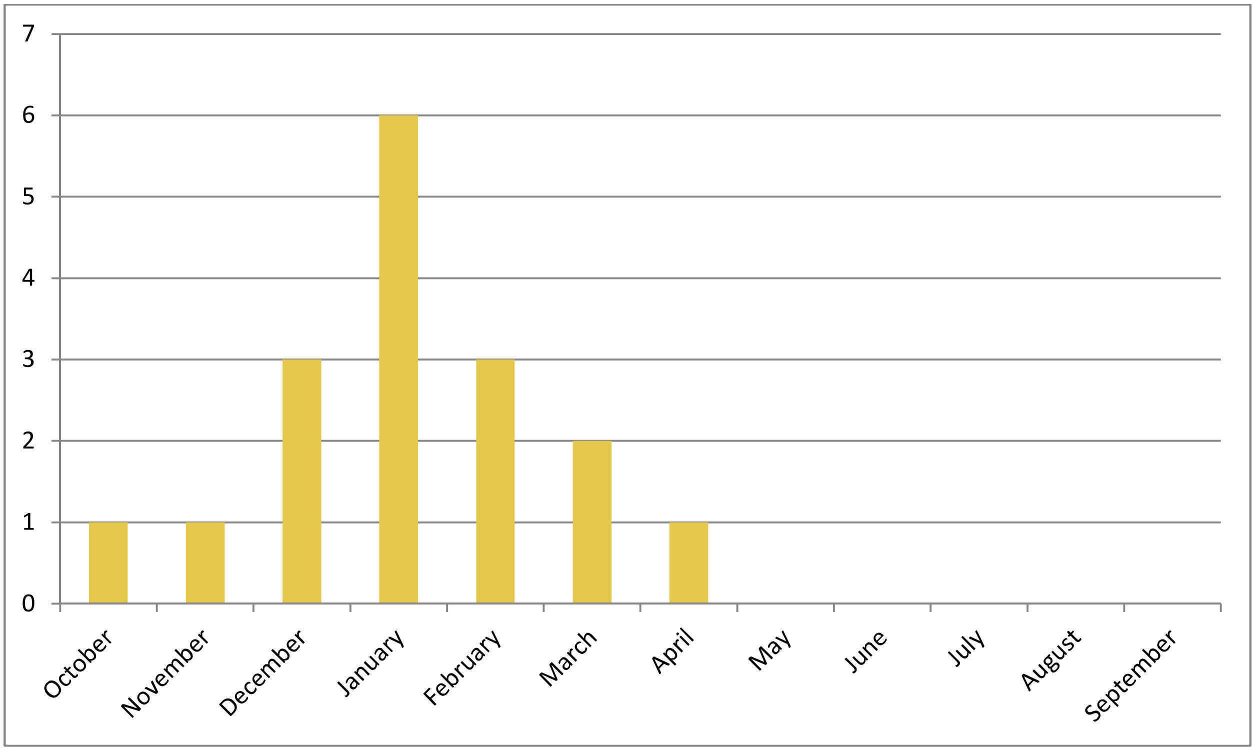
significant opportunity for energy savings in this particular segment, particularly in the northern parts of the state.

Figure 6.7. Greatest Electricity Usage by Month in Greenhouses and Nurseries



Source: Technical Field Survey, n = 7 - multiple responses, "In which month is your electric usage the greatest?"

Figure 6.8. Greatest Natural Gas Usage by Month in Greenhouses and Nurseries



Source: Technical Field Survey, n = 6 – multiple responses, "In which month is your natural gas usage the greatest?"

When asked about their energy usage, respondents identified pumps and lighting as their primary electric end uses. Cooling also contributed significantly to electrical load. Table 6.3 lists all responses. Heating and boilers were the most frequently mentioned equipment contributing to natural gas consumption. Respondents attributed 90-100% of their natural gas usage to these end uses. These responses support previous findings that this segment is a heavy user of gas due to the widespread use of boilers for space heating.[66] When asked how these respondents came to these estimates, only one referred to an engineering or cost accounting study, while most were unsure of how they determined these numbers. The lack of solid, supported end-use estimates suggests that greenhouse and nursery operators are not closely monitoring their energy consumption. There may therefore be a significant opportunity for utilities to approach these growers and help them to understand energy use within their operations. This could result in greater awareness of energy use, which growers could then pass along through the robust grassroots information channels already at work in the segment.

[66] Kerstin Rock and Crispin Wong (The Cadmus Group), 2009, *Process Evaluation of PG&E's Agriculture and Food Processing Program*. Portland, Oregon: Pacific Gas and Electric Company. CALMAC Study ID PGE0276.0, 50.

Table 6.3. Self-Reported End Use of Electricity

Process/Equipment	Number of Mentions	Range of Consumption Estimates	Average Consumption Estimate
Lighting	6	15%-30%	24%
Pumps	6	25%-35%	31%
Cooling	4	35%-70%	52%
Computerized Tables	1	Unknown	N/A
Fans	1	25%	25%
Office Equipment	1	25%	25%
Processing Equipment	1	15%	15%
Reverse Osmosis	1	Unknown	N/A

Source: Technical Survey n = 7 – multiple responses, "Which processes or equipment use the most electricity?"

Table 6.4. Self-Reported End Use of Natural Gas

Process/Equipment	Number of Mentions	Range of Consumption Estimates	Average Consumption Estimate
Heating	3	90%-100%	95%
Boilers	2	98%-100%	99%
Greenhouses	1	100%	100%

Source: Technical Survey, n = 6, "Which processes or equipment use the most natural gas?"

While the dominant energy end uses may be easy to identify in greenhouse and nursery operations, Navigant sought to understand where energy use fell in terms of overall operating costs. To understand respondents' perceptions of energy use in the Greenhouses and Nurseries segment, Navigant asked survey respondents what their most significant operating costs were over the last two years. Only two of the seven respondents listed electricity. The same two also listed natural gas. Navigant asked those respondents who did not list these fuels whether they considered either a significant production cost. Overall, four of the seven respondents admitted electricity was a significant cost, and four of the six natural gas users claimed it as a significant cost. Technical survey respondents estimated that electricity consumed 1.3-10% of their production costs (average of 6.3%). Natural gas reportedly used 2.6-15% of production costs, averaging 8%. Qualitative interview respondents reported lower percentages for electricity and natural gas use, both estimated at less than 5% of production costs. While this may be significant for these respondents, these estimates are low when compared to other agricultural market segments. When asked what method respondents used to calculate their estimates, all technical survey respondents claimed it was either their best guess or their recollection of their financial records. Given the emphasis that secondary research and subject matter experts placed on energy use – particularly for natural gas – utilities should conduct further analysis of energy usage in the Greenhouses and Nurseries segment to determine its magnitude and significance to the segment.

When asked about their consumption trends, two of the seven technical survey respondents claimed to have seen their electricity costs increase, while another three respondents said their electricity costs decreased. The remaining respondent said his electricity costs had not changed. The majority of technical survey respondents had seen decreasing natural gas costs over the past two years, with four of the six natural gas users reporting a decline in the percentage of their total production costs attributable to natural gas. One respondent had seen increasing natural gas costs and the remaining respondent reported no change in natural gas costs. Again, the respondents relied on their recollection of financial records or their best guesses to estimate these trends. While natural gas costs seem to be declining for growers and electricity costs seem to vary with the operation, utilities would benefit conducting further research to inform any future greenhouse and nursery program design.

6.5.2 Energy Management

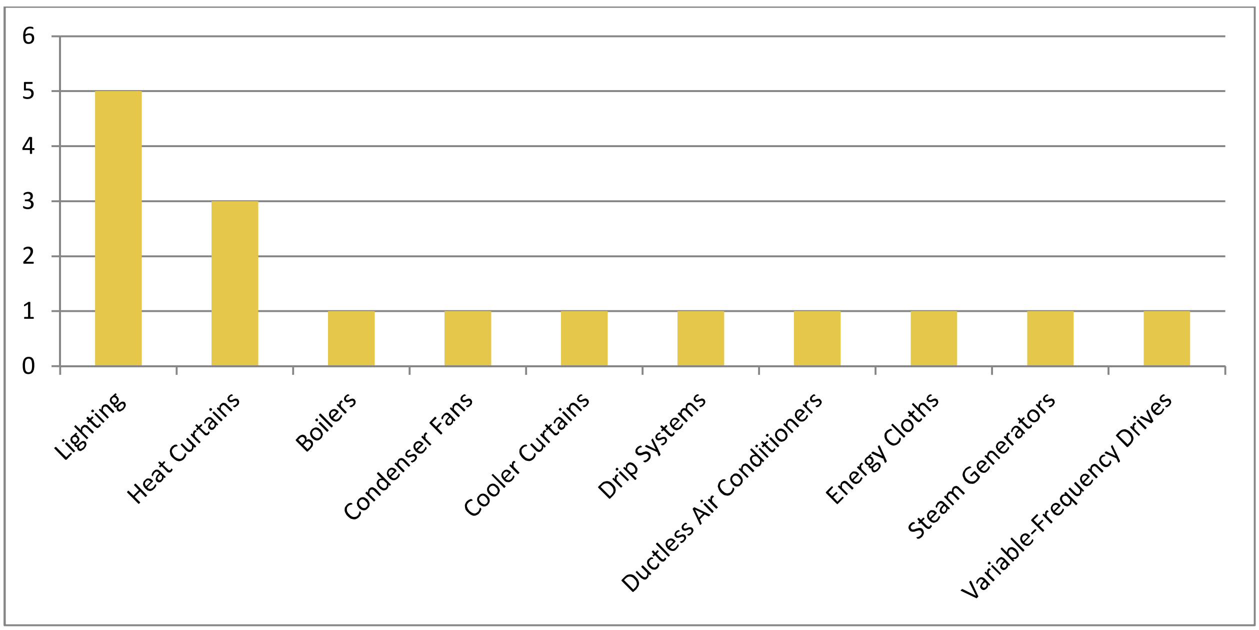
Operators in the Greenhouses and Nurseries segment do not seem to monitor energy use as closely as operators in other market segments. Three of the seven technical phone survey respondents used metrics to track energy costs, all of which were large greenhouse operators (over 1,000,000 square feet of greenhouse space). One respondent tracked using dollars per month on utility bills, and the other two used kWh or Btu per unit. When asked how they tracked their energy usage, all technical field respondents practiced some form of energy management, although many practices were less than robust. Five of seven respondents tracked changes in their monthly energy bills, one used an energy management system, one tracked production costs, and a number of respondents had implemented systems or procedures with the intention of lowering energy usage. Notably, none of the respondents claimed to rely on utility representatives to identify energy cost savings. All but one of the technical survey respondents had worked with utility representatives or outside consultants in the past to assess energy use in their operations. However, while respondents interact with their utility representatives, there appears to be much opportunity for utilities to strengthen their relationships with greenhouse and nursery customers to identify potential energy savings and track energy costs.

6.5.2.1 Efficient Measures and Savings

To mitigate energy use, all but one technical survey respondent had installed some form of energy-efficient equipment. As seen in Figure 6.9, the most frequently mentioned measures were lighting and heat curtains. Existing IOU programs offer incentives for both of these measures, and the majority of respondents who installed these measures were also those who had received rebates for energy-efficient equipment installations. This implies that greenhouse and nursery customers are taking advantage of the rebates offered to them. If utilities were to promote further rebates for additional measures, greenhouse and nursery operators would presumably take advantage of these additional rebates.

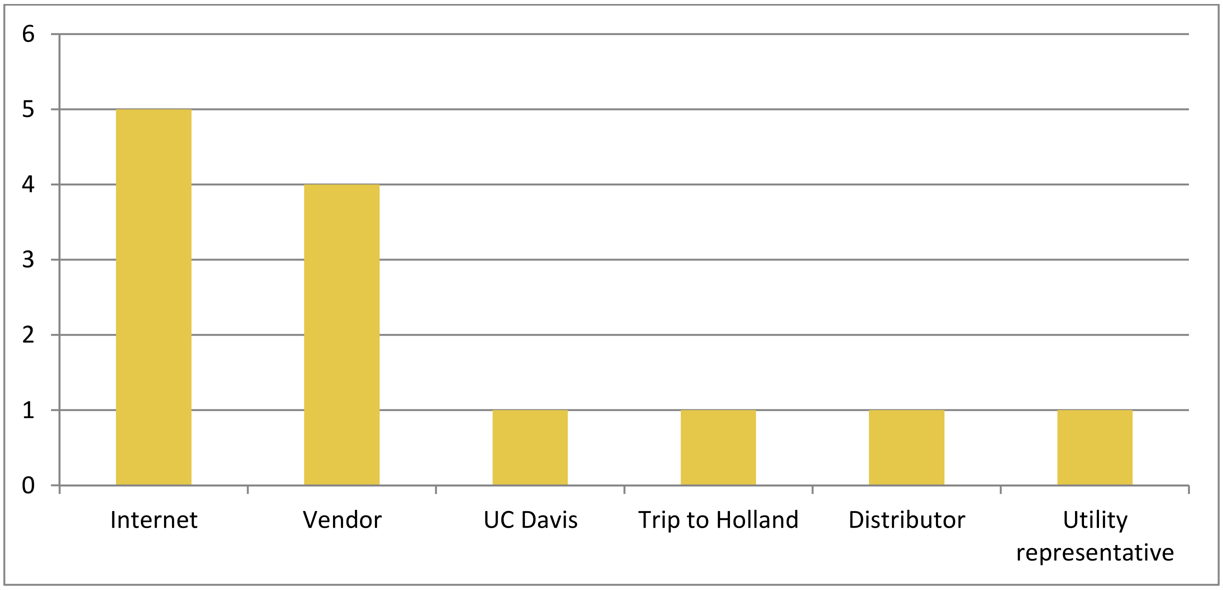
Respondents mentioned a number of other measures as well, yet there did not appear to be consistency among the measures mentioned. Expected energy savings ranged from 15% to 30%, with an average of 23%. Most respondents reported achieving those savings and said they had verified the savings through utility bill tracking. While some installations dated to 1985, growers had installed the majority of the measures since 2010, suggesting that growers are actively seeking new equipment installations. Both qualitative and technical survey respondents identified cost constraints as the primary barrier to installing further measures, and some technical survey respondents pointed to a lack of awareness of further measures. As seen in Figure 6.10, respondents typically learned about these measures through the Internet or a vendor, and only one respondent credited the local utility. This suggests that although growers have an interest in installing energy-efficient equipment, they are not receiving sufficient information on available measures. Furthermore, financial constraints are the primary barrier to the installation of efficient equipment, which is a barrier that utilities can help to overcome. Utilities should therefore create and actively promote programs that target the Greenhouses and Nurseries market segment, as growers are receptive to new information on energy efficiency, as well as financial support.

Figure 6.9. Greenhouse and Nursery Energy-Efficient Equipment Installations



Source: Technical Field Survey, n = 7 - multiple responses, "What equipment or devices have you installed to reduce energy use?"

Figure 6.10. Energy-Efficient Equipment Knowledge Source



Source: Technical Field Survey, n = 5 – multiple responses, "Where did you learn about this equipment/device?"

Although growers are open to conventional energy-efficient equipment, one subject matter expert alluded that the segment is reluctant to adopt innovation. Instead, she indicated that in order for a technology to spread within the segment, leading growers must be the early adopters. Subject matter experts concurred that innovative technologies such as sensor-based irrigation could greatly benefit the segment, and that large-scale demonstrations may be the most effective way to influence adoption. One expert claimed that as little as 10% of California's floriculture segment currently uses sustainable practices, but with the use of demonstrations, there could be room for much improvement and innovation. Because they can be expensive endeavors, utilities may be the most appropriate parties to execute these demonstrations. Utilities should therefore explore innovative, energy-saving technologies and showcase them to large greenhouse and nursery operations.

6.6 Greenhouse and Nursery Water Management

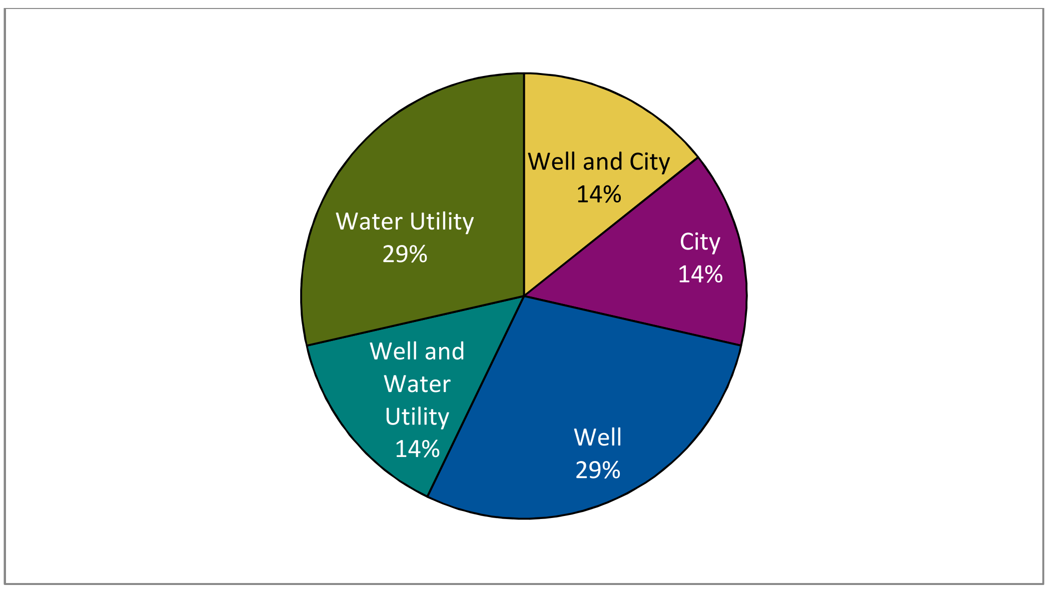
Adoption of wastewater management practices in the Greenhouses and Nurseries segment has been slow and gradual. However, due to competition for California water resources, growers have continued to pay close attention to water availability. Upon establishing a greenhouse or nursery, growers will estimate the approximate size of their operation and set boundaries as such. However, as businesses have grown, these boundaries have been stretched and with them, the resources. Larger operations are often able to build their own irrigation systems; however, there is a dearth of expertise supporting the installation of these systems. Although there are only a handful of greenhouse and nursery operators in the California segment, utilities should be sure to reach out to large facilities that install their own irrigation system. Offering advice and guidance to these growers could lead to educated choices as to the equipment used to run these systems.

Water regulations affect operations and cost money for the Greenhouses and Nurseries segment across federal, state, and local levels. Most of these regulations relate to wastewater discharge and code compliance for the installation, operation, and maintenance of ponds and pumps. While these regulations may mean nothing more than increased paperwork to some growers, other respondents felt that the regulations were confusing because of the organization of farms into tier levels for water discharge quality monitoring. According to one respondent, each tier has different monitoring requirements and water must be recycled appropriately. This variation in regulations can lead to a lack of clarity around growers' wastewater monitoring efforts.

6.6.1 Sources and Uses

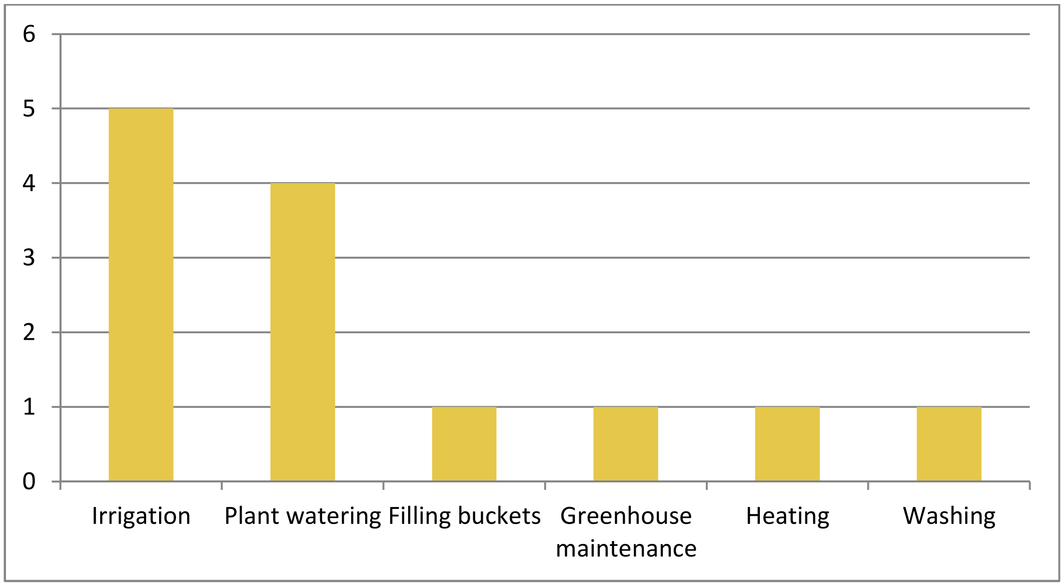
Greenhouse and nursery operators utilize three main sources of water: wells, the city, and the water utility company (see Figure 6.11). Irrigation was the most frequently mentioned use of water, followed closely by the watering of plants. Although both of these responses involve providing water for crops, Navigant kept these responses separate, as irrigation may refer to processes outside of greenhouse and nursery operations. These processes could include the pumping of water in an irrigated agriculture field, which requires water distribution that differs from the distribution in greenhouse- or nursery- based growing activities. As reported earlier, the majority of technical survey respondents did not see water as a significant production cost. This suggests that the cost of water is not as significant as other operational costs to these growers, and that management practices may be sufficient to mitigate some of these operation costs of water pumping.

Figure 6.11. Water Sources of Greenhouses and Nurseries



Source: Technical Field Survey, n = 7, "From what source do you receive your water?"

Figure 6.12. Water Usage in Greenhouses and Nurseries



Source: Technical Field Survey, n = 7 – multiple responses, "What are the major production or process applications that require water in your operation?"

6.6.2 Management and Equipment

Growers have achieved some level of innovation in their water management practices. Operators place heavy emphasis on technologies such as drip irrigation and root zone substrates, for instance. However, reducing water for crops often leads to increased need for fertilizers. The augmented use of fertilizers negatively affects the sanitation of wastewater, as does the often-used method of reverse-osmosis for water purifying. The increased contamination of this wastewater has forced some growers to allocate space for wastewater treatment lagoons that they might otherwise use for production. Because of this, greenhouse and nursery producers value water conservation and reuse methods such as wastewater recycling, regardless of upfront cost. However, according to segment experts, some growers may falsely claim to recycle their wastewater in order to comply with regulations.

The most common methods of water management among technical survey respondents were irrigation control (three mentions), water recycling (four mentions), and drip irrigation (two mentions). Concurrently, subject matter experts emphasized water recycling as a common method of water management during the interviews. One expert stated that while water recycling would be a beneficial practice across the segment, it is not currently a "workable situation" for all growers.

6.7 Greenhouse and Nursery Waste Management

Waste generation by the Greenhouses and Nurseries segment is predominantly composed of plant-based refuse. Currently, common means of disposal include composting and recycling, as reported by technical survey respondents. The qualitative interviews yielded mixed responses from respondents about waste management regulations and how they affect operations. The overall sentiment was that these regulations had little effect on their operations. When asked about what types of regulations affected them, responses included regulations involving chemicals, empty chemical containers, certification as a sustainable facility, recycling mandate for office supplies, and composting of green waste. One respondent felt that the waste regulations made operations harder and more time consuming, as there are varying regulations at different governmental levels. Compliance with these regulations could therefore present challenges for growers.

6.8 Greenhouse and Nursery Conclusions and Recommendations

Conclusion 1: The Greenhouses and Nurseries segment is stable and production is concentrated among a small number of growers compared to its market value. Grower-to-grower communication in this segment is substantial relative to other agricultural segments.

Recommendation 1: California greenhouse and nursery operations tend to be geographically clustered and closely networked. Navigant recommends that utilities leverage the close connections of this community to demonstrate and promote programming that includes efficient equipment (particularly natural gas-fired equipment) as well as energy management systems. The connectivity of this segment would facilitate the diffusion of technologies and techniques by early adopters and segment leaders throughout the state's commercial greenhouses and nurseries.

Conclusion 2: Heating and cooling continue to be significant costs for greenhouse growers. Sustainable measures have been installed by growers in the past, but growers can be reluctant to adopt new technology due to a lack of awareness, a lack of financing, or even a lack of proof that a technology is effective.

Recommendation 2: As mentioned in the previous recommendation, demonstration projects can be a cost-effective way for utilities to expose growers to the technology and convince them of its effectiveness. Engaging with leading growers could also increase technology adoption.

Conclusion 3: Labor remains a significant cost for growers and the long-term supply of labor is a concern. If a decrease in labor supply occurs, growers may need to improve labor efficiency by increasing mechanization.

Recommendation 3: Research into mechanized equipment and increased communication with growers would give utilities the opportunity to influence equipment choice if a grower transitions to more mechanized labor.

7 Mushrooms

7.1 Key Findings and Recommendations

Mushroom growing is a **stable and highly concentrated** segment of California's agriculture sector. While energy costs are significant, growers and grower associations **do not identify energy efficiency as an urgent issue** in need of resolution. Concerns about labor costs and availability, however, may cause growers to seek out and deploy mechanized processing. While such a transition would be slow, **energy intensity would increase over time**. If utilities partner with growers and grower associations before the transition takes place, demand-side management (**DSM) programs can influence decisions toward efficient choices and limit the load growth for this segment**.

Because of the small number of commercial operations (15 Agaricus mushroom growers and up to 40 "specialty" mushroom growers), it may not be practical to develop mushroom-specific programs or measures. However, **general outreach through reference partners regarding existing programs** could increase the participation of this segment in utility programs. However, outreach with an emphasis on resources to **develop energy metrics** as part of growers' overall sustainability efforts would be the first step in raising the profile of energy efficiency in this segment. While growers view their electric and natural gas utilities as sources of information, it is **organizations like the American Mushroom Institute that can actually motivate growers** to take action. Once motivated to develop metrics and manage to them, mushroom growers will more readily see the value of efficient equipment installation and participation in utility programs.

As with nurseries and greenhouses, utilities have an opportunity to engage with growers in their decision to purchase equipment, **before and during any transition to mechanization**. By educating growers regarding life-cycle costing and energy efficiency, utilities can **insure that mechanization adds as little to load** as possible in this segment. If utilities engage after the transition, the opportunities for efficiency will likely be less extensive and more costly.

7.2 Methodology

7.2.1 Secondary Research and Literature Review

To understand the information that currently exists on the mushroom market segment, Navigant's research team began by conducting secondary research. Sources ranged from agricultural statistical surveys, such as the 2007 Census of Agriculture, to peer-reviewed publications and IOU program evaluations. Using this array of sources, Navigant conducted an extensive literature review, complete with an annotated bibliography. The findings from this research are located in the Greenhouses and Nurseries chapter in the *Literature Review for the 2010 – 2012 Statewide Agricultural Energy Efficiency Potential & Market Characterization Study.*

7.2.2 Primary Data Collection

As Table 7.1 shows, the primary sources for data collection were technical surveys (both telephone and in-person) and qualitative interviews (telephone only).

Table 7.1. Data Collection for the Mushroom Segment

	Number of Completed Interviews
Subject Matter Experts	3
Technical Surveys (Telephone/In-Person)	8/8
Qualitative Interviews	2

7.2.2.1 Subject Matter Expert Interviews

The research team contacted two subject matter experts at Pennsylvania State University and a representative from one of the largest mushroom producers in California. The purpose of the interviews was to determine the Mushroom segment's current market structure and trends.

7.2.2.2 Technical Surveys

The research team conducted technical phone surveys with eight individuals in the Mushroom market segment. These surveys included topics such as operation firmographics, energy management and practices, waste and water issues, and business cycles. Each operator responded to an initial phone survey that covered these topics at a high level. If a respondent agreed to participate in a follow-up, in-person survey at their farm, a member of the research team would give one of three subsequent surveys based on their sophistication of energy metrics and history of energy-efficient measure implementation. These follow-ups included a General Technical Survey, an Intermediate Technical Survey, and a Detailed Technical Survey. Eight of the original eight Mushroom segment telephone respondents agreed to a subsequent technical survey.

Figure 7.1. Map of Mushroom Technical Survey Respondent Locations

Source: Navigant analysis

7.2.2.3 Qualitative Interviews

The research team conducted six qualitative interviews via telephone. The qualitative interviews were designed to complement the technical information, examining agricultural energy usage and efficiency potential. The qualitative interviews focused on market expectations, behaviors and practices, and potential barriers and opportunities related to increased efficiency.

7.2.2.4 Firmographics

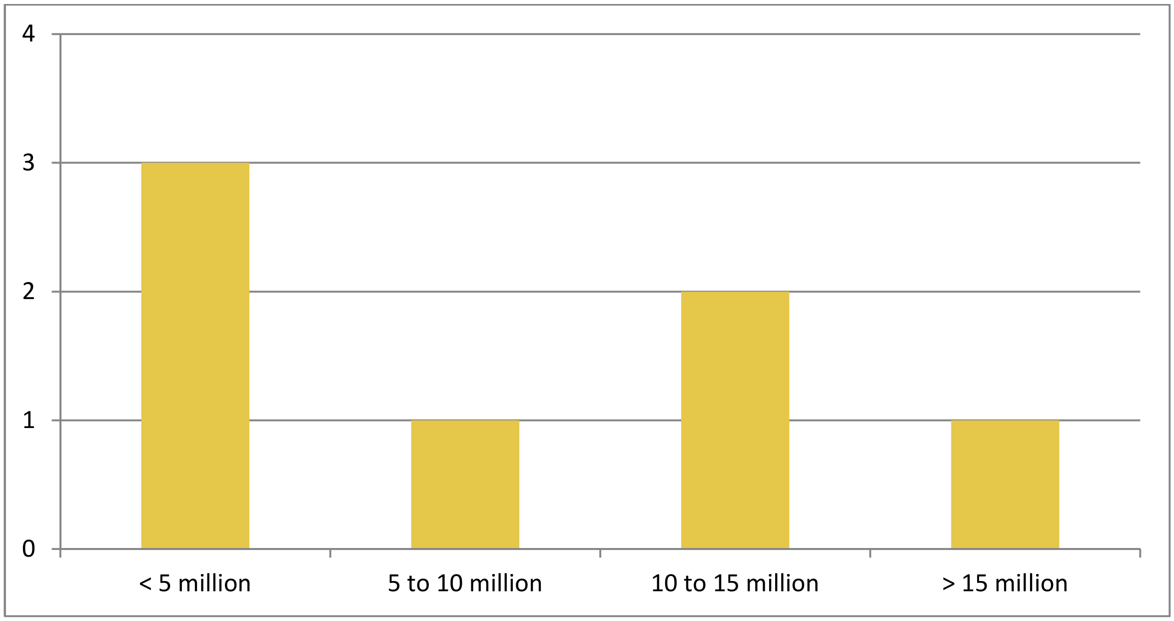
Due to the relatively small number of mushroom growers in California compared to other crop segments, there are not significant concentrations of mushroom farms within any particular county (despite being the second highest mushroom-producing state). However, on a regional level, most mushroom farms are located in the southern half of California. As outlined in section 7.6, although there is little data about the irrigation practices on mushroom farms, watering and cleaning mushrooms are significant water end uses for mushroom growers. Water is generally sourced from wells along with the local water utility.

To verify the findings from secondary research, the research team interviewed a number of mushroom growers. The USDA divides mushroom production into two types: Agaricus (button) mushrooms and "specialty" mushrooms, such as Shitake, Oyster and "other" mushrooms. Agaricus mushrooms usually constitute over 90% of annual production and growing area from year to year. Two of the technical survey respondents claimed to be "specialty" mushroom growers, while the other seven grew Agaricus mushrooms. Four of the eight technical survey respondents viewed their operations to be typical for Agaricus mushroom cultivation in California. Of the four who did not view themselves as typical, two were the "specialty" growers and one grew Agaricus mushrooms using advanced technologies on the largest scale of all respondents. The remaining respondent was a smaller grower (less than 7 million pounds of production and less than 150,000 square feet of production) who utilized less sophisticated production techniques.

Of the eight technical survey telephone respondents, seven reported that their production ranged from 1,500 to 38,000,000 pounds, as shown in Figure 7.2. The sum of reported annual production from these technical survey respondents was equivalent to 57% of total California "non-specialty" production as reported by USDA.[67] Six of the seven respondents who reported square footage operated facilities with fewer than 300,000 square feet, and the age of respondents' growing operations ranged from four to 60 years, with an average age of 33 years.

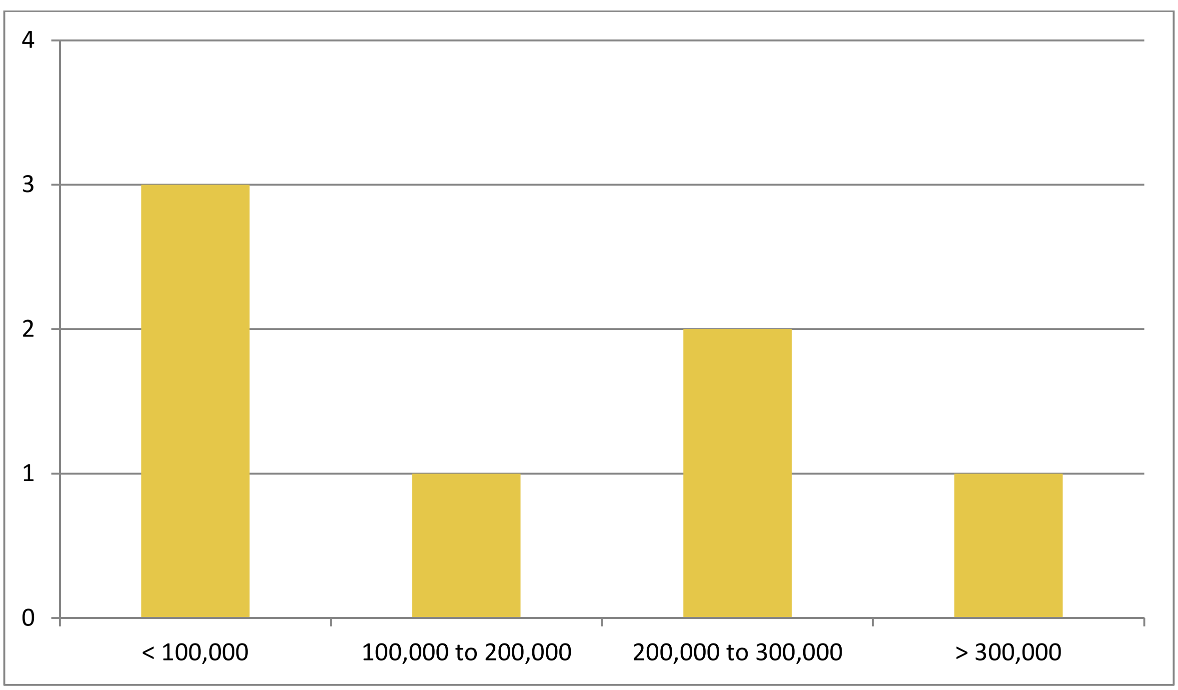
[67] Mushrooms (August 2012), National Agriculture Statistics Service, page 4.

Figure 7.2. Distribution of Respondents by Annual Pounds of Mushroom Production



Source: Technical Phone Survey, n = 7, "How many pounds of product do you produce per year?"

Figure 7.3. Distribution of Respondents by Square Footage of Growing Area



Source: Technical Phone Survey, n = 7, "How many square feet of production do you manage?"

7.3 *Structure of Mushroom Market Segment*

7.3.1 Description of Market Segment

Mushroom production falls under the broader NAICS category for Greenhouse, Nursery, and Floriculture Production (1114).This study has devoted a chapter particularly to the production of mushrooms, as specified by NAICS 111411. This particular sub-segment refers to operations "primarily engaged in growing mushrooms under cover in mines underground, or in other controlled environments.[68]" For an extensive analysis of general greenhouses and nurseries, see Chapter 6.

7.3.2 Description of Supply Chain

Commercial mushroom production in California is the second largest in the nation after Pennsylvania. Based on responses in both the technical and qualitative interviews, California mushroom growers view the state, nation, and some overseas locations as their markets. Foreign competition, from Canada and China, does pose a threat to their California sales.

The California segment is highly concentrated yet profitable, with just 55 farms—likely owned by an even smaller number of companies—responsible for about $223.5 million dollars in 2007 sales, an average of over $4 million per farm.[69] The qualitative interviews found that most of the mushroom growers either sell to restaurants directly or sell to a broker, distributor, or wholesaler who then sells to restaurants or food services as opposed to local farmers markets. Typical food service clients are distributors such as Cisco or US Food, who then sell to restaurants like Applebee's and Chili's. Some growers also sell directly to large restaurant chains like Pizza Hut or Papa John's.

Figure 7.4 provides a distribution of technical survey responses to the question: *What have been the three greatest production costs in your operation over the last two years?* The figure shows that electricity is the most frequently mentioned cost. The second and third most mentioned were labor and natural gas. These responses are at odds with the response from the qualitative survey, in which four of six respondents claimed that electricity costs ranged from 2% to 20%, while the other two did not know the proportion of these costs. Three respondents stated that natural gas came to less than 5% of their operating costs, while one was unsure and the other two refused to answer.

This disparity in perception may be an indicator of limited energy management experience and/or metrics within this segment.

One area where technical, qualitative, and subject matter expert interviews did agree was the cost of labor. It was the second most mentioned cost component among technical survey respondents, and qualitative interview respondents identified it as their largest cost and greatest concern. As labor becomes more expensive, or simply more difficult to acquire, the larger and more sophisticated growers will look for opportunities to mechanize. Increased mechanization will lead to greater electric energy

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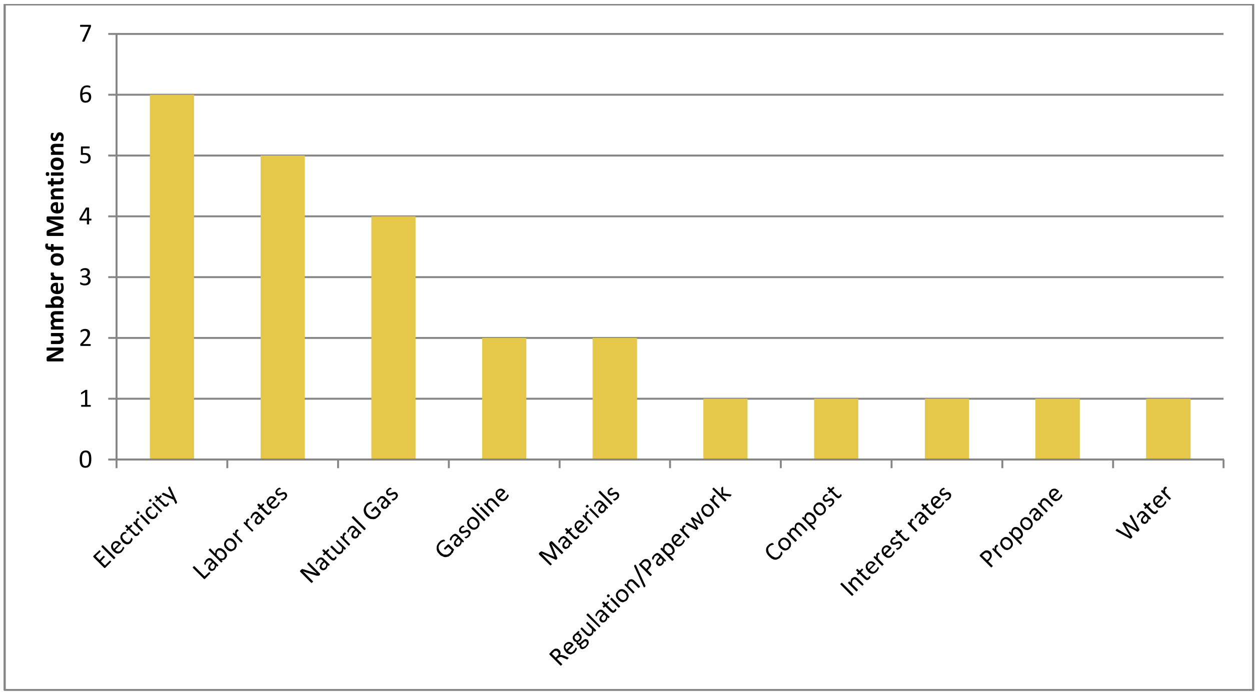
[68] North American Industry Classification System 2007. http://naics-code-lookup.findthedata.org/l/671/Mushroom-Production.

[69] NASS, 2007 Agricultural Census .

intensity. This transition will be an opportunity for local utilities to advise growers regarding energy-efficient purchases and operations.

Figure 7.4. Greatest Production Costs for Mushroom Growers



Source: Technical Phone Survey, n = 8 – multiple responses, "What are your three highest costs?"

7.3.3 Description of Market Reference Partners

Secondary research and the qualitative interviews identified the following organizations as valued sources of information and advice to California mushroom growers:

- American Mushroom Institute
- Pennsylvania State University
- California Farm Bureau
- University of California Santa Cruz

On their websites, none of these organizations identified energy or energy efficiency as an issue of particular concern for mushroom growers. However, these organizations do focus on the high level of sustainability (specifically recycling) exhibited by mushroom growers. Utility programs directed at this segment could leverage their credibility by collaborating with these organizations to communicate the opportunity and benefits of energy efficiency and energy management in this segment.

In addition to these organizations, the subject matter experts identified the following producers and influential market actors:

- Monterey Mushroom (large California-based grower with multiple facilities)
- CCD, Inc. (specialty mushroom grower based in California)
- Giorgio's Foods (Pennsylvania-based processor and distributor of mushrooms)
- Market Fresh (Pennsylvania-based mushroom growers' cooperative)

While qualitative interview respondents and subject matter experts pointed to growers and industry associations for key market reference partners, the technical survey respondents offered a different view of information sources. Rather, these respondents pointed to their local utilities as a key source of information. It would seem that, as individual operators, respondents recognize the value of their local utility as an information source. The associations, however, do not reflect this view. Given the influence of these associations, California utilities may have an opportunity to offer data and programming as new content on these websites and general communications.

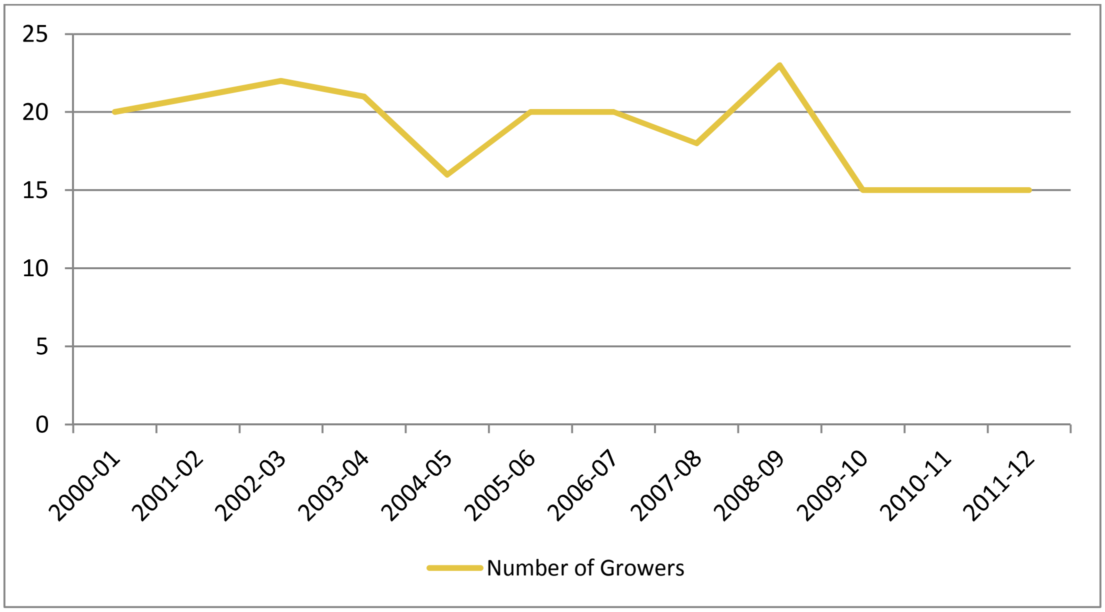
7.4 Status of Mushroom Market Segment

California is the second largest mushroom producer in the nation with 121,354,000 pounds of production (14% of national total) and 3,438,000 square feet of production (13% of national total).[70] As reported above, California was home to 55 mushroom growers in 2011.[71] As shown in Figure 7.5, the number of dominant producers—Agaricus mushroom growers—has ranged from a high of 23 in 2008–2009 to a current low of 15. The remaining growers are likely "specialty" growers that enter and exit the market as prices and regulations allow.

[70] Mushrooms (August 2012), National Agriculture Statistics Service, page 4.

[71] Literature Review for the 2010 – 2012 Statewide Agriculture Energy Efficiency Potential & Market Characterization Study, Navigant Consulting, Inc., October 2011, page 36.

Figure 7.5: California Agaricus Mushroom Growers 2000–2011



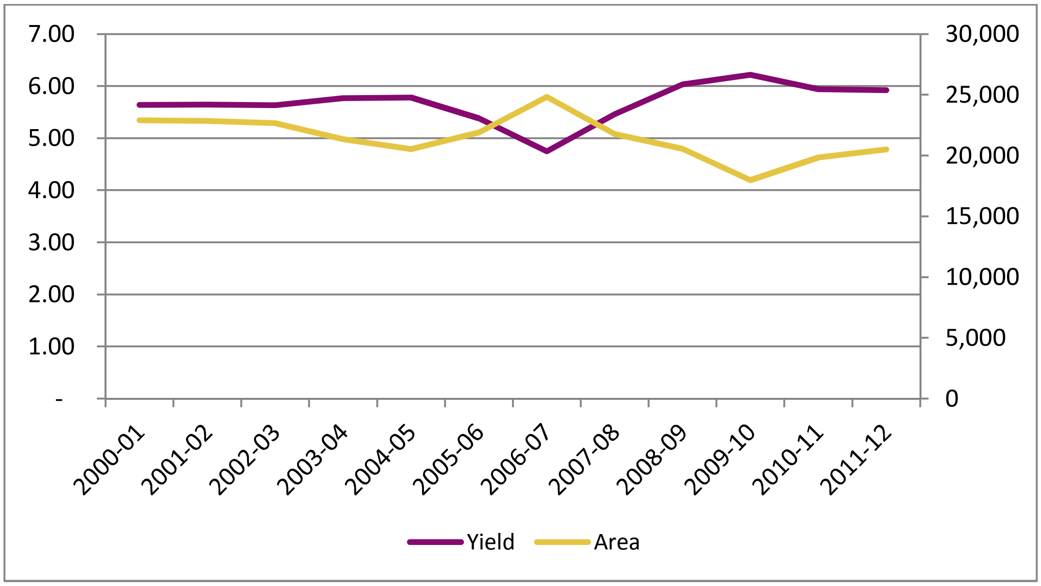
Source: Mushrooms (August 2012), National Agriculture Statistics Service. Yield is pounds per 1,000 square feet and Area is square feet.

7.4.1 Current Trends and Issues

Limited information is currently available on high-level trends in California's mushroom production. Most of the current information on this market segment dates to the mid-to-late 1990s. Given the relative dominance of this segment on a national scale, there is a significant gap in available data and industry knowledge related to this sub-segment.

Of the 13 technical survey respondents, five had seen an increase in activity over the last two years and eight remained stable over the same period. Of those respondents who had seen an increase in activity, five said it was due to increased production capabilities. This sentiment is supported by data from the National Agricultural Statistics Survey. As illustrated in Figure 7.6, California mushroom production has seen a flattening of Agaricus yield with a slight increase in planting area since 2009.

Figure 7.6. California Agaricus Mushroom Production - Yield and Growing Area



Source: Mushrooms (August 2012), National Agriculture Statistics Service. Yield is pounds per 1,000 square feet and Area is square feet.

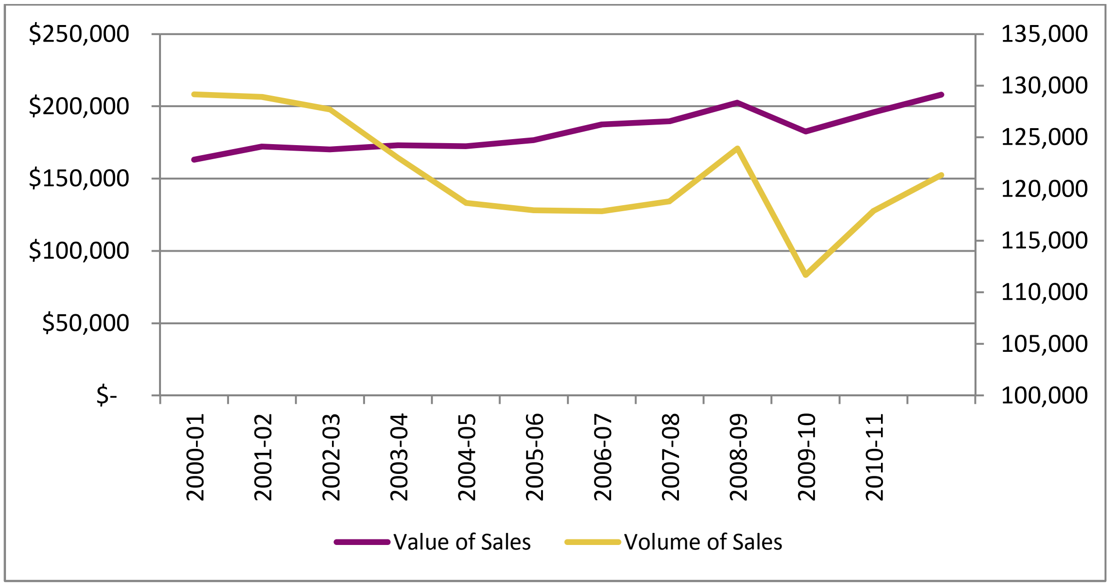
7.4.2 Future Prospects

Looking to the future, qualitative interviews showed that mushroom growers anticipated that demand for their product was going to increase—particularly for "specialty" varieties—as demand has continually grown in recent years. As one qualitative interview respondent stated:

> *People will keep wanting more 'different' mushrooms. Everyone is a 'foodie'; [the market has] continued to grow every quarter and it will keep going. Consumers are more aware of where produce comes from so [local mushrooms are] increasing in popularity. People [are] better educated about different types of mushrooms.*

While growth in yields has remained flat, overall growing area is increasing. As shown in Figure 7.7, the overall value of Agaricus mushrooms has increased since 2000 while volume has fluctuated over the last decade. In the last two years, however, the volume of sales has increased sharply. This trend, combined with a static number of growers and increasing sales due to steady demand for mushrooms, will likely result in a healthy business environment for this segment.

Figure 7.7. California Agaricus Mushroom Production - Value and Volume of Sales



Source: Mushrooms (August 2012), National Agriculture Statistics Service. Volume is in 1,000 pounds.

7.5 Energy Use and Efficiency in Mushroom Segment

7.5.1 Energy Consumption

As with other greenhouse and nursery operations, secondary research indicated that key energy end uses for mushroom production can include space conditioning (cooling, heating, and humidification), sorting, packing, lighting, cold storage, and irrigation-related (pumping, sprinklers). Mushroom production also requires energy for sanitization and cleaning. The qualitative interviews found that mushroom growers use energy to control the climate for growth and for steam sterilization of equipment (if necessary). This is primarily true for electricity, although natural gas is used to a lesser extent. Table 7.2 shows the self-reported estimates of end-use consumption in the California mushroom-growing segment. Note that the sum of the average consumption estimates is greater than 100% due to the variety of configurations and techniques used in growing operations.

Table 7.2. Self-Reported Estimates of Electric End Use among Mushroom Growers

End Use	Number of Mentions	Range of Consumption Estimates	Average Consumption Estimate
Air Conditioning/Cooling/Chillers	8	34%-75%	57%
Pumps/Misting	6	5%-50%	20%
Lighting	2	10%-45%	33%
Refrigeration/Walk-in Cooler	2	10%-13%	12%
Conveyance	1	15%	15%

Source: Technical Survey, n = 8- multiple responses, "Which processes or equipment use the most electricity?"

Based on these end-use estimates, the greatest opportunity for electrical energy efficiency is likely cooling systems and pumps. By nature, mushroom cultivation does not always require light. It is therefore possible that the range offered by the respondents for this end use may be high. Alternatively, the lighting use estimated by respondents may not relate to cultivation, but rather may contribute to other facility operations, such as lighting offices or sanitation areas.

Of the eight in-person technical surveys, only five used natural gas in any capacity. Regarding natural gas consumption, one respondent said that they would like to have the infrastructure for natural gas so they could save energy by not having to use propane. Table 7.3 shows the distribution of consumption for the two end uses mentioned by respondents. Again, the sum of the average consumption estimates is greater than 100% because of the variety of configurations and techniques used in growing operations.

Table 7.3. Self-Reported Estimates of Natural Gas End Use among Mushroom Growers

End Use	Number of Mentions	Range of Consumption Estimates	Average Consumption Estimate
Heating	5	10%-100%	42%
Boilers/Steam/Hot Misters	3	50%-90%	70%

Source: Technical Field Survey, n = 5 - multiple responses, "Which processes or equipment use the most natural gas?"

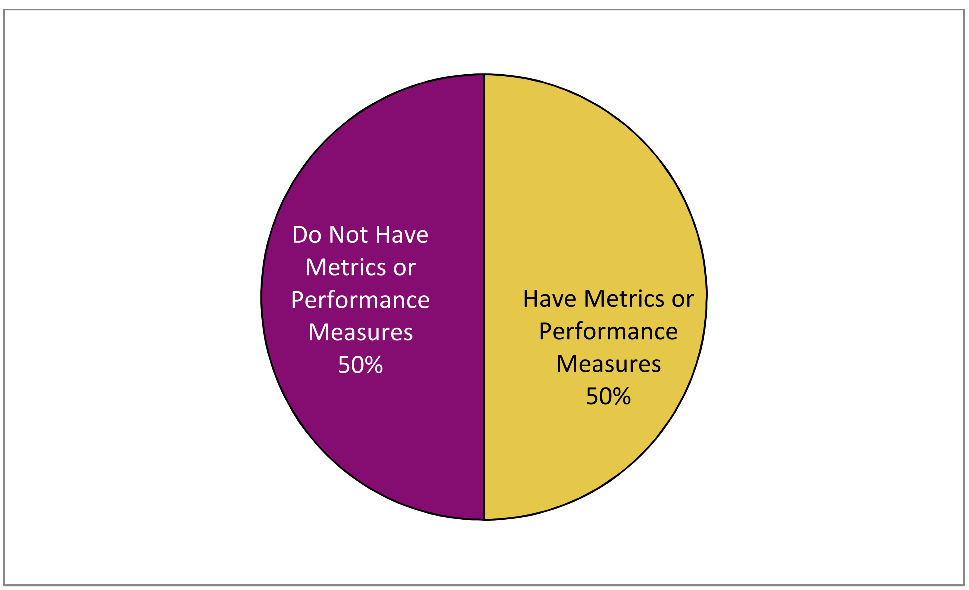
For both the electric and natural gas end-use estimates, none of the respondents based their estimates on energy audits, sub-metering or formal energy management practices. Because of the lack of solid information on energy use in mushroom production, this market segment could benefit greatly from further studies such as baseline surveys. One opportunity for future program design may be more detailed energy modeling for these operations. This can help growers understand their energy usage and the purpose of their energy dollars ($30,000 to $50,000 per month according to both qualitative and technical surveys). Moreover, an audit of one of North America's largest producers—Rolland Farms — reduced the operations' electricity use by 9.5% through cooling improvements. It also reduced natural gas use by 18% through boiler system upgrades and process efficiency improvements.[72] Other such opportunities may become evident once utilities have a better understanding of the segment's specific needs and production requirements.

7.5.2 Energy Management

7.5.2.1 Metrics

Qualitative interviews revealed that growers believe they are already trying to be as efficient as possible, with five of six respondents claiming that energy efficiency is very important to their operation. Technical survey respondents stated that they generally relied on management techniques rather than equipment to minimize their energy costs. This is possibly because some of the smaller mushroom growers do not have the financial capability to upgrade their energy-using equipment. Unfortunately, only 50% could articulate a kWh or Btu per pound metric for their production, as shown in Figure 7.8. This indicates that while the larger, more sophisticated, growers are better able to articulate energy management metrics, the smaller growers are not. As suggested in the previous section, this absence of metrics is an opportunity for utilities to both introduce energy metrics as well as show the long-term value of energy-efficient equipment.

Figure 7.8. Energy Metrics among Mushroom Growers



Source: Technical Survey, n = 8 - multiple responses, "Do you have metrics or performance measures for your energy costs?"

[72] Natural Resources Canada, Canadian Industry Program for Energy Conservation, "10 Companies That are Making a Difference", 2007. Available: http://oee.nrcan.gc.ca/publications/infosource/pub/cipec/annualreport-2008/companies.cfm?attr=24#thinking.

7.5.2.2 Efficient Measures and Savings

Secondary research pointed primarily to air handling or exchange units as technologies appropriate for mushroom production.[73] However, when asked about individual installed efficiency measures, the technical survey respondents referred to a range of 19 equipment installations dating from 2007 to 2011. Individual measures included variable frequency drives, insulation and sealing, and lighting, each receiving three mentions. Respondents could recall only eight of the original savings estimates, which ranged from 5% for the insulation to 25% for the VFDs.

When asked if they had achieved the promised savings, 10 of the respondents stated that they did achieve the expected savings, while one respondent stated that he did not think the installed VFD had achieved its original promise. When asked how they knew that they had achieved these savings, the respondents either knew they had achieved the expected savings by "tracking their utility bills," or they could not articulate how they knew. The respondent who did not think he achieved the expected savings was among those who could not articulate how they came to their conclusions.

When asked where they learned of the installed equipment, six of the 19 relied on information from their local utility, while three relied on vendors. Four of the eight relied on simple payback (in terms of energy savings) to calculate return on investment while three did not calculate a return at all. All eight agreed unanimously that lack of financing and first costs were the primary barriers to the future purchase and installation of energy-efficient equipment. Rebates would allow farmers to overcome these barriers, and could enhance energy efficiency in the mushroom market segment. Utilities should therefore target incentives or rebates to mushroom growers in order to promote energy-efficient equipment installations.

7.6 Mushroom Water Management

According to secondary research, water-related end uses for the mushroom segment include watering and cleaning mushrooms, as well as washing the facilities. Little data exists regarding standard irrigation practices in the mushroom segment. However, known technologies include micro-sprinkler and drip irrigation systems that maintain soil moisture.

Technical surveys indicated that mushroom growers' sensitivities to disruptions of water and electric service were nearly the same, 9.4 and 9.8, respectively.[74]

Only one technical survey respondent mentioned water as a significant operating concern. However, qualitative interview respondents split evenly when asked if water regulations affected their operations. Most of the water regulations relevant to mushroom production refer to effluent and overflow. Because of this, wastewater regulations tend to have a higher impact on operations situated in a floodplain. To comply with these regulations, growers must often run expensive wastewater tests and install lagoons or storm-water management plants. The consensus among interview respondents was that initial compliance with water regulations was quite costly. However, many of the respondents had installed

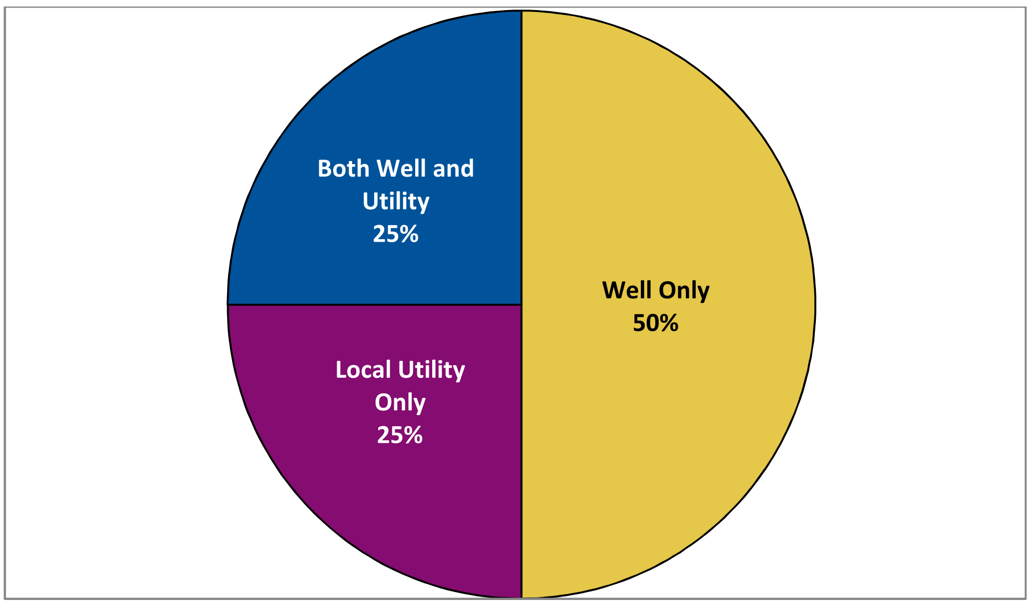
[73] James Grant and Liam Staunton, 1999. Integrated Environmental Control in Mushroom Tunnels. Kinsealy Research Centre. http://www.teagasc.ie/research/reports/horticulture/4093/eopr-4093.pdf.
[74] On a scale of 1 to 10, how sensitive is [your operation] to interruptions in your water/electric supply?

wastewater management systems years ago, making compliance with these regulations far less costly than it might have been.

7.6.1 Sources and Uses

As shown in Figure 7.9, half of the technical in-person interview respondents took water from on-site wells while two relied upon local water utilities. The remaining two respondents had access to both. Water use among these respondents included growing operations (eight mentions); cleaning/washing (four mentions); irrigation (three mentions); and cooling (two mentions).

Figure 7.9. Water Sources for Mushroom Growers



Source: Technical Field Survey, n = 8, "From what source do you receive your water?"

7.6.2 Management and Equipment

Five of the eight in-person technical survey respondents managed their water use through recycling or reuse. Only one actively tracked moisture levels. Given that pumping is a significant end use and the reliance on wells combined with limited efforts in formal water management, pump optimization and testing may provide opportunities for programs in this segment.

Qualitative interviews found that most of the waste management regulations that the growers identified involved the disposal of "spent" – the residual compost waste generated by mushroom production. Some growers send their "spent" to other farms to be composted, while others compost their own. Only two respondents could identify specific equipment used for solid waste: "dump trays" and "dedicated waste bins." One respondent claimed there were local regulations designating the amount of "spent" that operators can keep on the farm due to the smell. Another qualitative interview respondent claimed he had to autoclave his disposable bags before throwing them into the trash. However, despite these regulations, nearly all of the growers said that the regulations do not have a significant effect on their operations.

7.7 Mushroom Conclusions and Recommendations

Conclusion 1: The California Mushroom segment is stable with a limited number of market actors, although demand for all varieties may increase over time. Sustainability is a hallmark of this segment that has not yet translated into energy efficiency as a segment-wide priority.

Recommendation 1: Because of the small number of commercial growers (15 Agaricus and up to 40 "specialty"), it may not be practical to develop mushroom-specific programs or measures. However, general outreach through reference partners regarding existing programs could increase the participation of this segment in utility programs.

Conclusion 2: While growers did identify energy as a leading cost component, none of the data collection activities (technical, qualitative or subject matter expert) revealed great concern or urgency to reduce or even manage energy use. Nearly half of technical survey respondents did not have energy metrics.

Recommendation 2: Outreach with an emphasis on resources to develop energy metrics as part of growers' overall sustainability efforts would be the first step in raising the profile of energy efficiency in this segment. While growers view their electric and natural gas utilities as sources of information, it is organizations like the American Mushroom Institute that can actually motivate growers to take action. Once motivated to develop metrics and manage to them, mushroom growers will more readily see the value of efficient equipment installation and participation in utility programs. Cooling and pumping equipment will be the most likely candidates for such programs.

Conclusion 3: Long-term labor costs and availability may lead to greater mechanization and, therefore, greater energy use. Any shift towards increased mechanization may start slow but disruptions in labor supplies will accelerate this process.

Recommendation 3: Utilities have an opportunity to engage with growers in their decision to purchase equipment, before and during this transition. By educating growers regarding life-cycle costing and energy efficiency, utilities can insure that mechanization adds to as little of load as possible in this segment. If utilities engage after the transition, the opportunities for efficiency will likely be less extensive and more costly.

8 Field Crops

8.1 Key Findings and Recommendations

Field crop production occurs at the initial stages of the agricultural supply chain. **Production among respondents has generally been increasing**, primarily due to **increased consumer demand**. Major production costs include materials, labor and electricity, and water, of which the latter is estimated to be the most influential factor on future production.

In field crop operations, both **electricity and natural gas are predominantly devoted to water pumping** when farms' sole business includes field crop production. However, when ancillary services such as cold storage are included, the end uses vary significantly. When making energy-using equipment purchases, farm operators **see utilities as a source of information, but do not rely on them for energy decisions**. Equipment and cost considerations will typically **favor water conservation over energy efficiency.**

Program design for irrigated agriculture should **focus on equipment that will save water as well as energy** because field crop growers tend to favor water conservation over energy efficiency. Navigant recommends that any future programming for this segment address the measure **impact on the grower's water consumption** as well as energy usage.

As with fruit, tree nut, and vine crop growers, Navigant recommends that programming **address the varied end uses of vertically integrated operations**. Some field crop growers have both electric and natural gas-fired pumps in addition to greenhouses for growing seed stock or refrigeration for post-harvest cooling. Growers will tend to be more amendable to programming that **addresses the overall operational needs** rather than disparate sets of measures that address varied end uses.

8.2 Methodology

8.2.1 Secondary Research and Literature Review

To gain an understanding of the information that currently exists on the Field Crop market segment, Navigant's research team began by conducting secondary research. Sources ranged from agricultural statistical surveys, such as the 2007 Census of Agriculture, to peer-reviewed publications and IOU program evaluations. Using this array of sources, Navigant conducted an extensive literature review, complete with an annotated bibliography. The findings from this research are located in the Irrigated Agriculture chapter in the *Literature Review for the 2010 – 2012 Statewide Agricultural Energy Efficiency Potential & Market Characterization Study.*

8.2.2 Primary Data Collection

Having conducted secondary research on the market, Navigant was able to identify the knowledge gaps on which the team's primary data collection should focus. As illustrated in Table 8-1, this research included technical surveys – via both telephone and in-person – as well as qualitative interviews.

Table 8.1. Data Collection for the California Field Crop Segment

	Number of Completed Interviews
Subject Matter Experts	4
Technical Surveys (Telephone/In-Person)	14/12
Qualitative Interviews	6

8.2.2.1 Subject Matter Expert Interviews

The research team conducted interviews with four subject matter experts to gain a high-level understanding of segment trends and developments. Subject matter experts held a variety of positions at industry organizations. One expert held a farm advisory role for Yolo and Solano Counties. The other three experts worked at renowned research institutions, including:

- Cal Poly San Luis Obispo’s Irrigation Training & Research Organization
- California State University Fresno, Center for Irrigation Technology
- University of California Cooperative Extension

8.2.2.2 Technical Surveys

The research team conducted technical phone surveys with 14 individuals in the Field Crop market segment. These surveys addressed topics such as operation firmographics, energy management and practices, waste and water issues, and business cycles. The team conducted an initial phone survey with each respondent that covered these topics at a high level. For those respondents who agreed to participate in a follow-up survey, a member of the research team gave one of three subsequent surveys – typically at the respondent’s farm – based on the respondent’s sophistication of energy metrics and history of measure implementation. Twelve of the 14 telephone respondents agreed to participate in the follow-up surveys.

Figure 8.1. Map of Field Crop Technical Survey Respondent Locations

Source: Navigant analysis

8.2.2.3 *Qualitative Interviews*

The research team conducted six qualitative interviews via telephone. The qualitative interviews were designed to complement the technical information, examining agricultural energy usage and efficiency potential. The qualitative interviews focused on market expectations, behaviors and practices, and potential barriers and opportunities related to increased efficiency.

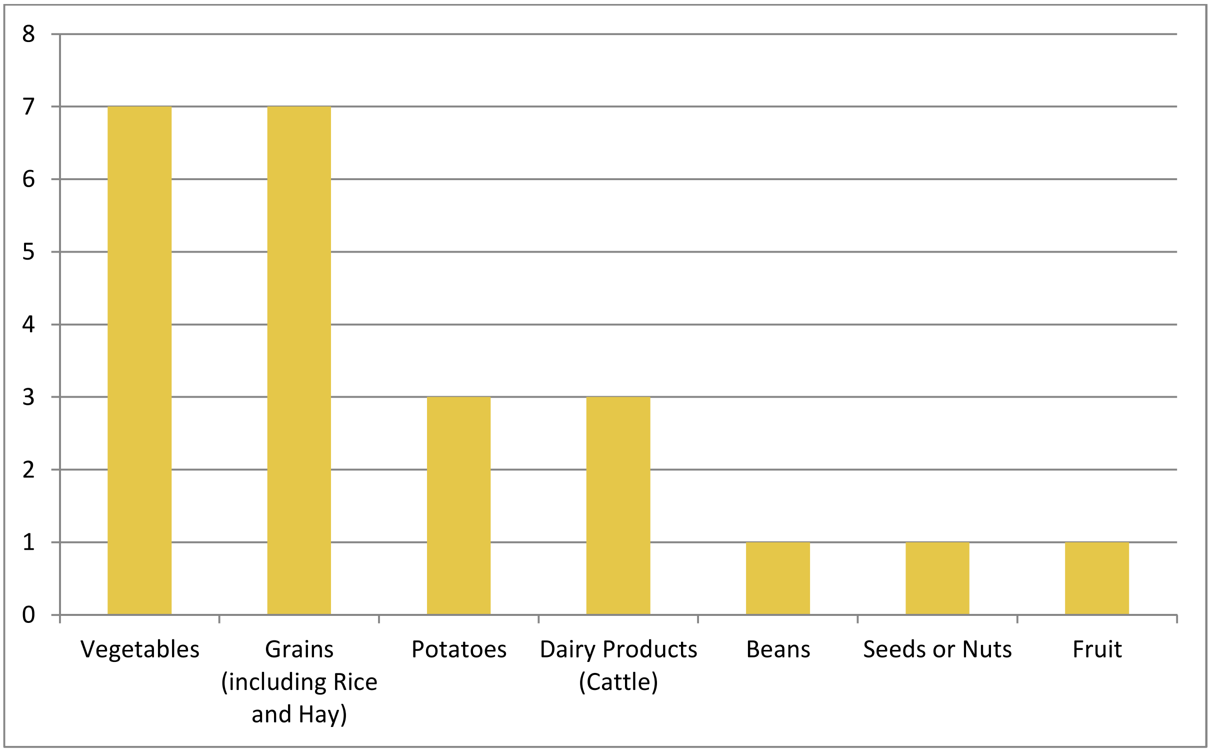
8.2.2.4 *Firmographics*

The Field Crop market segment is extremely diverse in terms of market actors, owing largely to the variety of field crops that exist, the tendency for farmers to grow multiple crop types, and the popularity of demand-influenced crop rotation. As detailed in Section 8.4, fewer than one third of the state's farms and ranches control 60% of California's 8 million irrigated crop acreage. Except for forage and rice crops that predominantly utilize non-pressurized surface irrigation practices, most of the high-value orchard, vineyard, and vegetable crops are irrigated using pressurized irrigation technologies. The market trended toward drip and subsurface irrigation from 1994-2008. However, producers are currently reversing that trend, shifting once again toward pressurized irrigation systems. Section 8.6 discusses this trend in further detail.

To verify the findings from secondary research, the research team interviewed a number of California Field Crop growers. Of the 14 technical phone survey telephone respondents, seven were farm owners, five were in management positions, and the remaining two were an Energy Analyst and the CFO, respectively. Eleven of the 14 respondents interacted with their local utility representatives in their role, and all but one tracked production costs.

The average age of the sample farms was 47 years old; however, the age of the farm ranged from 2 years to 122 years in operation. Farm acreage ranged from 35 to 7,000 acres, averaging 1,560 acres. When asked about the main products grown on their farm, seven of the technical phone survey respondents claimed to grow grains, including rice, wheat, and hay. Another seven respondents grew at least one type of vegetable, and other crops mentioned included potatoes, fruits, and beans. Ten of the 14 respondents claimed to grow their main crops every year, while the other four practiced regular crop rotation. As seen in Figure 8.2, three of the 14 respondents ran small dairy farms in addition to their primary operations. This finding exemplifies the vertical integration that is common practice in the agricultural industry. Although a farm may fall under an individual NAICS code, the operations themselves are often very diverse in terms of products. Utilities should be aware that targeted programs such as those for dairies could serve a broader agricultural market than the intended segment.

Figure 8.2. Main Products of Field Crop Farmers



Source: Technical Phone Survey, n = 14 – multiple responses, "What are the main products that you produce?"

8.3 Structure of Field Crop Market Segment

8.3.1 Definition of Market Segment

The Field Crop market segment falls primarily under the 111 NAICS category, which includes "crops [grown] mainly for food and fiber."[75] For the purposes of this report, Navigant has included NAICS 1111 (Oilseed and Grain Farming), 1112 (Vegetable and Melon Farming), and 1119 (Other Crop Farming) in this section.[76] The broader NAICS 111 also includes greenhouses, vines, and tree nuts, which are covered in Section 3 (Fruit, Tree Nut, and Vine Crops) and Section 6 (Greenhouses and Nurseries).

8.3.2 Description of Supply Chain

Field crop production occurs at the initial stages of the agricultural supply chain. Field crop growers source the materials from various companies and utilities. These materials can include water, fuel, seeds and starter plants, which typically ship via truck. Each year, when field crop growers have cultivated and harvested their crops, they will transport their products by truck, plane, or automobile to their customers. When asked who these customers were, the qualitative interviews revealed that three of six field crop respondents sell directly to the end user by means of farm stands. Another two respondents sell to retail stores, while other responses included food processors, distribution centers, "big box"

[75] North American Industry Classification System, 2007, http://www.census.gov/econ/industry/def/d111.htm.
[76] NAICS 2007.

stores, and restaurants. Most of the respondents reported to operate at a local level, while one respondent also sold their products to end users across the U.S. Two respondents declined to answer.

8.3.3 Description of Market Reference Partners

A number of high-profile industry organizations support California's Field Crop market segment. These organizations offer best practice information, member benefits, scholarships, and research publications. Some of the key industry organizations include the following:

- California Farm Bureau Federation
- California Department of Food and Agriculture
- California Agricultural Irrigation Association
- Grower-Shipper Association
- Western Growers

The Navigant research team reviewed each organization's website and relevant publications. Many of the topics addressed on these websites include recent news about the field crop market, water use, and conservation practices, discussions around relevant regulations; and statistical information on California field crop production. Navigant found that the California Farm Bureau was the only one of the three organizations that offers energy education on their website. This site devotes a subsection on the "Issues and Regulations" tab to the topic of on-farm energy use. This subsection offers energy-saving tips, brief fact sheets, and links to websites such as the CEC's site for further information. However, there is no mention of utilities or energy programs for growers. Given the prominence of these organizations within the segment, utilities should engage these groups to promote irrigation programs and offer updated information regarding on-farm energy efficiency.

California also hosts a number of research associations operated out of the state's leading academic institutions. These associations include, but are not limited to, the following:

- Cal Poly Irrigation Training & Research Center
- University of California (Davis) Agricultural Extension
- California State University (Fresno) California Water Institute
- UC Cooperative Extension
- Fresno State Center for Irrigation Technology

These organizations are devoted to research in the irrigated agriculture segment. Although their purpose is not explicitly to provide general information to the public, much of their research informs growers and other market actors of innovations available to the market. Utilities could collaborate with these institutions to ensure that they remain informed of the most current research available. Furthermore, a partnership with these institutions could allow for research and development into specific technologies, as well as the promotion of energy-saving measures within the market.

To identify the information channels that respondents used for energy-related issues, Navigant asked operators to identify their main sources of energy-related information. Ten of 14 respondents listed their local utility, indicating that field crop growers recognize the value of their utility for information. Other information sources included vendors, contractors, and private consultants. Some of the government and academic institutions listed above were also mentioned, namely the UC Davis Agricultural Extension and the USDA Extension Service. While five of the technical survey respondents listed vendors as a source of information, only one of the six qualitative interview respondents considered their suppliers to be knowledgeable about energy efficiency. Utilities could work with suppliers and vendors to educate them on energy efficiency opportunities in the agricultural market. Increased energy awareness within the supply chain could, in turn, result in increased awareness among growers themselves.

8.4 Status of Field Crop Market Segment

California farms irrigate over 8 million acres of arable land,[77] employing mostly electric power to extract, move, and pressurize water for food and fiber commodities. In 2010, California's 81,700 farms and ranches generated a record $37.5 billion in revenue.[78] Although these operations occupied over 25 million acres, only 8 million of these acres were irrigated. Less than one third of California's farms and ranches controlled 60% of these irrigated acres,[79] 83% of which they cultivated for orchards, forage crops, vegetables, grapes, and rice, as shown in Table 8-2.

Table 8.2. California's Major Irrigated Acreage by Crop, 2007

Type of Crop	Irrigated Acreage
Orchards	2,728,176
Forage (includes hay and haylage, grass silage, and greenchop)	1,554,197
Vegetables	968,965
Grapes	868,330
Rice	531,075
Total	6,650,743

Source: 2007 Census of Agriculture

8.4.1 Market Trends

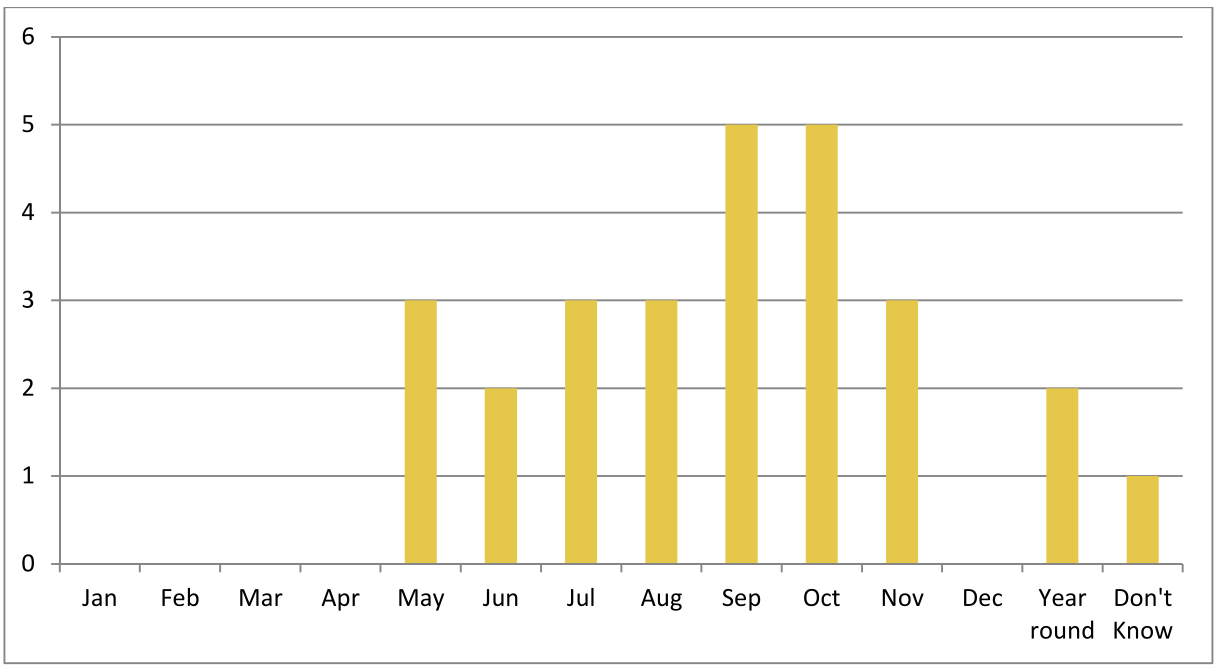
Secondary research and subject matter expert interviews revealed that the most significant trend occurring in the Field Crop market segment is the widespread adoption of pressurized irrigation systems. Section 8.6 covers this topic in greater detail.

To gain an understanding of market trends amongst individual operators, Navigant asked technical survey respondents about their production over the last two years. Ten of the 14 respondents claimed

[77] National Agricultural Statistics Service (NASS), 2009, *2007 Census of Agriculture: United States*. U.S. Department of Agriculture. Report No. AC-07-A-5. http://www.agcensus.usda.gov/Publications/2007/Full_Report/usv1.pdf.
[78] California Agricultural Statistics, 2010 Crop Year, USDA National Agricultural Statistics Service http://www.nass.usda.gov/Statistics_by_State/California/Publications/California_Ag_Statistics/Reports/2010cas-all.pdf.
[79] NASS, 2009.

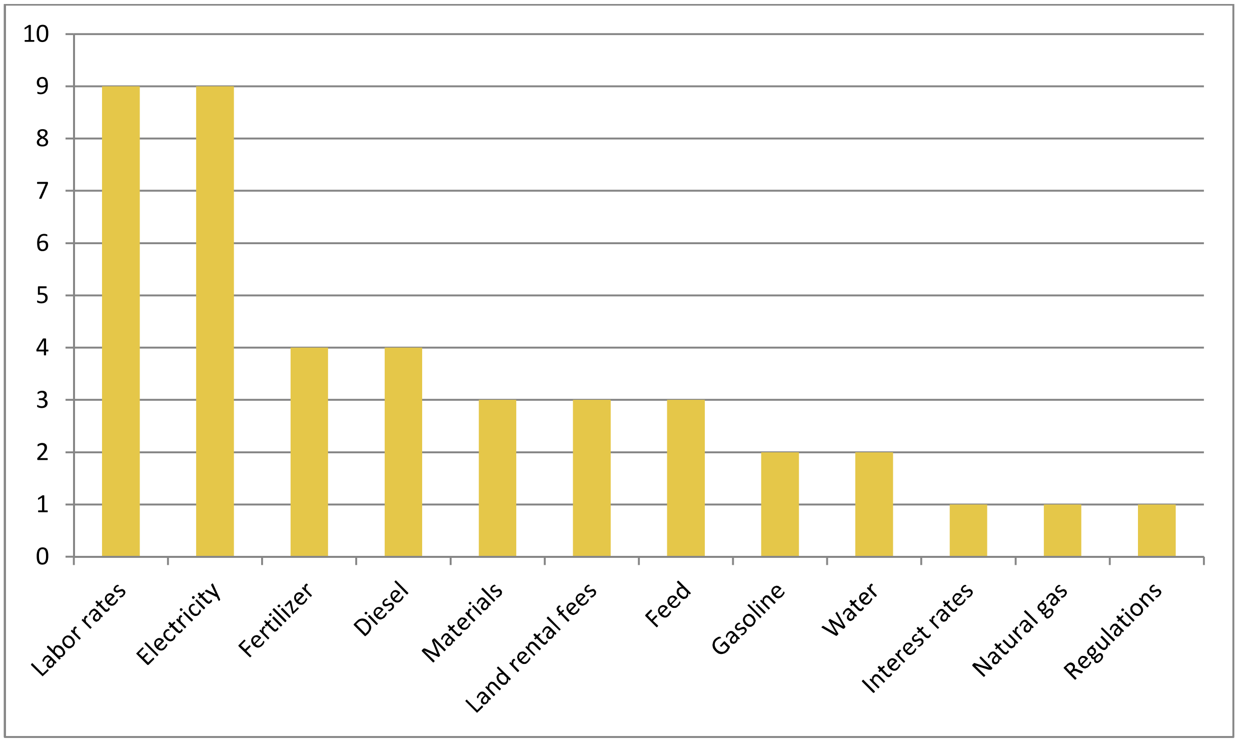
that production had increased over the last two years, primarily due to an increase in consumer demand. Year-round production patterns are illustrated in Figure 8.3. When asked their greatest production costs over the last two years, most respondents listed labor rates and electricity (see Figure 8.4). Unlike other market segments that viewed labor rates as a higher cost than electricity, field crop respondents appeared to be equally concerned with the cost of electricity and labor. This is presumably because of the segment's heavy reliance on pumping water, which requires high amounts of electrical power. Of the five respondents who did not mention electricity in their original response, four agreed that it was also a major cost when probed on the subject. Natural gas, however, was less of a concern for field crop respondents. Of the five natural gas customers in the sample, only one initially listed it as a major cost. Upon asking the other four about their natural gas costs, three respondents stated that natural gas was not among their top operating costs. Indeed, while electricity constituted up to 50% of growers' operating costs, natural gas costs only came to 5% at most.

Figure 8.3. Year-Round Production Patterns



Source: Technical Phone Survey, n = 14 – multiple responses, "In what months is your production the greatest?"

Figure 8.4. Greatest Production Costs of Field Crop Farmers



Source: Technical Survey, n = 14 – multiple responses, "What are your top three production costs?"

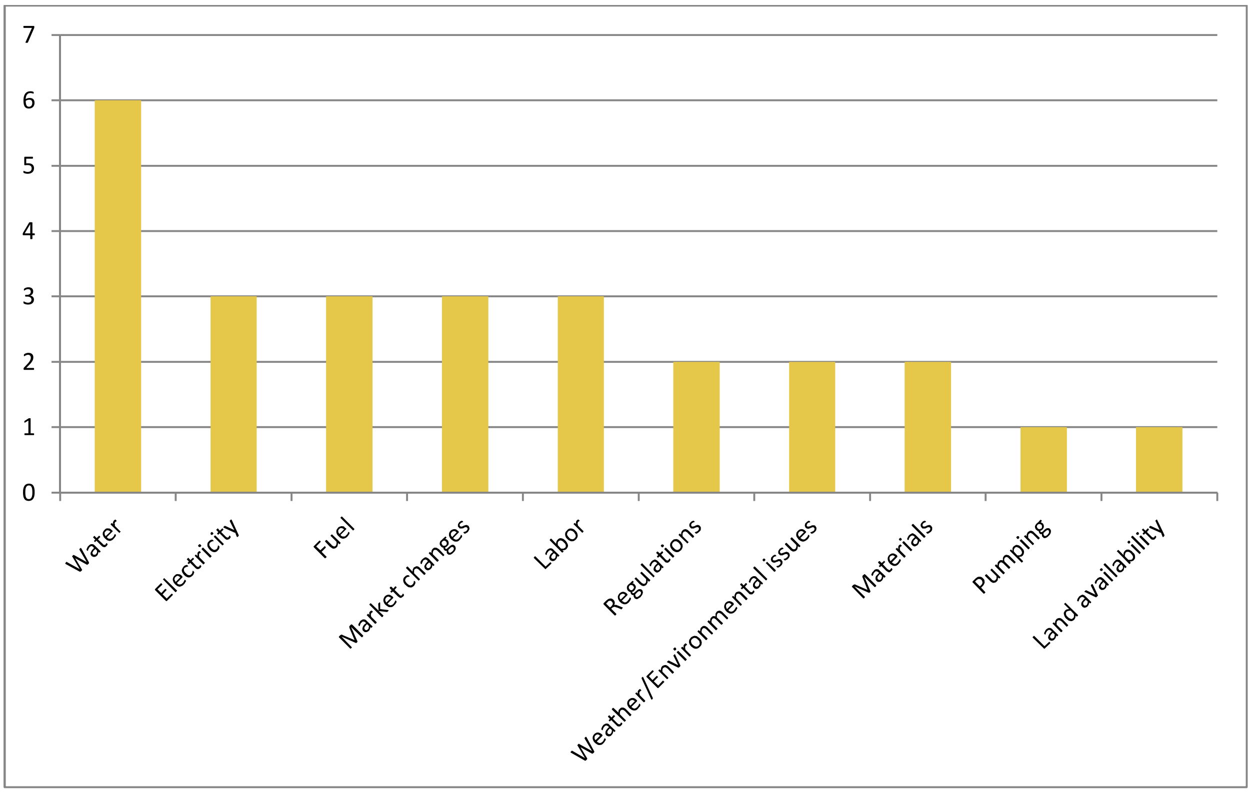
The production costs as specified by qualitative interview respondents were similar to the responses from the technical surveys; five of the six respondents listed labor as the main production cost in the last two years, followed by energy, fuel, and fertilizer. Respondents also deemed natural gas a relatively insignificant expense as compared to other costs. The findings from both sets of interviews indicate that for field crop program design to be successful, utilities should focus heavily on electricity-related rebates, as gas-related programs will be less applicable to this market segment.

8.4.2 Future Prospects

When asked about their outlook on the future of their industry, qualitative interview respondents suggested that they expected strong demand for their services, particularly for specialty, organic, and locally grown crops. This is largely due to consumers' increasing awareness of how they source their foods. One respondent warned that while demand will continue to grow, the outlook of the California market will depend heavily on international markets. Although respondents were optimistic about demand growth, they also identified a number of challenges to their operations. The primary concern was increasingly stringent regulations, in some part due to the use of genetically modified organisms/food in the agriculture business. Other concerns included labor availability and competition at the local, state, regional, national, and international levels.

Navigant also asked technical survey respondents about their projected future costs. As seen in Figure 8.6, six of 14 technical survey respondents identified water as a top factor affecting their future production. This is in line with the subject matter interviews, which also showed water to be a main concern for the Field Crop segment. As one market expert explained, field crop farmers will prioritize water quality and access over cost, and will pay higher water costs as long as it is profitable to grow that crop. However, if a particular crop becomes too costly to grow, a farmer may choose to fallow their rows rather than forfeit that revenue. Utilities should recognize that as a segment with the options to fallow, rotate, or change crops altogether, growers will make choices that increase production yield at the lowest possible cost. In a market with increasing utilities, this will result in the prioritization of water over energy efficiency. Utilities should therefore be prepared to present their programs in a manner that acknowledges, if not promotes, water efficiency as well as energy efficiency.

Figure 8.4. Factors Influencing Future Field Crop Production



Source: Technical Phone Survey, n = 14 - multiple responses, "What factors do you think will most impact your future production?"

8.5 Energy Use and Efficiency in Field Crop Segment

Irrigated agriculture consumes the most electricity of any agricultural market segment in the California IOU service territory, equaling 39% of the market's overall electricity consumption (see Figure 8.5).[80] The balance of the electrical use depends on the crop grown, the hydrological conditions, climate, and the extent to which the business engages in Post-Harvest activities. Similarly, embedded energy associated with groundwater resources varies by source and location (see Table 8.3). Gas sales to the irrigated

[80] 2011 QFER data provided by California IOUs through Market Characterization Data Request.

agriculture sector constitute a much smaller portion of the market share, representing approximately 15% of the IOUs' total sales in 2010 (see Figure 8.6). Gas usage in this market segment contributes primarily to gas-fired irrigation pumping, although secondary processes such as small-scale dairy farming or greenhouse cultivation could also be contributing factors. When designing programs, utilities should consider the heavy use of electricity in the market segment, as well as the supporting practices that can take place on irrigated agriculture farms. Figure 8.7 and Figure 8.8 illustrate the usage patterns for on-farm electricity and gas.

Table 8.3. Embedded Energy in Water (Sample for Central Valley)

Source	Embedded Energy
Sample Groundwater[81]	210–430 kWh/AF
State Water Project Imports[82]	600–700 KWh/AF
Central Valley Project Imports[83]	200–650 kWh/AF
	(AF = Acre-foot = 325,851 Gallons)

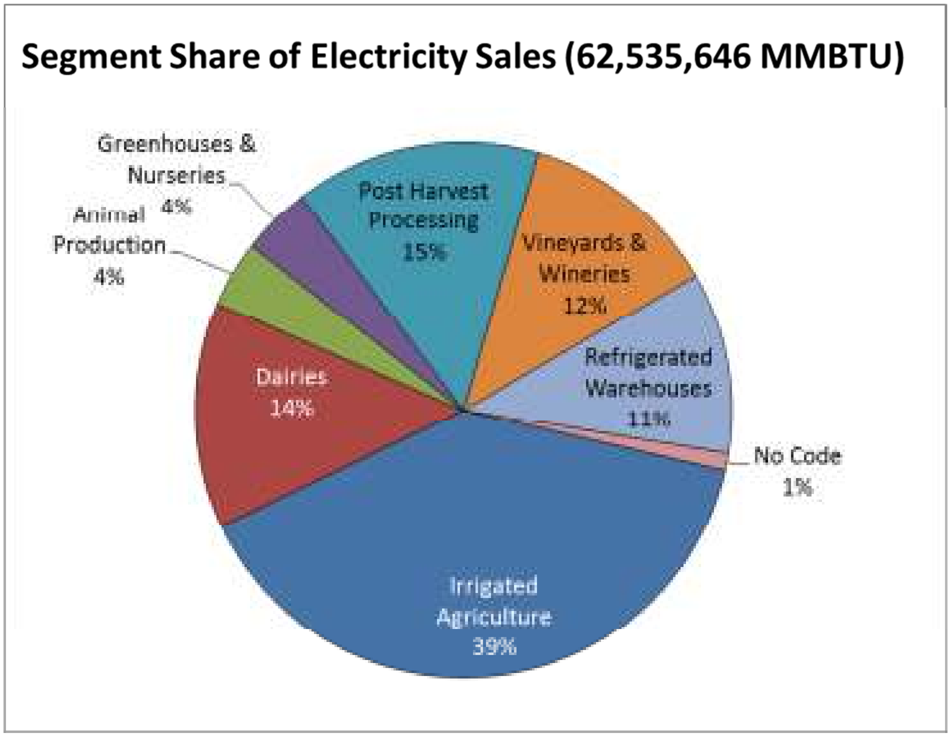
Source: GEI Consultants and Navigant Consulting, Inc. 2010. See footnotes 81 – 83.below.

[81] GEI Consultants and Navigant Consulting, Inc. 2010. *Embedded Energy in Water Studies—Study 1: Statewide and Regional Water-Energy Relationship*. San Francisco, Calif.: California Public Utilities Commission. CALMAC Study ID CPU0052. Appendix G, page G2. http://www.cpuc.ca.gov/PUC/energy/Energy+Efficiency/EM+and+V/Embedded+Energy+in+Water+Studies1_and_2.htm.

[82] "CPUC Study 1: Wholesale Water Energy Model": http://arcgis01.geiconsultants.com:8080/waterEnergy/.

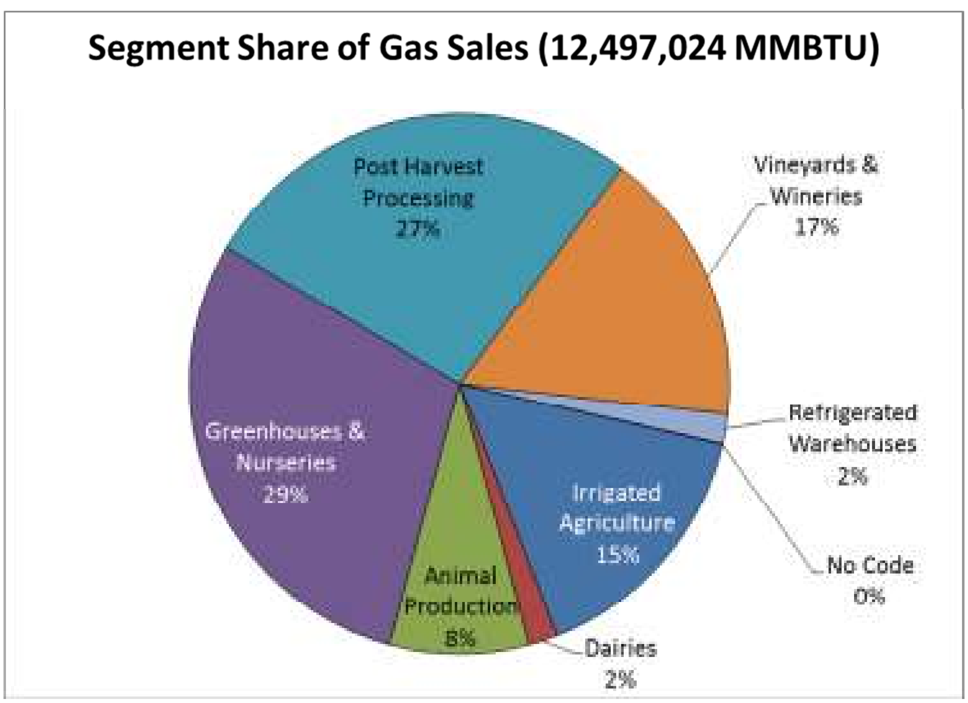
[83] "CPUC Study 1: Wholesale Water Energy Model": http://arcgis01.geiconsultants.com:8080/waterEnergy/.

Figure 8.5. 2011 California Agriculture Consumption of Electricity (IOUs Only)



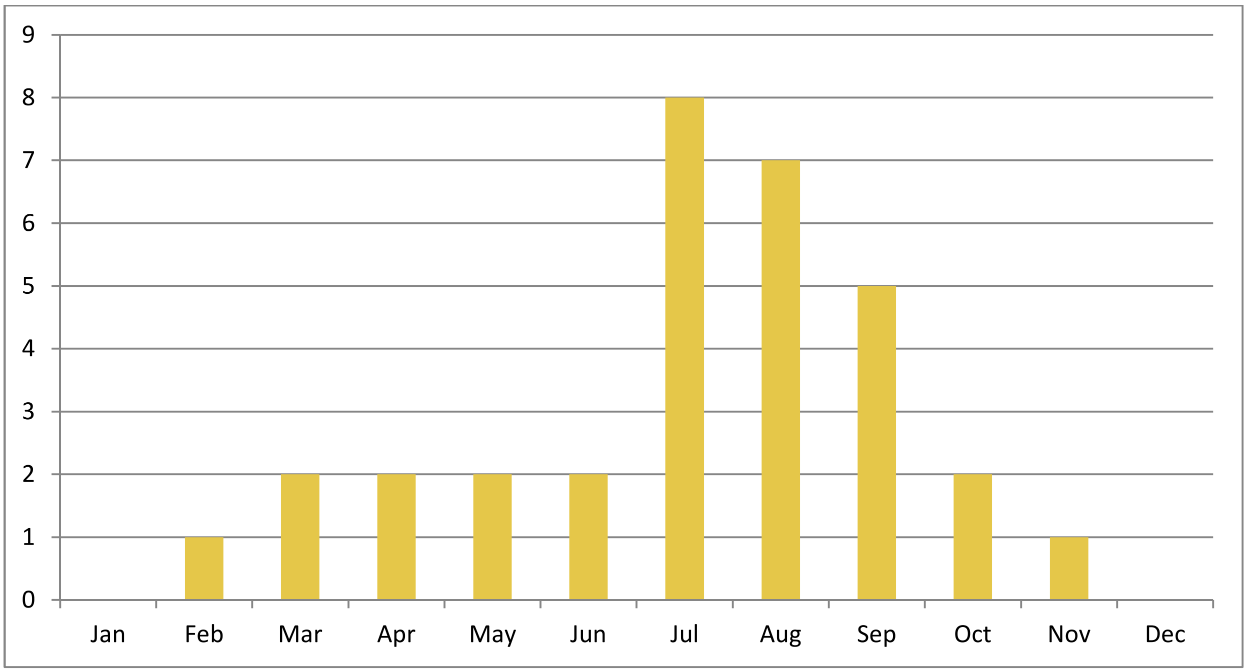
Source: Navigant analysis of CPUC electric consumption data

Figure 8.6. 2011 California Agricultural Natural Gas Consumption (IOUs Only)



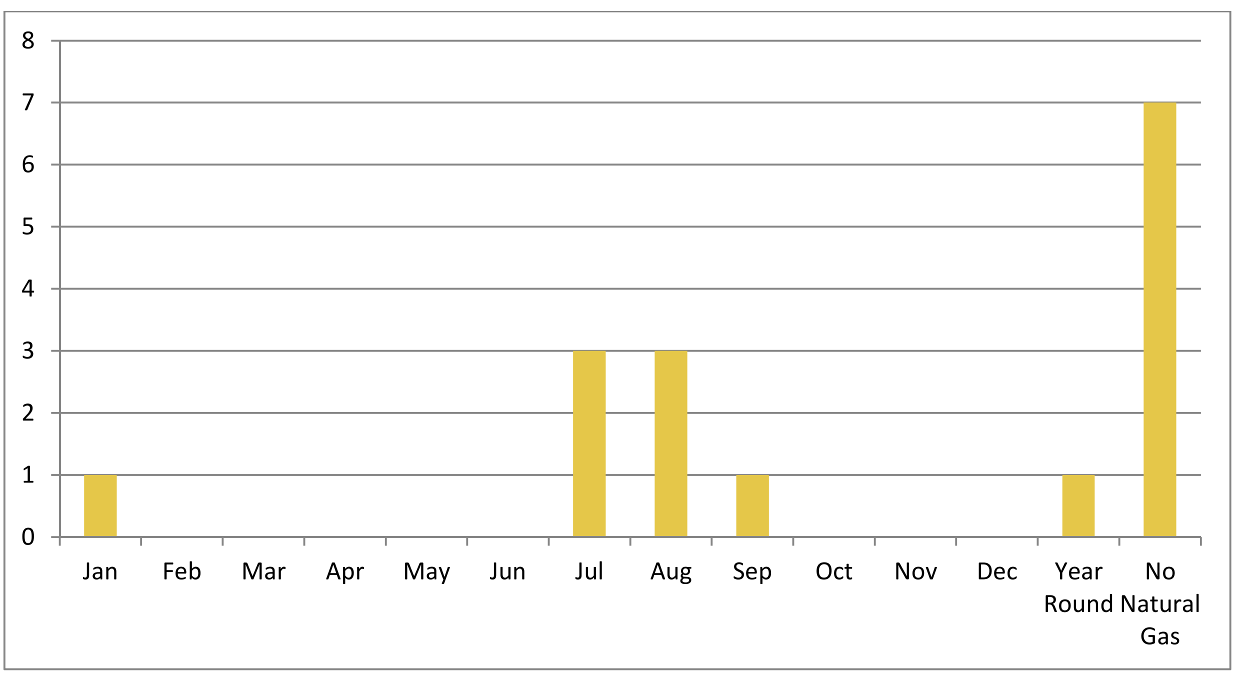
Source: Navigant analysis of CPUC gas consumption data

Figure 8.7. Field Crop Electricity Usage by Month



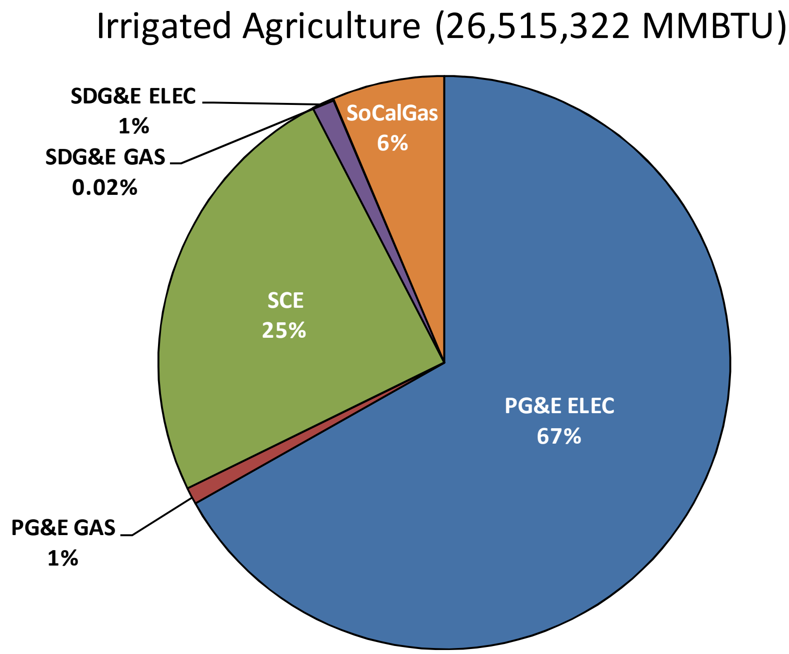
Source: Technical Field Survey, n = 12 – multiple responses, "In which month is your electricity usage the greatest?"

Figure 8.8. Field Crop Natural Gas Usage by Month



Source: Technical Field Survey, n = 12 - multiple responses, "In which month is your natural gas usage the greatest?"

Figure 8.9: 2010 Irrigated Agriculture Energy Sales by IOU



Source: Navigant analysis of CPUC electric consumption data

8.5.1 Energy End Uses

Although there is some natural gas use in field crop operations, electricity is the dominant fuel type used in this market segment. Water pumping typically accounts for more than 95% of all on-farm electric use.[84] California's electricity demand from groundwater pumping comes to 4.5 million MWh per year, with an additional 2.9 million MWh per year from the use of on-farm booster pumps.[85] While groundwater pumping consumes a significant amount of the segment's energy, most field crop operations receive surface water allocations from irrigation districts. Field crop operations also use electricity for pumping and transportation of surface water resources through conveyance and delivery systems.

The use of surface water is declining within this segment, however, as farms convert their land use to higher value crops. Because irrigation district water is not always available when farmers need it, the segment is trending toward the widespread adoption of pressurized groundwater systems. To accommodate this vast adoption of new irrigation technology, many irrigation districts are investing in modern water delivery systems. However, market experts agree that the trend toward pressurized

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[84] V. Cervinka et al. 1974, Energy Requirements for Agriculture in California. Davis, Calif.: *California Department of Food and Agriculture*.

[85] Charles Burt, Dan Howes, and Gary Wilson (Irrigation Training and Research Center), 2003, *California Agricultural Water Electrical Energy Requirements.* Sacramento, Calif.: Public Interest Energy Research Program. ITRC Report No. R 03-006. http://www.itrc.org/reports/energyreq/energyreq.pdf.

irrigation systems will continue, and will have a significant impact on the segment's electricity consumption.

In addition to the adoption of pressurized irrigation, many farmers who previously relied on diesel engines are changing to electric motors. The combination of these trends will make it critical for utilities to recognize and adapt to the increasing electric consumption that will likely arise in the near future. Pressurized irrigation systems can be extremely energy intensive, thus highlighting the need for farmers to improve pump efficiency on their farms. One subject matter expert emphasized the need to develop crop rotations using a whole-farm systems approach, with a particular focus on the type of irrigation method that is best suited to the crop. To help mitigate increasing electricity consumption, utilities should help individual field crop customers to develop holistic farm design strategies. Emphasizing pump optimization and crop-specific irrigation technologies will be vital for utilities working with this segment. There is also increasing opportunity for utilities to promote ancillary services such as water recirculation pumps and water storage, which could reduce the use of electricity for groundwater pumping.

When asked about their on-farm electricity usage, 11 of the 12 technical field survey respondents who offered meaningful responses[86] listed water pumping or irrigation among their most electricity-intensive processes. This process reportedly consumed between 70 and 100% of farms' electricity usage. All but one of the respondents based their estimates on the recollection of their financial records, suggesting that respondents are aware of the energy consumed on their farms. Those who claimed that water pumping used less than 70% typically listed refrigeration – or, in one instance, a milking barn – as a higher cost. This suggests that water pumping is the most significant energy consuming end use on farms where field crop production is the primary or only business function. However, when farms engage in secondary processes, such as cattle production or on-site cold storage, these services could alter the energy consumption patterns of the farm. In designing programs or offering incentives, utilities should be aware that field crop farms could have alternative operations running at any given time. This could present an opportunity for utilities to extend other programs to field crop producers, such as those targeting the Dairy segment.

The technical surveys supported the finding that natural gas is less common among field crop operations. Seven of the 12 technical field interview respondents did not use any natural gas on their farms. Of those who did use natural gas, respondents used this fuel for well pumping, although respondents also mentioned processing equipment, water heating, peelers, and juicers. Where respondents listed pumping as their primary end use, this process reportedly constituted 50-100% of the farm's natural gas usage, based on the respondents' recollection of their financial records. This indicates that regardless of the fuel source, well pumping serves as a major end use across field crop production, and should be targeted in future program design.

[86] One of the respondents offered electricity-consuming end uses; however, no percentage of electricity consumption was offered. Navigant believes that this response was atypical of field crop producers and provided insufficient information to include these particular questions in the data set.

Table 8.4. Self-Reported Estimates of Electric End Use among Field Crop Farmers

End Use	Number of Mentions	Range of Consumption Estimates	Average Consumption Estimate
Pumps	10	15%-100%	67%
Lighting	3	5%-10%	8%
Cold storage	2	30%-80%	55%
Drying	2	15%	15%
Irrigation	2	20%-90%	58%
Processing	2	20%-25%	23%
Shop equipment	2	5%-10%	8%
Condensers	1	30%	`
Cooling	1	10%	10%
Manure management	1	10%	10%
Milking barns	1	40%	40%
Packing line	1	5%	5%

Source: Technical Survey, n = 12 - multiple responses, "Which processes or equipment use the most electricity?"

Table 8.5 Self-Reported Estimates of Natural Gas End Use among Field Crop Farmers

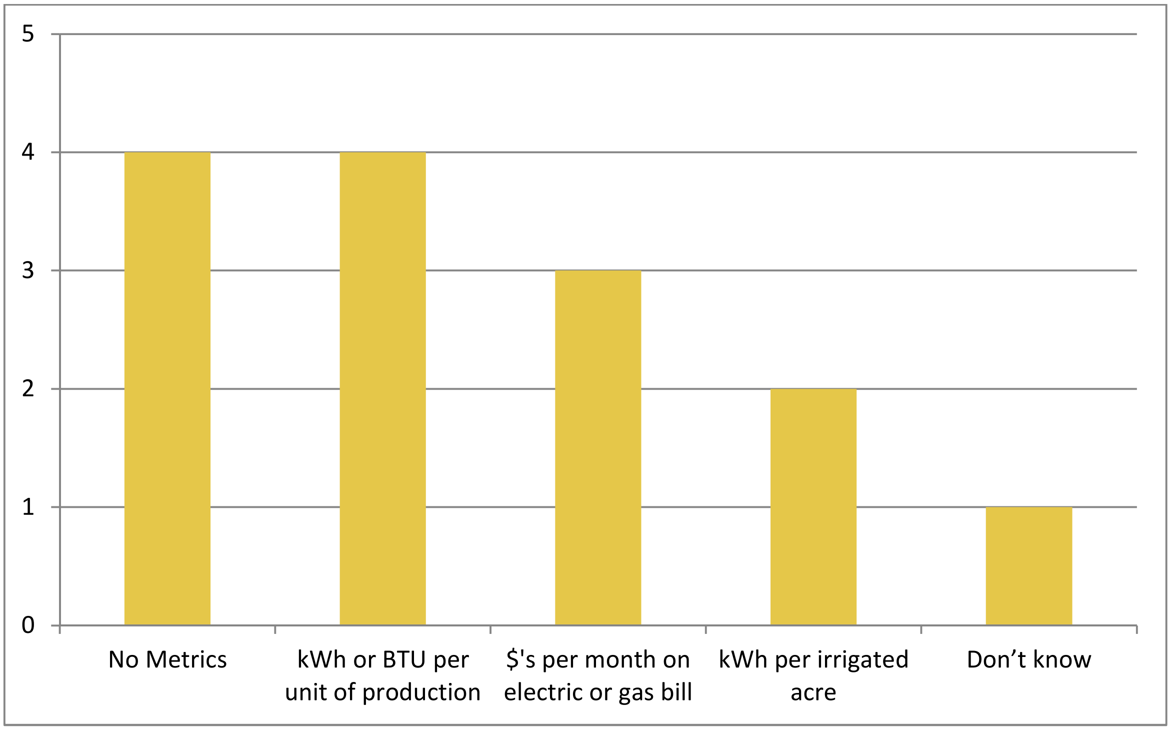
End Use	Number of Mentions	Range of Consumption Estimates	Average Consumption Estimate
Pumps	3	50%-100%	75%
Water heating	2	50%	50%
Peelers	1	30%	30%

Source: Technical Survey, n = 5 - multiple responses, "Which processes or equipment use the most natural gas?"

8.5.2 Energy Management

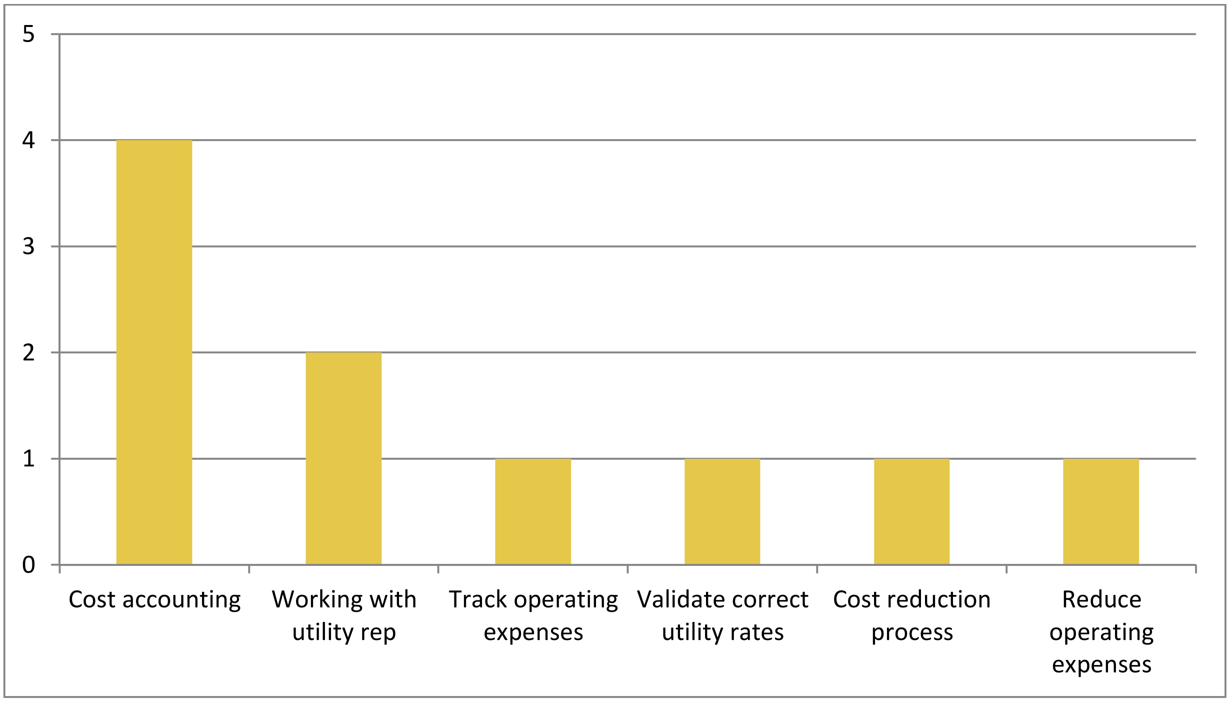
Every technical survey respondent reported to have metrics or performance measures for energy costs in their operations. When asked how they measured their performance, half of the respondents claimed to use kWh or Btu per unit of production and another quarter used kWh per irrigated acre (see Figure 8.10). Most of the respondents had been tracking these metrics since the early 2000s, although some operations had been tracking since the 1960s-1970s. All 14 respondents who tracked their metrics claimed to have developed them internally, using the methods illustrated in Figure 8.11. The popularity of metrics within this segment suggests that field crop producers are already cognizant of energy use. Producers would likely welcome further utility assistance to increase energy efficiency.

Figure 8.10. Metrics or Performance Measures for Field Crop Growers



Source: Technical Phone Survey, n = 14, "Do you have metrics or performance measures for energy costs?"

Figure 8.11. Field Crop Respondents' Reasons for Metrics



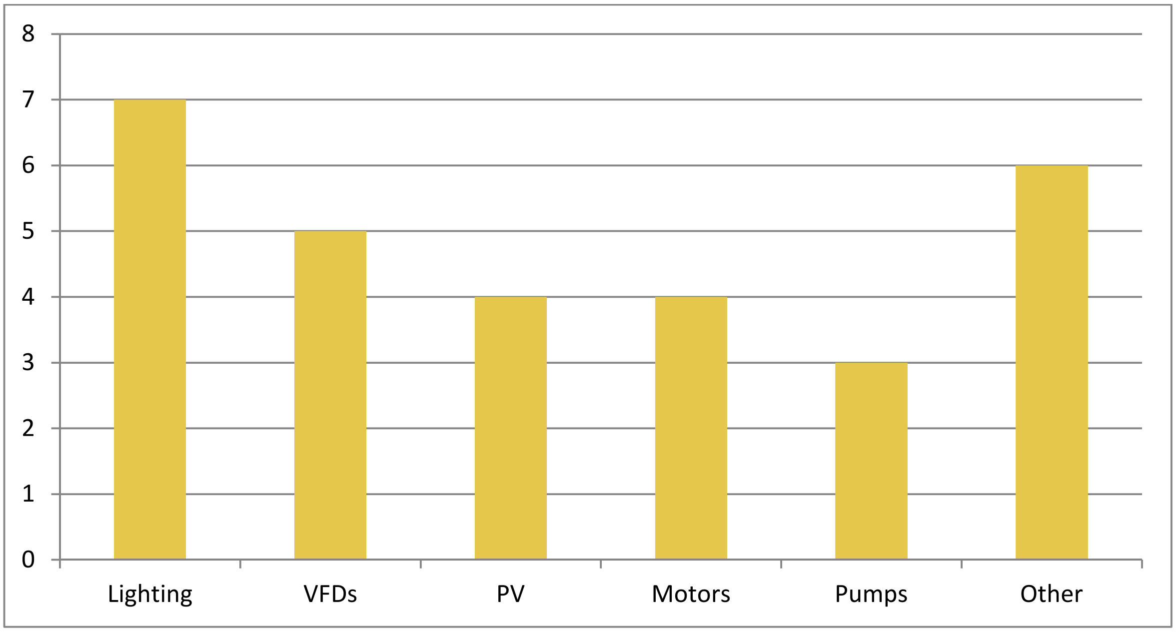
Source: Technical Field Survey, n = 10 - multiple responses, "What led you to develop these metrics/performance measures?"

8.5.3 Equipment Installations and Utility Involvement

As discussed earlier, field crop producers are increasingly adopting pressurized irrigation systems. Additionally, many farmers are beginning to use drip and micro-irrigation technologies with certain crops. These systems are applicable to most permanent new crop plantings in the Central Coast, using either surface or subsurface water sources. However, aside from pepper cultivation, these systems are most popular among vineyards, nuts, and tree plantings, which are covered elsewhere in this report.

When asked about efficient equipment installations, all 12 of the technical field survey respondents claimed to have installed at least one energy-efficient measure since 2000 (see Figure 8.12). The most frequently mentioned installments included variable frequency drives and pumps. The oldest of these measures dated back to 2000, although most operators had installed their equipment in the last few years. Anticipated savings ranged from 10-75%, and nearly all of the respondents claimed to have achieved those savings according to their utility bills.

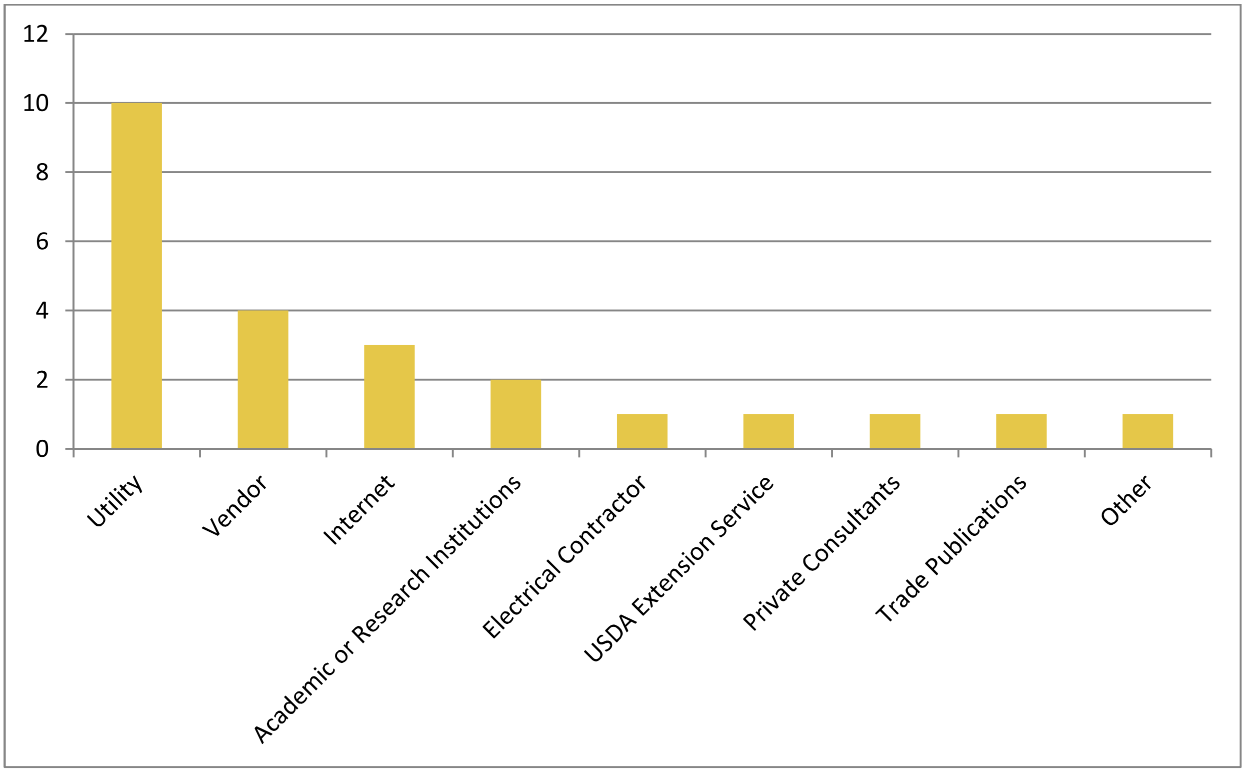
Figure 8.12: Energy-Efficient Equipment Installations



Source: Technical Field Survey, n = 12, "What equipment or devices have you installed to reduce energy use?"

Eight of the 12 respondents claimed that they typically install energy-efficient equipment when replacing failed equipment, and the same amount of respondents claimed that they install energy- efficient equipment when installing new systems. Seven respondents claimed they heard about their aforementioned newly installed equipment through their utility, and ten respondents identified their utility as their most likely source for gathering energy-related information (see Figure 8.13). However, only three respondents stated that they regularly rely on their utility representatives to identify energy savings. This suggests that growers recognize the utilities as a source of information, but do not work directly with their representatives to identify savings applicable to their particular operation. Rather, it would appear that these farmers take information gather upon themselves when making equipment decisions. These findings indicate that many growers are currently in the process of equipment replacements or new equipment purchases. Field crop growers appear to be self-motivated toward energy-efficient equipment installations, regardless of the utility's involvement. This could present an opportunity for utility representatives to form more coherent bonds with their customers and promote higher-efficiency equipment within the market.

Figure 8.13. Energy Efficiency Information Channels for Field Crop Growers



Source: Technical Survey, n = 12 – multiple responses, "What are your three most likely sources for gathering information about reducing energy use or generating energy?"

Regarding barriers to installing or implementing energy-efficient measures, all but two respondents cited financial reasons as their primary concern. Other responses included regulations and timing. Given that the cost of energy-saving equipment is likely preventing growers from purchasing more measures, utilities should consider incentives when designing programs for this segment. Although growers are already inclined to purchase high-efficiency options, utilities could offer incentives for only the most efficient options. Utilities' best opportunity for energy savings will likely be in high-efficiency water pumps, as most electricity and natural gas is devoted to this process. However, if there is a trade-off between energy efficiency and water efficiency, field crop growers will always prioritize water.

8.6 Field Crop Water Management

Energy and water use in the Field Crop market segment are inextricably linked. In 2000, approximately 80% of California's 44.3 acre-feet[87] of withdrawn water went to agricultural purposes, while the remaining 20% went toward residential, commercial, and industrial use.[88] During the early 1990s

[87] An acre-foot equals the amount of water needed to cover an acre of land to the depth of one foot (326,000 gallons) and is approximately the amount of water used by an average family of four during one year.
[88] Heather Cooley, Juliet Christian-Smith, and Peter H. Gleick, 2008, *More with Less: Agricultural water conservation and efficiency in California*. Oakland, Calif.: Pacific Institute. http://www.pacinst.org/reports/more_with_less_delta/more_with_less.pdf.

drought, scientists, consultants, and farmers made significant efforts to research, develop, and adopt best water management practices and technologies. Innovations included improved irrigation techniques, and both hardware and software systems to monitor weather and soil conditions for irrigation scheduling. California farmers also adopted advanced soil tillage and land-leveling practices, as well as advanced planting and cultivation methods that influenced water use efficiency.

Within two decades of the early 1990s drought, California irrigated agriculture has made significant improvements in the management of its water resources. Although there are few scientific studies documenting the scope of the improvements achieved, segment experts believe the use of advanced technologies and management practices has optimized the amount of water available for plant growth. Farmers' water use efficiency and improved management of deep percolation and runoff have resulted in "phenomenal across-the-board improvements in yield per acre, and per unit of crop evapotranspiration in crops such as almonds, processing tomatoes, and peppers."[89] Table 8.6 provides examples of current and emerging technologies related to water extraction, pressurization, and delivery, as identified through secondary research.

Table 8.6. Examples of Energy Efficiency Technologies for Irrigated Agriculture

End Use	Existing Technologies	Emerging Technologies
Water Extraction, Pressurization, and Delivery	• Low-pressure sprinkler nozzle • Sprinkler to micro-irrigation conversion • Irrigated scheduling systems • Water filters • Flush lines/automatic flushing systems (for filters) • Flow meters • Booster pumps • Hand-move sprinklers • Slide roll sprinklers • Moisture sensors	• Advanced water well design and construction • Advanced long-lasting materials for pumping plant components • Improved irrigation system design to reduce pump discharge pressures

Source: Various sources, Navigant secondary data analysis

8.6.1 Sensitivity of Field Crops to Water Issues

As evidenced by the technologies prevalent in field crop production, virtually all water use in this market segment contributes to irrigation. Of the 14 technical phone interview respondents who offered irrigation information, ten reportedly irrigate 100% of their field crop acreage. Twelve of 14 total respondents rated their sensitivity to interruptions in their water supply as "Highly Sensitive" (score of 8-10/10) to their operations, and six of 14 identified water as one of the top factors that will impact their production in future years. Twelve respondents also listed their sensitivity to electric power supply disruptions as high, possibly to facilitate the pumping of water. These findings were concurrent with the qualitative interviews, in which two thirds of the respondents listed water as a major input.

[89] Subject matter expert interview, 2011.

Although most respondents considered water to be of significant concern, only one of the six qualitative survey respondents and only two of 14 technical survey respondents referenced water as a top operating cost. This supports the subject matter expert assertions that farmers are willing to pay high water costs to grow higher value crops, so long as their yield remains profitable. With the increasing scarcity of water throughout parts of California, farmers will place a higher priority on water than they will on other resources, such as energy. Utilities should be aware of farmers' priorities and ensure that when incorporating measures into their programs, utilities are not increasing water consumption for the sake of energy efficiency.

8.6.2 Water Regulations

Field crop farmers are subject to a number of local, state, and national water-related regulations. The most notable of these, as reported by respondents, include the following:

- Federal Clean Water Act (1972)
- Safe Drinking Water Act (1974)
- Various state groundwater regulations
- Various state water quality laws and regulations
- Various local water quality control board regulations

The level to which farms are subject to or affected by these regulations depends largely on the type of farm. For instance, laws regulating water runoff may affect farms that use pesticides more than their organic counterparts. Of the six qualitative interview respondents, three claimed that the water quality regulations to which they were subject had a neutral effect on their operations. However, two of the respondents claimed that these regulations had a somewhat-to-strongly negative impact on their farms, while the final respondent was unsure of the effect of these regulations. The technical phone survey respondents were less concerned with regulations; only one of 14 respondents listed regulations as an impact on their production costs, and only two expected that regulations would affect their production in future years. These responses suggest that although field crop operations are subject to environmental regulations, these regulations are a secondary concern to productivity and water availability.

8.6.3 Sources and Uses

In terms of geographic water demand, the Sacramento and San Joaquin Valley regions consume the majority of electricity for water pumping, while the Central Coast regions demand higher energy intensity per unit of water pumped. Central Valley farms receive an important proportion (50% or more in good water years) of total water used from surface water deliveries, whereas Central Coast farms rely almost exclusively on groundwater for irrigation. The highest irrigated agriculture pumping energy users are located in western Fresno, Merced, and Kern counties in the San Joaquin Valley region.[90]

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[90] Charles Burt, Dan Howes, and Gary Wilson (Irrigation Training and Research Center), 2003. *California Agricultural Water Electrical Energy Requirements.* Sacramento, Calif.: Public Interest Energy Research. Program. ITRC Report No. R 03-006. http://www.itrc.org/reports/energyreq/energyreq.pdf; C. Burt, 2011 personal conversation.

Water for California irrigation comes from groundwater found in aquifers, or from surface water sourced from rivers, lakes, and reservoirs. The Colorado River and the Sacramento-San Joaquin Delta are the predominant sources for California's surface water. When asked about their water sources, all but two technical field survey respondents used well water in their operations. As anticipated, nearly all of the respondents used water for irrigation during growing or harvest season. Other uses included pasture or barn maintenance and food processing.

8.6.4 Management and Equipment

Irrigation systems generally fall into two broad categories: pressurized systems, which rely on water piped under pressure, and gravity-fed systems, in which water flows and is distributed by gravity.[91] With the exception of forage and rice crops, which predominantly utilize non-pressurized surface irrigation practices, most of the high-value orchard, vineyard, and vegetable crops are irrigated using pressurized irrigation technologies.

Traditionally, surface irrigation has been the most common technology in California due to the flat (and therefore easily leveled) ground in the Central Valley, the applicability of the technique to an array of crop types, and the fact that the infrastructure is already in place for this type of technology. [92] Currently, approximately 5.1 million acres of California's irrigated agricultural land currently utilize surface irrigation, while 1.7 million acres use micro-irrigation techniques. However, both pressurized groundwater pumping and gravity-fed micro-irrigation systems are becoming increasingly popular as water resources are becoming scarcer.[93] Section 8.5, Energy Use and Efficiency in the Field Crop Segment, details the implications of this trend.

When asked how they managed water use in their operations, nine of the 12 technical field survey respondents had adopted some form of water management practice, as seen in Table 8.7. When asked if they had installed systems or equipment to reduce water usage, all but one respondent claimed to have installed at least one form of water savings equipment or system. The respondents' list of systems and equipment included the following:

- Drip emitters
- Low-flow tubes or water heads
- Drainpipes to reclaim water
- Water control systems
- Timers
- Solar-operated valves
- Micro-sprinklers
- Ozone generators
- Glass media filters

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[91] Cascade Economics, 2011, *Electrical Energy Efficiency and Emerging Technologies in Northwest Agriculture*. Portland,OR.: Northwest Energy Efficiency Alliance. https://conduitnw.org/_layouts/Conduit/FileHandler.ashx?RID=287.
[92] http://ucanr.org/sites/irrmgm/files/52523.pdf.
[93] http://ucanr.org/sites/irrmgm/files/52523.pdf.

- Moving media filters
- Pressure sensors
- Plastic mulch
- Ground leveling
- Water brooms
- Altered irrigation patterns

Table 8.7. Water Management for Field Crop Growers

Water Management Practice	Number of Responses
Water monitoring and controls	4
Water recycling	2
Drip irrigation	1
Moisture sensors	1
Drought-resistant crops	1
Minimize spills	1
No management	3

Source: Technical Survey, n = 12 – multiple responses, "How do you manage water usage in your operation?"

The propensity for field crop producers to adopt water-saving measures supports the finding that water availability is a vital component in these operations. Any utility program that targets this market segment must address the criticality of water, and should account for water efficiency as well as energy efficiency.

8.7 Field Crop Waste Management

Virtually all waste generated by the Field Crop segment consists of plant-based, organic material. Seven of the 14 technical field survey respondents reported producing some type of organic waste. Six of these respondents sold or reused their waste for cattle feed or compost, while one respondent recycled their waste mulch. The management of solid waste was virtually a non-issue for the field crop farmers; only two respondents had implemented any equipment to manage waste in the last two years. One of these pieces of equipment was a manure separator, while the other included recycling containers. None of the respondents used waste for energy generation.

According to the qualitative interviews, business cycles had almost no effect on waste management costs. While some of the respondents are subject to state or local waste disposal regulations, the majority (5 of 6) of respondents felt that these regulations had no effect on their operations. The relatively low concern over waste management indicates that solid waste is not a significant issue in the Field Crop market segment. Rather, any by-product from the farm's regular operation serves a supporting function of the production process as feed or compost. Alternatively, farmers may sell their waste as a secondary means of income generation.

8.8 Field Crop Conclusions and Recommendations

Conclusion 1: Water availability is the primary concern for most field crop operators. Most of the energy use in field crop production – both from electricity and natural gas – is devoted to pumping water from its source and moving it to the desired location. However, this is only true for the portion of the operation devoted to field crop production. Any ancillary services, such as cold storage or dairies, could require greater electricity or natural gas for alternative end uses.

Recommendation 1: Program design for field crops should focus on equipment that will save water as well as energy as field crop growers tend to favor water conservation over energy efficiency. When promoting their programs, utility representatives should therefore be prepared to explain how their technologies will address the measure impact on the grower's water consumption as well as energy usage.

Conclusion 2: Some field crop operations also offer ancillary services or business operations, such as dairies, cold storage, or processing plants. The energy end uses for these facilities vary greatly as opposed to irrigated agricultural operations that focus solely on field crops. On farms such as these, high levels of electricity may be devoted to refrigeration, which may equal energy use in irrigation.

Recommendation 2: When targeting field crop growers, utilities should be aware of the agricultural services that each customer offers. For farms that focus solely on field crop production, utilities should promote high-efficiency irrigation pumps, whether electric or natural gas fueled. Alternately, if an operation has a cold storage facility, utilities should promote equipment that will lower the operation's refrigeration load. This can be in addition to high-efficiency pumps, depending on the agricultural customer.

Conclusion 3: The Field Crop segment is rapidly adopting pressurized groundwater irrigation systems to ensure consistent access to water resources. As this trend continues, the segment will likely see a rise in energy consumption from this market segment. This will be particularly true for electricity.

Recommendation 3: Utilities should prepare for this increase in agricultural electricity consumption by developing or promoting pump efficiency programs for agricultural customers. For customers whose equipment is nearing the end of measure life, utilities can incentivize new, high-efficiency pumps. For those who have recently installed new equipment, an opportunity exists to promote periodic pumping optimization.

9 Refrigerated Warehouses

9.1 *Key Findings and Recommendations*

Refrigerated warehouses serve as a crucial link in the supply chain between growers and consumers; however, not all of these operations fall into the agricultural sector. These facilities can either act as a service provider to growers, or a grower-owned means of adding value to their production process. In either case, warehouse operators consider **energy to be a primary operational cost**. **Warehouse operators are therefore keenly aware of this cost and actively seek to manage their energy consumption**.

Individually, operators believe they are working with their local utilities to manage their energy consumption; however, there is **limited evidence of segment-wide collaboration through which to benchmark performance or develop best energy management practices**. One opportunity for future program design is utility sponsorship of activities that would create a statewide understanding of energy management and areas for improvement.

Navigant recommends that utilities **conduct outreach activities**, with particular attention to cooler space in private and semi-private refrigerated storage, to **this segment's reference partners** to promote existing conservation programs and measures, as well as to provide general information about energy management best practices. Utilities could also **develop statewide energy management benchmarking opportunities to compare the relative energy efficiency of each participating warehouse**. This could spur a general competition and drive down overall consumption in this segment. In support of the latter, Navigant also recommends that utilities **offer energy engineering and verification expertise** to warehouse operators, so that they could fully understand the impact of efficiency measures on their operations and **optimize their efforts to manage energy use**.

9.2 *Methodology*

9.2.1 Secondary Research and Literature Review

To understand the information that currently exists on the refrigerated warehouse market segment, Navigant's research team began by conducting secondary research. Sources ranged from national statistics and codes and standards information to IOU evaluations, industry reports, and peer-reviewed articles. Using this array of sources, Navigant conducted an extensive literature review, complete with an annotated bibliography. The findings from this research can be found in the Refrigerated Warehouses chapter in the *Literature Review for the 2010 – 2012 Statewide Agricultural Energy Efficiency Potential & Market Characterization Study*.

9.2.2 Primary Data Collection

As illustrated in Table 9.1, the primary sources for data collection in this study included technical surveys (both telephone and in-person) and qualitative interviews (telephone only).

Table 9.1. Data Collection for the California Refrigerated Warehouse Segment

	Number of Completed Interviews
Technical Surveys (Telephone/In-Person)	7/6
Qualitative Interviews	3

9.2.2.1 Subject Matter Expert Interviews

The research team did not interview any subject matter experts for this segment.

9.2.2.2 Technical Surveys

The research team conducted technical phone surveys with seven individuals in the Refrigerated Warehouse market segment. These surveys included topics such as operation firmographics, energy management and practices, waste and water issues, and business cycles. Each operator responded to an initial phone survey that covered these topics at a high level. If a respondent agreed to participate in a follow-up, in-person survey at their farm, a member of the research team would give one of three subsequent surveys based on their sophistication of energy metrics and history of energy-efficient measure implementation. These follow-ups included a General Technical Survey, an Intermediate Technical Survey, and a Detailed Technical Survey. Six of the original seven Refrigerated Warehouse telephone respondents agreed to a subsequent technical survey.

The research team initially contacted potential respondents using customer contact information provided by the IOUs. However, the majority of these contacts did not prove to be actual refrigerated warehouses. The research team therefore networked with known refrigerated warehouse operators and their customers to identify appropriate respondents.

Figure 9.1. Map of Refrigerated Warehouse Technical Survey Respondent Locations

Source: Navigant analysis

9.2.2.3 *Qualitative Interviews*

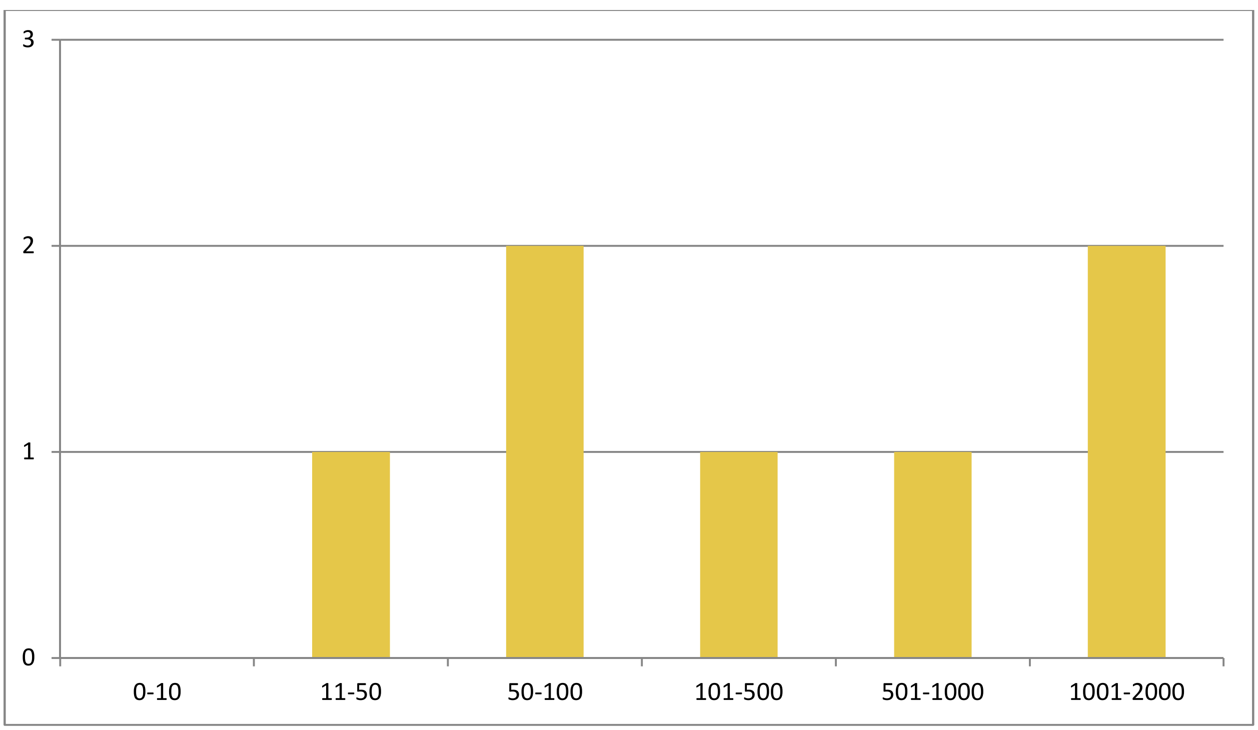
The research team conducted three qualitative interviews via telephone. The qualitative interviews were designed to complement the technical information, examining agricultural energy usage and efficiently potential. The qualitative interviews focused on market expectations, behaviors and practices, and potential barriers and opportunities related to increased efficiency.

9.2.2.4 *Firmographics*

Refrigerated warehouses serve a variety of different segments within the agricultural market, from fruits and vegetables to processed meats. The majority of California refrigerated warehouses tend to be strategically located along major interstate highway routes in urban areas, making them easily accessible. Those that do not fall under this majority are smaller, private refrigerated warehouses that are dispersed among growers. Section 9.3.1 provides more information on the geographic location of refrigerated warehouses.

To verify the findings from secondary research, the research team interviewed a number of Refrigerated Warehouse operators. The technical survey respondents included both publicly and privately owned California warehouse operators with cooler (maintained temperatures between 0 and 50 degrees Fahrenheit) and freezer facilities (maintained temperatures at 0 degrees Fahrenheit or lower). Of this sample, refrigerated warehouse space ranged from 20,000 to 2,000,000 square feet, as shown in Figure 9.2. The age of these facilities ranged from one to 29 years, with an average age of 20 years.

Figure 9.2. Distribution of Respondents by Refrigerated Warehouse Space (in 1,000s of Sq. Ft.)



Source: Technical Survey, n = 7, "How many square feet of refrigerated warehouse space do you manage?"

All seven respondents were facilities or operations managers and, as part of their job function, tracked production costs, including electricity and (where applicable) natural gas consumption. Similarly, all seven interacted with their utility representatives.

9.3 Structure of Refrigerated Warehouse Market Segment

9.3.1 Definition of Market Segment

Refrigerated warehouses are large, strategically located cold and frozen storage facilities for raw or processed fruit and vegetable products, processed meats, and frozen prepared dishes. Although refrigerated warehouses serve the agricultural industry (among others), the operations themselves are categorized as commercial facilities. Falling under NAICS 49312 as "Refrigerated Warehousing and Storage," these operations are subsectors of the warehousing and storage category in "Transportation and Warehousing."

California's warehouse companies offer refrigerated warehousing and cold storage services for raw or processed fruit and vegetable products, including processed meats and frozen prepared dishes. These facilities are located along urban regions in the Central Coast, Southern California, Sacramento Valley region, and the San Joaquin Valley. The segment consists of private facilities operated by food processing companies, and by public facilities operated by wholesalers and supermarkets.

9.3.2 Description of Market Actors

The following is a list of the largest operators in California and the number of facilities in that state:[94]

- AmeriCold Logistics – 14 facilities
- Lineage Logistics – 14 facilities
- US Growers Cold Storage – 8 facilities
- United Cold Storage of California – 8 facilities
- Preferred Freezer Services – 6 facilities
- Partner Alliance – 5 facilities
- Los Angeles Logistics – 4 facilities

Most of these refrigerated warehouse facilities operate both cooler and freezer space. These organizations tend to dominate the refrigerated logistics chain in California and define demand for purveyors of refrigeration repair and supply. In addition to providing services to growers, these firms also manage import/export transactions.

9.3.3 Description of Supply Chain

California's vast agricultural production has supported the development of a sophisticated refrigerated logistics system, underpinned by a broad group of trade allies. Within this system, refrigerated

[94] Global Cold Chain Alliance membership directory inquiry: http://www.gccaonline.com/eweb/DynamicPage.aspx?Site=GCCA_NEW&WebKey=50fc23eb-722b-4270-a3b2-7610e83226a1 . Accessed on January 14, 2013.

warehousing serves as an intermediate link in the supply chain between growers and consumers. Agricultural producers ship, usually by truck, from their field or packing house to the refrigerated warehouse. The warehouse, whether public or private, holds the produce until customers are ready to accept delivery for distribution to fresh produce markets or to food processors for further manufacture.

As detailed in Section 9.5.2.1, refrigerated warehouses in California have established operational metrics, including energy use. However, Navigant's research team uncovered no efforts on behalf of the respondents to minimize energy, labor or maintenance costs through conservation measures. Operators address each type of cost individually, yet there is no evidence that facilities managers are aware that conservation measures can yield non-energy benefits, such as the reduction of labor and maintenance costs.

9.3.4 Description of Market Reference Partners

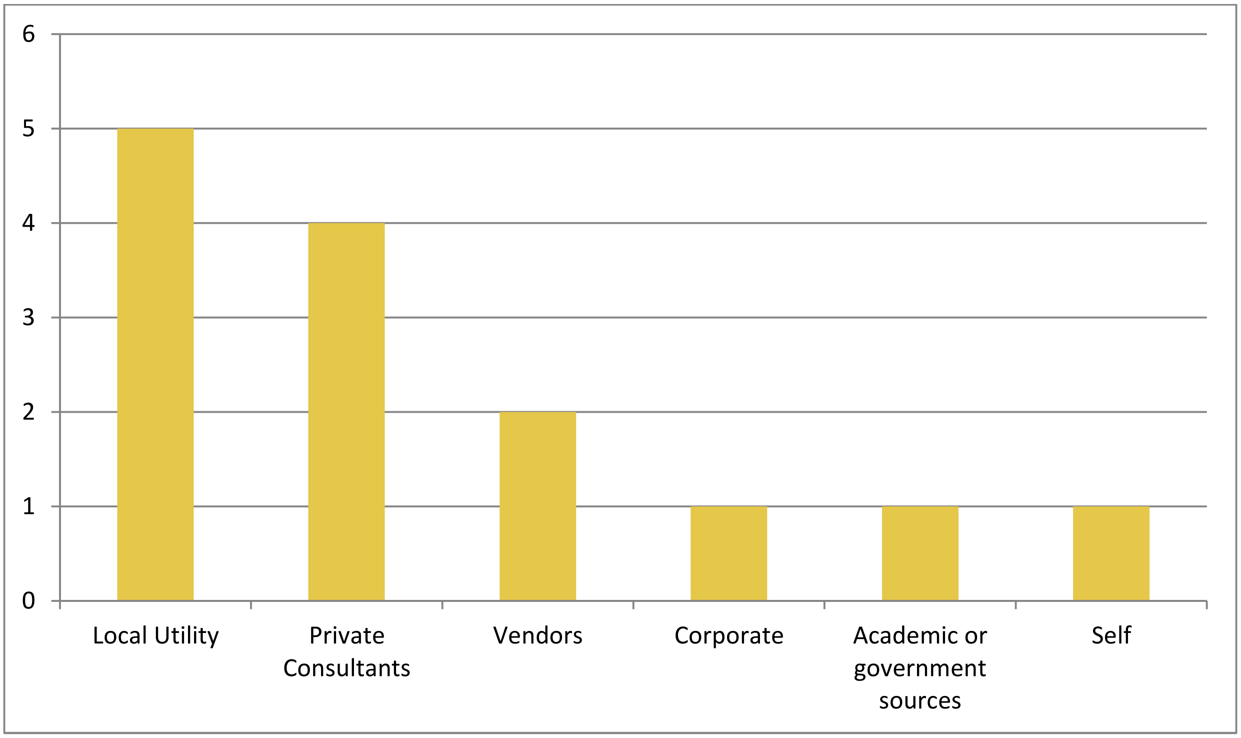
The qualitative interviews identified the following organizations as valued sources of information and advice to refrigerated warehouse operators:

- Warehousing Education and Research Center
- International Association of Refrigerated Warehouses
- Council of Supply Chain Management Professionals
- International Association of Refrigerated Warehouses, a partner of the Global Cold Chain Alliance

The research team reviewed each organization's website, all of which provided reference materials regarding labor and maintenance issues. Although one website offered a general benchmarking program, none had specific, energy efficiency-related information or significant discussion of general energy issues. Further, there was limited reference to utilities as suppliers, partners or sources of information.

To determine where respondents did gather their information, Navigant asked operators what their three most likely sources for gathering energy-related information were. The research team found that the technical survey respondents offered a different view from the qualitative interview respondents. All but one of the technical survey respondents identified their utilities as a source of information (see Figure 9.3), indicating that, as individual operators, the respondents recognized the value of their local utility as an information source. The associations, however, do not reflect this view. Given the influence of these associations, California utilities may have an opportunity to offer data and programming as new content on these websites and general communications.

Figure 9.3. Refrigerated Warehouse Energy Efficiency Information Channels



Source: Technical Survey, n = 6, number of mentions, "What are your three most likely sources for gathering information about reducing energy use or generating energy?"

9.4 Status of Refrigerated Warehouse Market Segment

The profitability of California's agricultural industry is consolidated through the supply chain services provided by public and private refrigerated warehouse ("warehouses") businesses. In terms of floor space, California currently leads the nation with 547,959,000 square feet of gross available refrigerated warehouse space.[95] This constitutes approximately 18% of the gross refrigerated warehouse space available across the country. The magnitude of this share of warehouse space supports a broad range of trade allies that stand ready to repair, enhance, and improve existing facilities.

Table 9.2 details both the available cooler and freezer space in refrigerated warehouses. Generally, cooler space holds agriculture produce prior to its delivery to the fresh market or food processors. Freezer space tends to hold frozen fruits and vegetables, as well as processed food products, such as ice cream. Warehouse operators will commonly manage both types of space at a single facility.

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[95] Capacity of Refrigerated Warehouses 2011 Summary (January 2012), USDA, National Agriculture Statistics Service (January 2012), pages 7 – 8.

Table 9.2. California Refrigerated Warehouse Space Available

	Gross Space Available (1,000 Square Feet)		
	Public	Private & Semi-Public	Total
Cooler Only	83,551	126,818	210,369
Freezer Only	287,238	50,352	337,590
Total Refrigerated	370,789	177,170	547,959

Source: Capacity of Refrigerated Warehouses 2011 Summary (January 2012), USDA, National Agriculture Statistics Service (January 2012)

As mentioned earlier, refrigerated warehouses can be categorized by ownership style, distinguishing between public ownership and private or semi-public ownership. Table 9.2 further details refrigerated warehouse space by this distinction. Public warehousing includes facilities that store agricultural or finished food products for other organizations, at a specified rate. This type of refrigerated warehousing, particularly freezer space, tends to be associated with activities and practices associated with the commercial and industrial sectors.

Conversely, private and semi-public warehousing includes facilities operated in conjunction with the principal function of the owner as a producer, processor, or manufacturer of perishable products. Examples of this type of operation include the storage of fruit after harvest until it is requested by a grocery distributor, or the holding of milk prior to shipment before processing into cheese. Private and semi-public cooler space tends to be more closely associated with primary agriculture production, as opposed to its public counterpart. However, while agricultural producers use this space to store their products, other growers may rent unused space at specified rates per unit stored, providing a secondary use for the facility.

While the technologies are essentially the same between the sectors, the core operational perspectives dictate that public warehouses provide a third-party service, while private and semi-private warehouses add value to existing agricultural production. Because of this integral difference, utilities should make efforts to ensure that the benefits of agricultural programs indeed serve agricultural customers. Program design for the agriculture sector should therefore target the 126,818,000 square feet of private cooler space, with a focus on the needs of growers to maintain or enhance the value of their produce. Such program design need not ignore public warehouses entirely; however, programs incorporating public warehouses should focus only on those that deliver fresh produce from California farmers to consumers for table stock.

9.4.1 Current Trends and Issues

Both secondary research and the qualitative interview respondents identified health and sanitary issues as a key concern for future business. In October 2011, a Food and Drug Administration report investigated the deadly outbreak of *Listeria monocytogenes*, tracing it back to a Colorado cantaloupe facility. The report noted several of the contributing factors that most likely led to the spread and growth of the pathogen, specifically:

Spread:

- The packing facility floor was constructed in a manner that made it difficult to clean.
- The packing equipment was not easily cleaned and sanitized; washing and drying equipment used for cantaloupe packing was previously used for Post-Harvest handling of another raw agricultural commodity.

Growth**:**

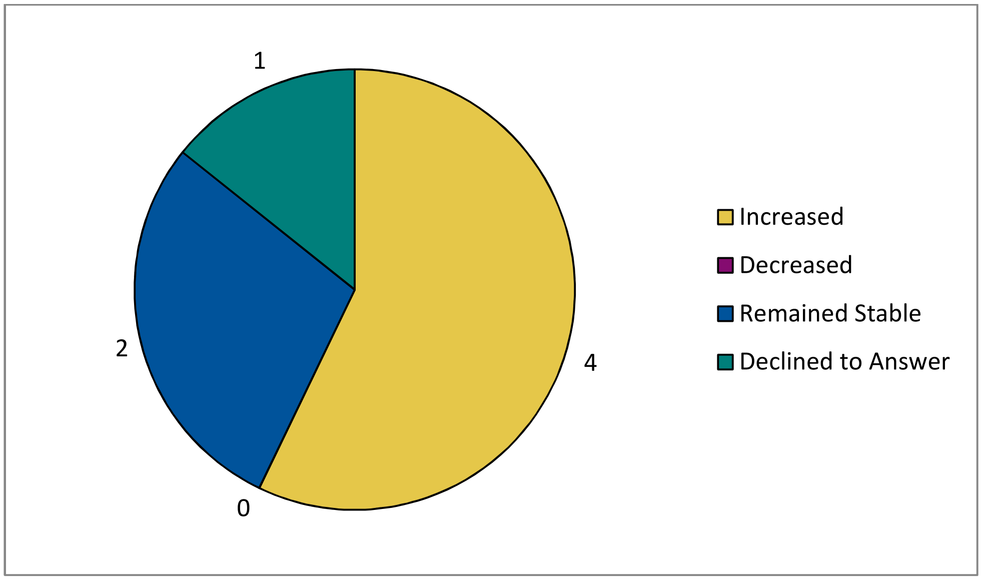
- There was no pre-cooling step to remove field heat from the cantaloupes before cold storage. As the cantaloupes cooled there may have been condensation that promoted the growth of *Listeria monocytogenes.*[96]

Refrigerated warehouses are a key player in the agricultural supply chain, and proper handling and storage of goods is important for ensuring that bacteria, diseases, and other contaminants do not spread. In an effort to avoid food contamination issues, the agriculture industry is likely to move toward stricter standards that could increase water and energy use. As energy and water costs are likely to rise in an already cost-conscious segment, refrigerated warehouses may become even more receptive to energy efficiency programs offered by the IOUs. At the same time, programs must recognize that food safety will be the priority; new, energy-efficient technologies and techniques will therefore need to be vetted to ensure performance that is equal to or better than conventional methods.

In terms of trends noted by respondents, four of the seven technical survey respondents reported an increase in production over the last two years (as seen in Figure 9.4). Two more respondents claimed that production had remained stable over the same period, while only one reported to have experienced a decline in production. Of those respondents that had seen an increase in production, three attributed this activity to increased demand or market share, while the fourth credited it to acquisition of a rival business (see Figure 9.5).

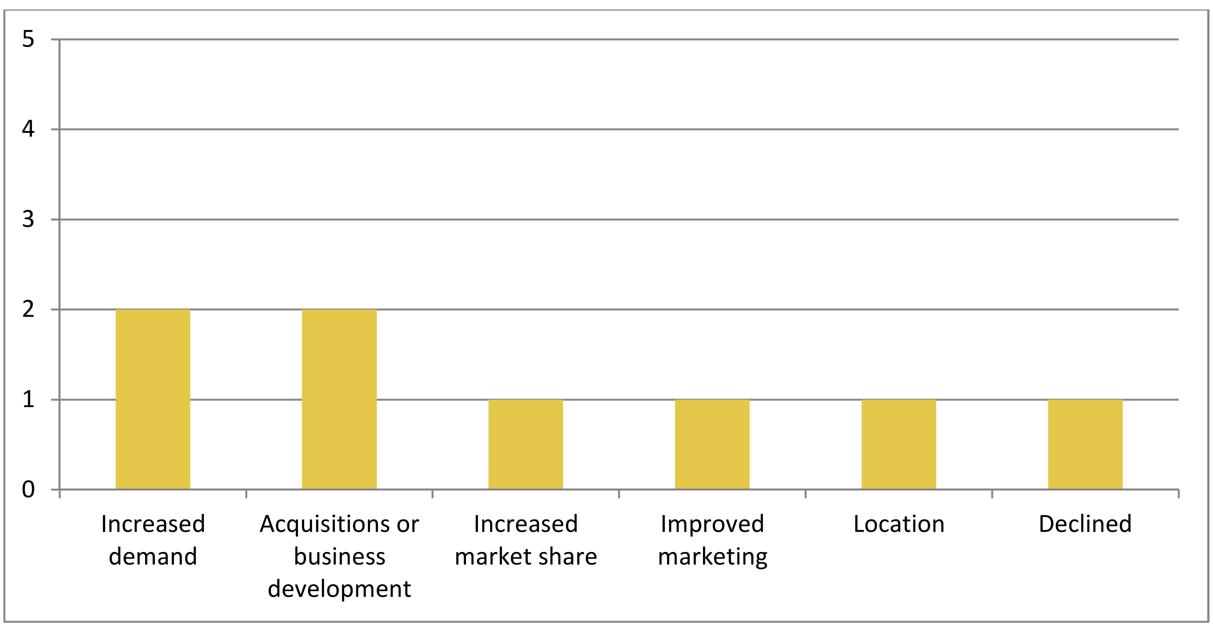
[96] U.S. Food & Drug Administration, Information on the Recalled Jensen Farms Whole Cantaloupes, October 21, 2011. Available: http://www.fda.gov/Food/FoodSafety/CORENetwork/ucm272372.htm.

Figure 9.4. Respondent Stability of Production



Source: Technical Phone Survey, n = 7, "Over the last two years, has your production been increasing, decreasing, or remaining stable?"

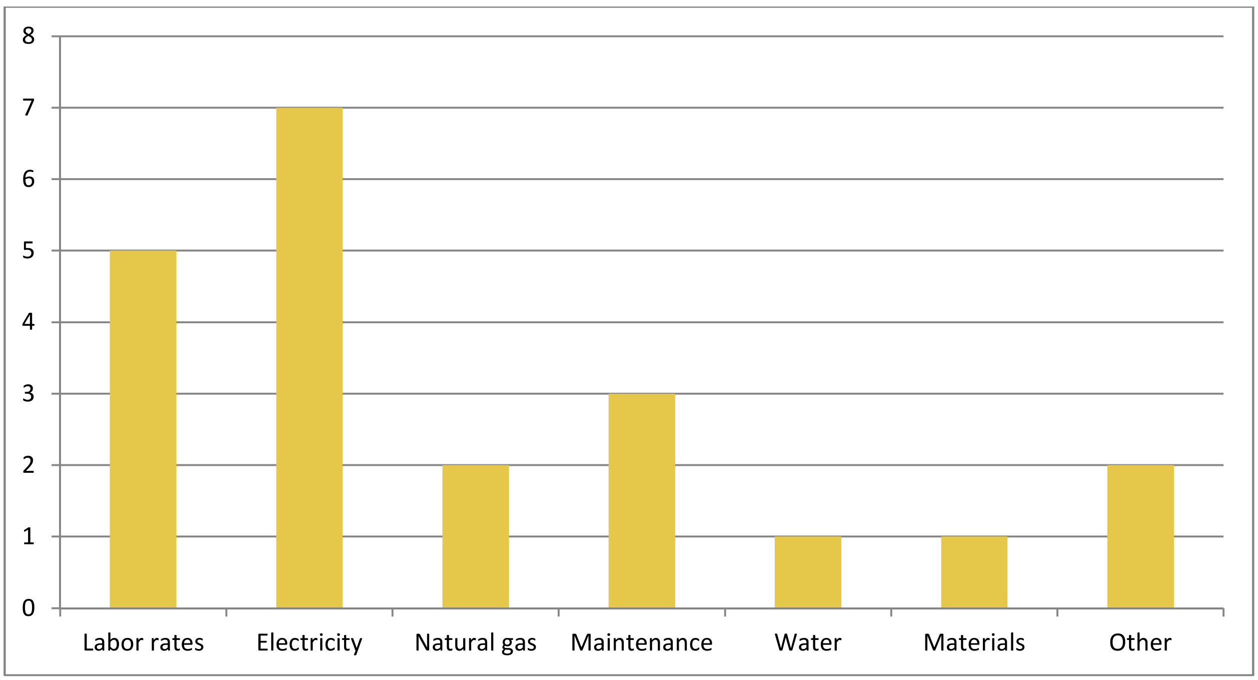
Figure 9.5. Causes for Fluctuations in Refrigerated Warehouse Production



Source: Technical Phone Survey, n = 8, "What have been the primary reasons that your production has increased, decreased, or remained stable?"

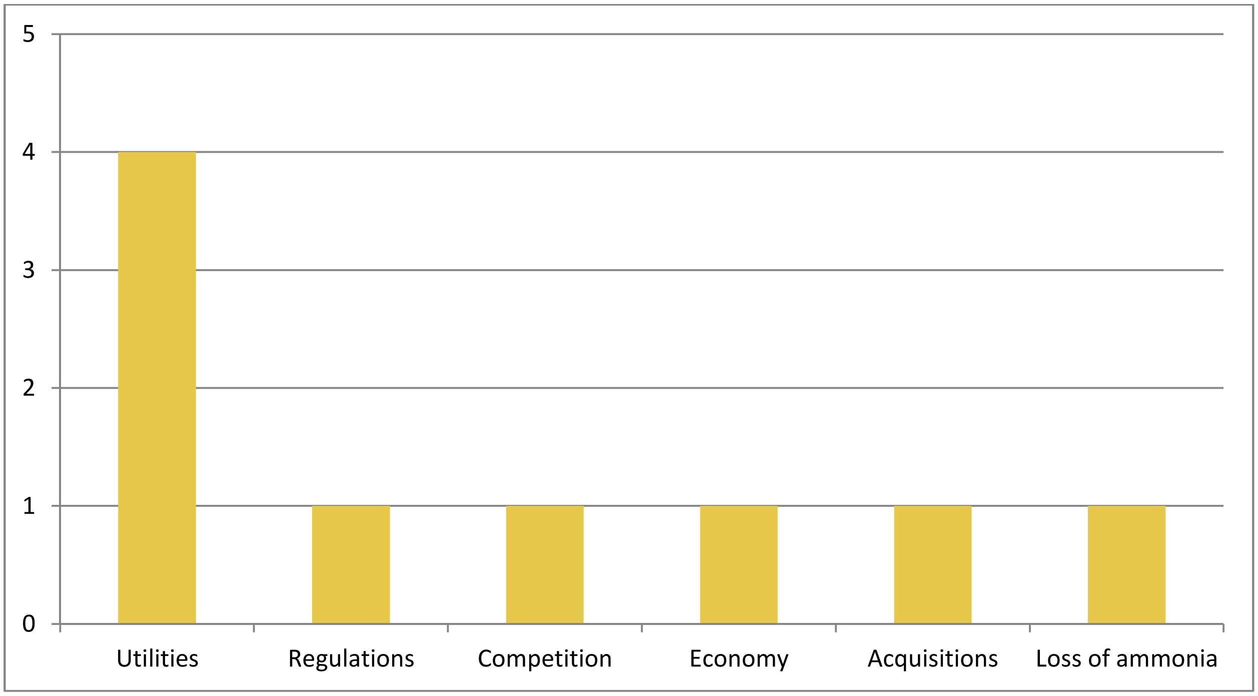
When asked about the greatest production costs over the last two years, all respondents listed electricity as a top expense, and five of seven respondents also identified labor rates (see Figure 9.6). Similarly, four respondents claimed that utilities would be one of the most influential factors affecting production in future years (Figure 9.7). One utility-related issue identified by two private warehouse operators was that their fresh fruit storage facility had been reclassified from an agricultural tariff to a more expensive commercial electric tariff. According to these respondents, the reclassification put in jeopardy the continued viability of their facilities and those of the growers who relied upon them for distribution. While the technical surveys revealed a high degree of attention to energy management, the qualitative interviews did not uncover a great deal of interest in energy issues. Rather, these respondents were more concerned with labor, health, and sanitary regulations as well as diesel emissions (AB-32). The only structural trend identified by the trade association respondents was the shift towards more distributed warehousing rather than single centralized locations.

Figure 9.6. Greatest Production Costs for Refrigerated Warehouse Operators



Source: Technical Survey, n = 7 - multiple responses, "What are your top three production costs?"

Figure 9.7. Factors Influencing Future Production



Source: Technical Phone Survey, n = 7- multiple responses, "What factors do you think will most impact your future production?"

9.4.2 Future Prospects

Looking to the future, both of the trade associations responding to the qualitative interviews indicated that the overall economic situation and demand for refrigerated warehouse space/services would stay the same or decline. One qualitative interview respondent identified the trend that operators are changing from centralized locations to distributed operations to allow for quicker shipments to their customers. However, should this trend continue, it could result in increasing transportation and distribution energy consumption, as well as less efficient warehouse space. Furthermore, the construction of new, distributed facilities will lead to the associated energy use involved in the initial construction of these facilities. Utilities should target these new warehouses to ensure that developers adopt energy-efficient measures and practices early in the design stage.

9.5 Energy Use and Efficiency in Refrigerated Warehouse Segment

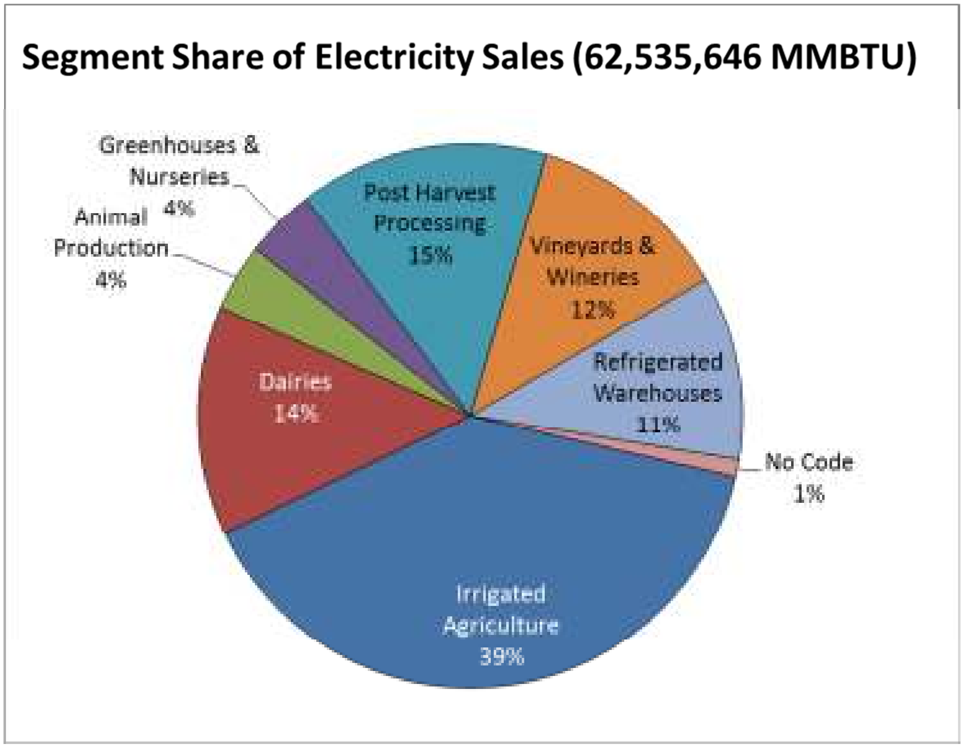
9.5.1 Energy Consumption

As of 2008, California's cold storage segment reached $39.5 million in annual energy costs and consumed over 1 billion kWh of annual electricity.[97] This represented about 20% of the total electric energy consumption in the food industry. As shown in Figure 9.8, refrigerated warehouses are the fifth largest consumer of electricity in California, and nearly the smallest consumer of natural gas. However, these

[97] R. Paul Singh, 2008, *Benchmarking Study of the Refrigerated Warehousing Industry Sector in California*. Davis, Calif.: California Energy Commission. PIER Report. http://ucce.ucdavis.edu/files/datastore/234-1193.pdf.

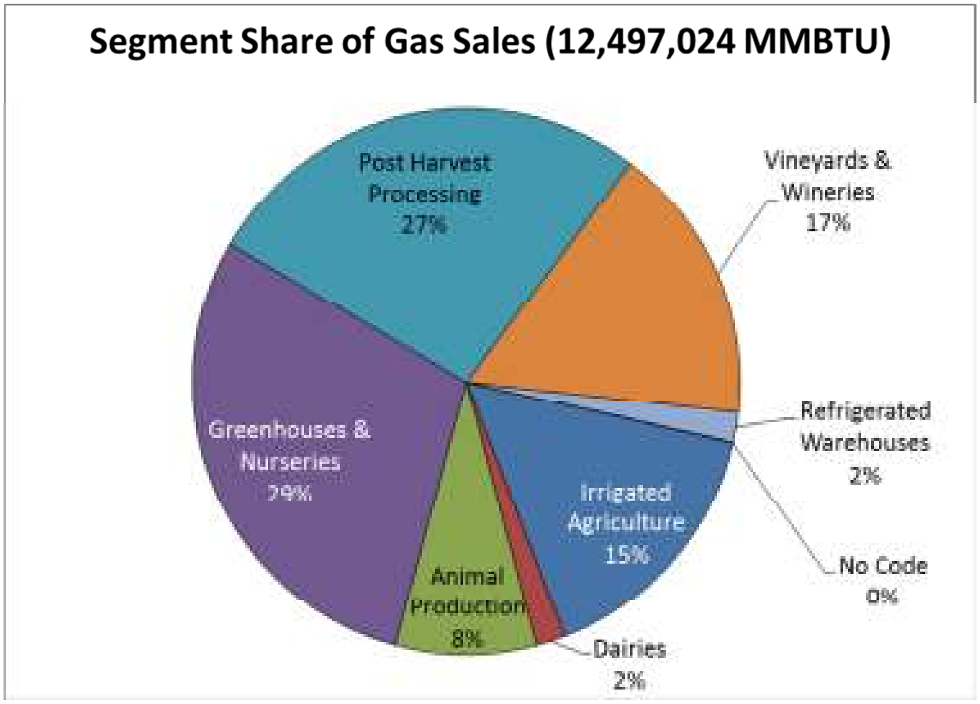
rankings actually belie the importance of this segment, as almost all other agricultural market segments eventually feed the production of refrigerated warehouses to some extent. Any production increase among the other segments would in turn magnify the energy inefficiency in refrigerated warehouses, as perishable produce began to flow into cooler storage. As such, refrigerated warehouses constitute a key leverage point from which to increase the overall conservation for California's agricultural sector.

Figure 9.8. 2011 California Agriculture Consumption of Electricity (IOUs Only)



Source: Navigant analysis of CPUC electric consumption data

Figure 9.9. 2011 California Agricultural Natural Gas Consumption (IOUs Only)



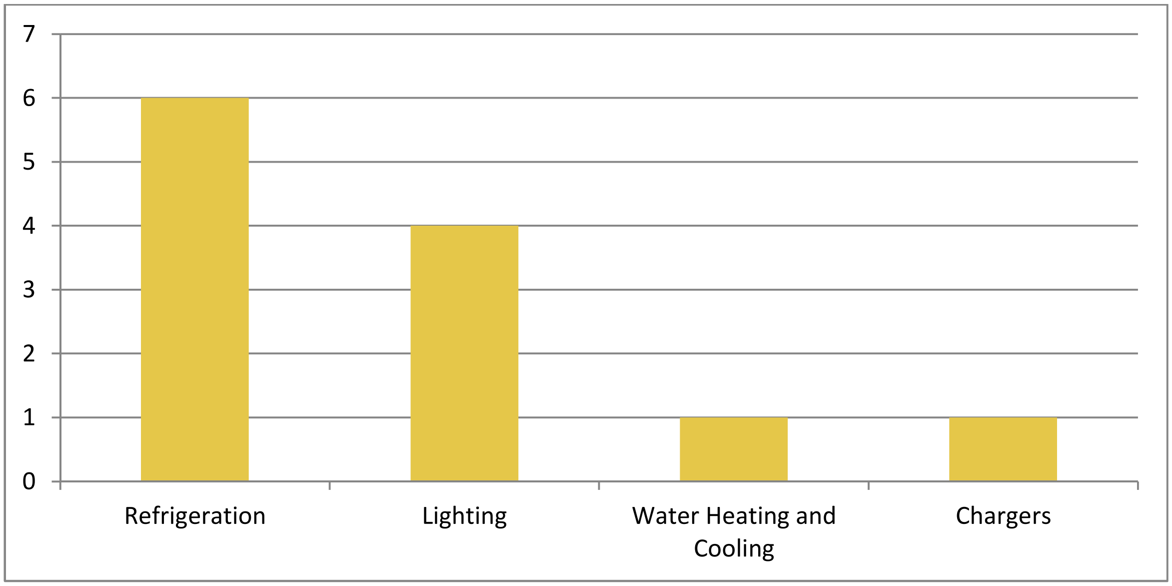
Source: Navigant analysis of CPUC gas consumption data

A study conducted in 2008 estimated that electricity end uses in a typical warehouse included 15% for pumps, motors, fans, conveyors, and lighting systems, 5% for sanitation and cleaning, and the remaining 80 % for cooling, freezing, and refrigeration.[98] Navigant's analysis roughly mirrored these findings.

Figure 9.10 provides an allocation of electrical end uses for the Refrigerated Warehouse segment, as found through the technical surveys. As anticipated, the primary end use was refrigeration, with lighting, motors (for conveyance), and water heating/cooling constituting the balance.

[98] B. Prakash and R. Paul Singh (University of California, Davis), 2008, *Energy Benchmarking of Warehouses for Frozen Foods*. Sacramento, Calif.: California Energy Commission, PIER Program. http://ucce.ucdavis.edu/files/datastore/234-1194.pdf.

Figure 9.10. Electrical Energy Use in Refrigerated Warehousing



Source: Technical Field Survey, n = 6 – multiple responses, "Which processes or equipment use the most electricity?"

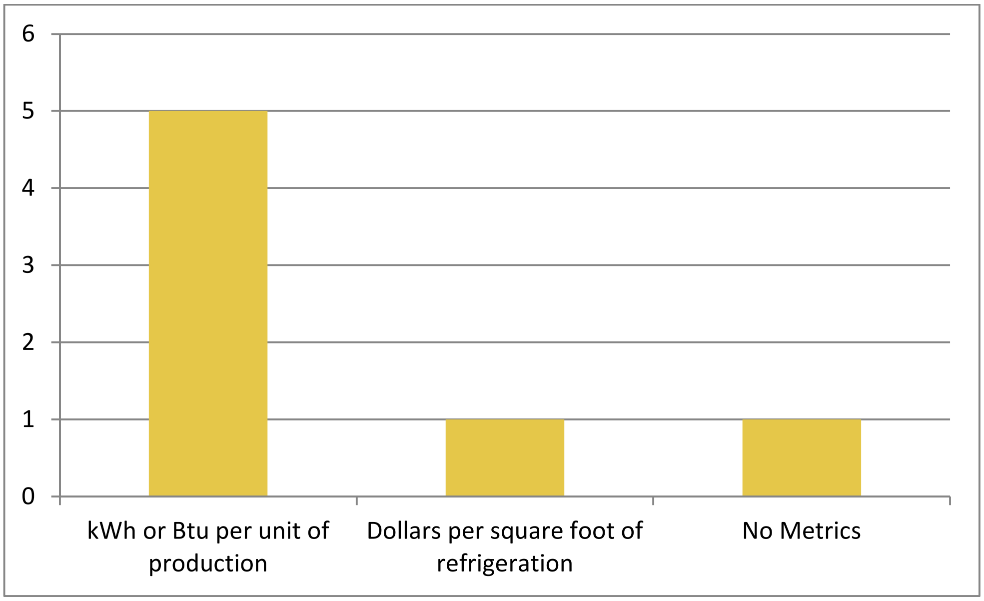
9.5.2 Energy Management

In addition to key end uses, Navigant was also interested in gauging the importance of energy management to warehouse operators. The six in-person technical surveys informed the following analysis of energy management within this segment.

9.5.2.1 Metrics

As seen in Figure 9.11, six of the seven respondents reported to have metrics for measuring overall facility performance in terms of energy use, whether by kWh per square foot or kWh per pallet. For the two respondents that used sufficient natural gas to warrant management, their metrics were Btu per unit. All but one of the respondents had been using these metrics prior to 2000, with two respondents having been using their metrics prior to 1990. All of the respondents described metrics as "internally" developed by their corporation, although four had also sought input from utility representatives, and one had sought input from an independent consultant.

Figure 9.11. Energy Management Metrics



Source: Technical Survey, n = 7,"Do you use metrics or performance measures in your operation?"

Table 9.3 and Table 9.4 are examples of portfolio-level summations of individual facility metrics developed by one of the technical survey respondents. It shows a decline in consumption during a period when square footage and cooler/freezer use were fairly constant. The aim of the metric at this level is to show regional improvement. Within regions, individual facilities benchmark their performance against each other to determine relative energy efficiency.

Table 9.3. Portfolio Savings for Technical Survey Respondent (2008 vs. 2007)

Energy Savings 2008 vs. 2007			
Region	**2007 Actual Consumption**	**2008 Actual Consumption**	**Reduction in kWh**
North	183,983,533	187,561,727	-3,578,194
South	215,607,184	205,424,791	10,182,393
East	149,192,233	144,725,594	4,466,629
West	127,858,650	120,572,391	7,286,259
Total	676,641,590	658,284,503	18,357,087

Source: Technical surveys

Table 9.4. Portfolio Savings for Technical Survey Respondent (2009 vs. 2008)

Energy Savings 2009 vs. 2008			
Region	2008 Actual Consumption	2009 Actual Consumption	Reduction in kWh
North	187,561,727	164,545,782	23,015,945
South	205,424,791	170,369,639	35,055,152
East	144,725,594	127,788,939	16,936,655
West	120,572,391	112,182,196	8,390,195
Total	658,284,503	574,886,556	83,397,947

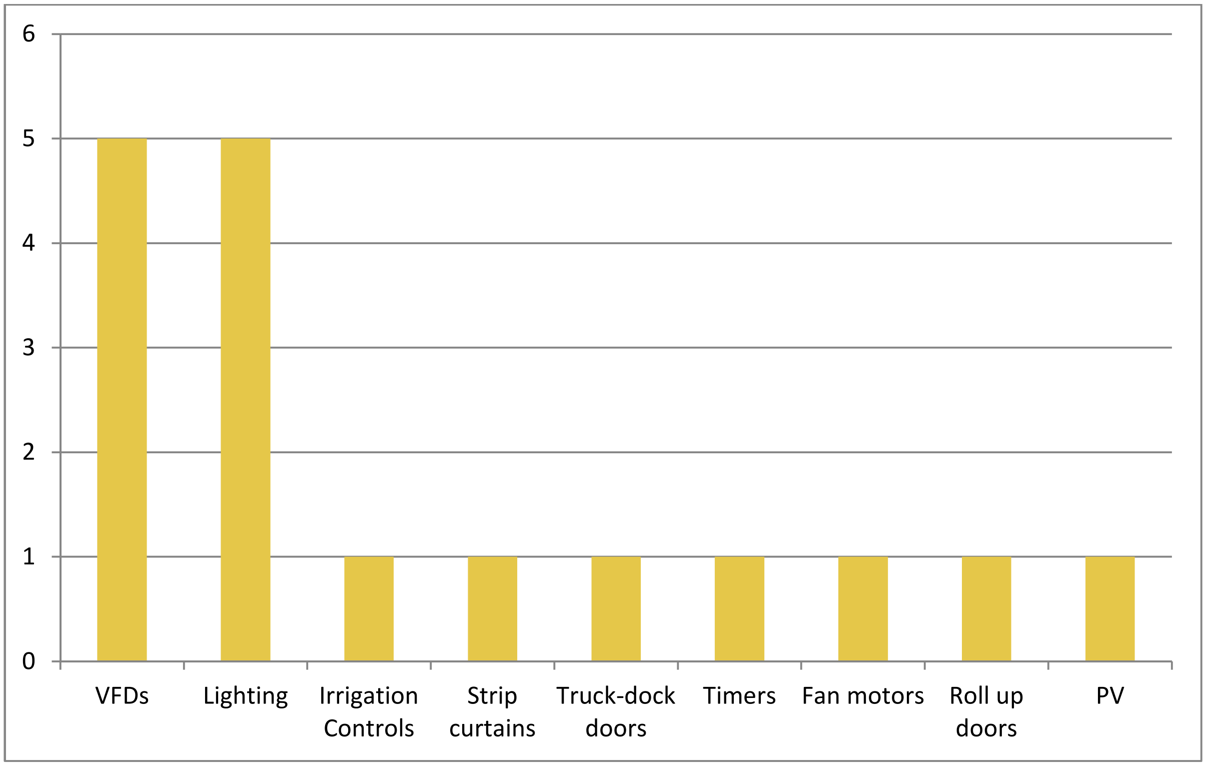
Source: Technical surveys

Among the segments examined in this study, the Refrigerated Warehouse segment was the most consistent in the development of internally developed energy performance metrics. None of the respondents, however, indicated that their utility representatives used these metrics as tools to determine opportunities for additional efficiency measures or other conservation actions.

9.5.2.2 Efficient Measures and Savings

When asked about installed efficiency measures, the technical field interview respondents referred to a range of 22 equipment installations dating back as far as 1989 to as recently as 2011. Individual measures such as variable frequency drives received the most mentions, followed closely by lighting such as light-emitting diodes (LEDs) (see Figure 9.12). The estimated ex ante savings ranged from 5% to 50%, depending on the measure.

Figure 9.12. Energy-Efficient Equipment Installations



Source: Technical Survey, n = 6 - multiple responses, "What equipment or devices have you installed to reduce energy use?"

When asked if they had achieved the promised ex ante savings, the respondents stated that they did achieve the expected savings in all 22 cases. When asked how they knew that they had achieved these savings, the respondents stated that they knew they had achieved the expected savings by "tracking their utility bills." The respondent responsible for the 22nd installation stated that he used his "best guess" to determine that the installation had achieved its savings.

Based on California impact studies over the past 20 years, it does not seem likely that all measures achieved full realization. While the operators may not require the same level of precision as utilities in establishing energy savings impacts, the absence of measure-specific data to assess the success or failure of individual measures handicaps energy management efforts at the level of a system or process.

The high-level energy performance metrics for whole facilities appear to be disconnected from an understanding of how individual measures affect facilities over time. This may be the result of the sources that respondents look to for information about equipment and potential savings. For instance, 11 of the 22 installations relied on vendor information as the primary source of information, yet in only three of the 22 cases did the respondent use input from their local utility.

This is not to say that utilities do not target refrigerated warehouse operations in their programs. In fact, California IOUs have targeted the refrigerated warehouses segment with a handful of segment-specific programs, summarized in Table 9.5. Additionally, many general commercial measures offered in IOU programs could be applied to refrigerated warehouses. However, there may be an opportunity for California utilities to partner with refrigerated warehouse operators more effectively. At a high level, these operators have the motivation to improve their measurement systems to see how much savings they can achieve over time. What is lacking, at least among the respondents in these interviews, is an understanding of how to optimize their energy efficiency efforts based on sound energy engineering as well as measurement and verification.

Table 9.5. Current and Historical IOU Programs for Refrigerated Warehouses

Program Name	IOU	Year	Measures Offered	Stats or Anticipated Results
2009-2011 Energy Efficiency Portfolio Program (Statewide Agriculture Program PG&E2103)[99]	PG&E	2009-2011	Financial incentives for EE pumping, refrigeration, process loads, process heating, lighting. Specifically: • Lighting (0.05 cents/kWh + $100/pk kW) • AC & refrigeration: (0.15 cents/kWh + $100/pk kW) • Motors & other: (0.09 cents/kWh + $100/pk kW) • Gas measures: ($1 per therm)	Not yet evaluated: Target audits: 100 in 2009, 430 in 2010, 370 in 2011 Incentives delivered: $8,657,512 in 2009, $12,120,518 in 2010, $13,852,020 in 2011
2004-2005 IDEEA Constituent Program[100]	SCE	2004-2005	*Refrigerated Warehouses* activity, providing information and financial incentives for EE freezer/cooler doors, refrigeration controls, lighting retrofits and non-condensable purgers	Five measures were offered, the program met its energy savings goals and expended all available incentives to fund the projects (only four participants) - the kWh realization rate was 104% and kW realization rate was 100%

Source: Kerstin Rock and Crispin Wong *(The Cadmus Group)* and Ben Bronfman and Anne West *(Quantec)*. See footnotes 99 - 100.

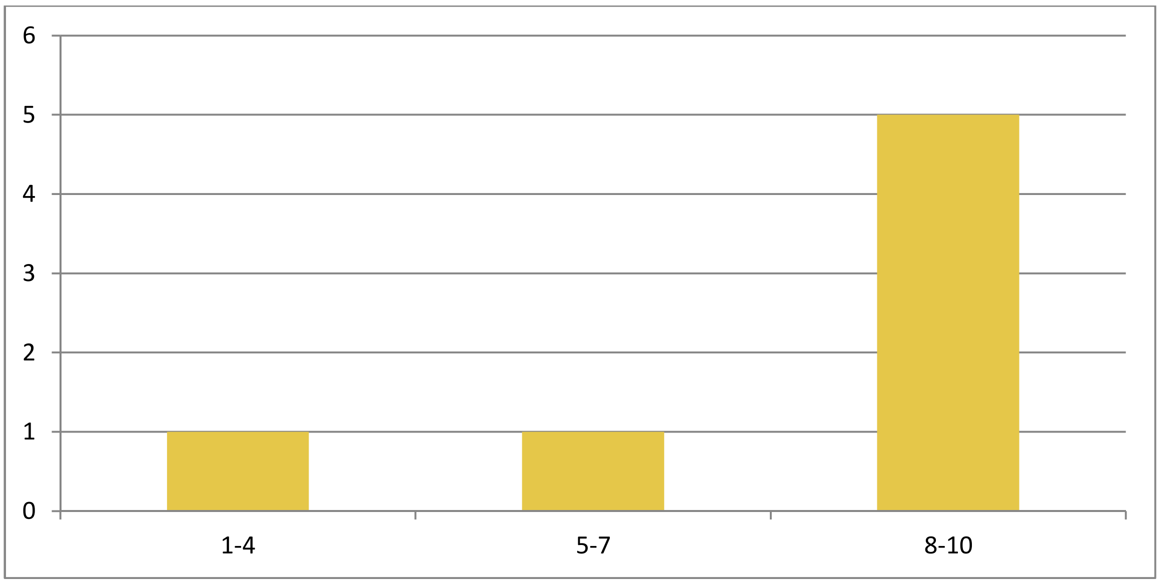
[99] Kerstin Rock and Crispin Wong (The Cadmus Group), 2009, *Process Evaluation of PG&E's Agriculture and Food Processing Program*. Portland, Oregon: Pacific Gas and Electric Company. CALMAC Study ID PGE0276.0. http://www.calmac.org/publications/PG%26E_AG_and_FP_Report_20090727.pdf.

[100] Ben Bronfman and Anne West (Quantec), 2008, Southern California Edison 2004-2005 IDEEA Constituent Program Evaluations. Portland, Oregon: *Southern California Edison*. Report number SCE0234.01. http://www.calmac.org/publications/IDEEA_Constituent_Program_Evaluations_-_Vol_1_FINAL_072808.pdf; http://www.calmac.org/publications/IDEEA_Constituent_Program_Evaluations_-_Vol_2_FINAL_AppendicesES.pdf

9.6 *Refrigerated Warehouse Water Management*

Water use among refrigerated warehouses is less important than in other agricultural market segments. Unlike in other segments, refrigerated warehouse technical survey respondents were more sensitive to interruptions in electricity than to interruptions in water service. Of the seven technical survey telephone respondents, the average sensitivity was 8.0 out of 10 for electric interruptions, and 7.7 out of 10 for water (see Figure 9.13 and Figure 9.14).[101] This is not unexpected as respondents indicated that water was a much less important cost input per electricity and labor rates.

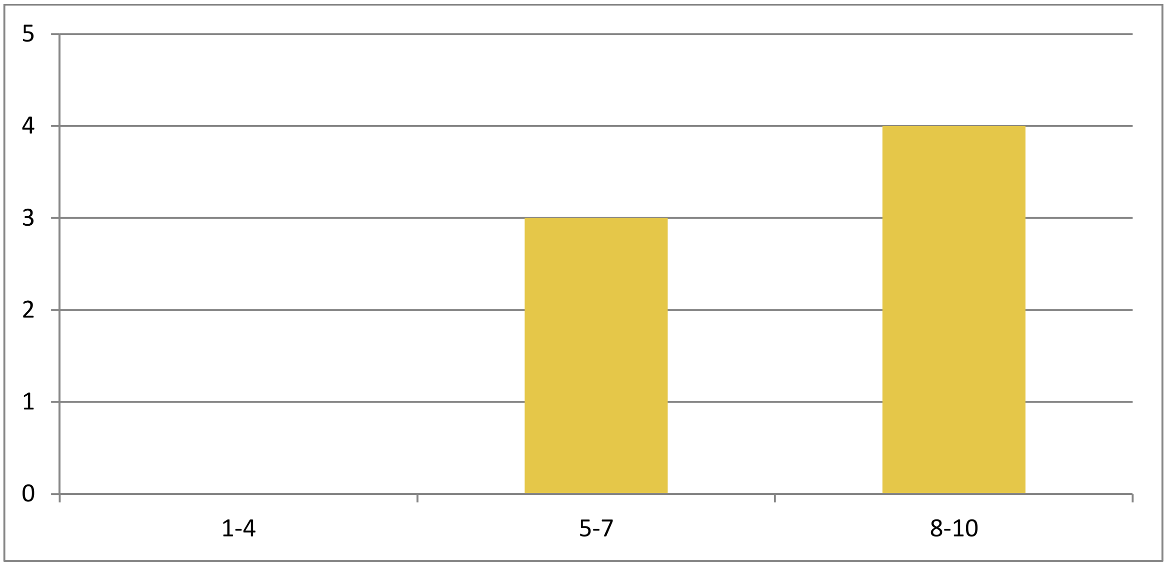
Figure 9.13. Sensitivity to Interruption in Electric Power Supply



Source: Technical Phone Survey, n = 7, "How sensitive is your operation to significant interruptions in your electric supply?

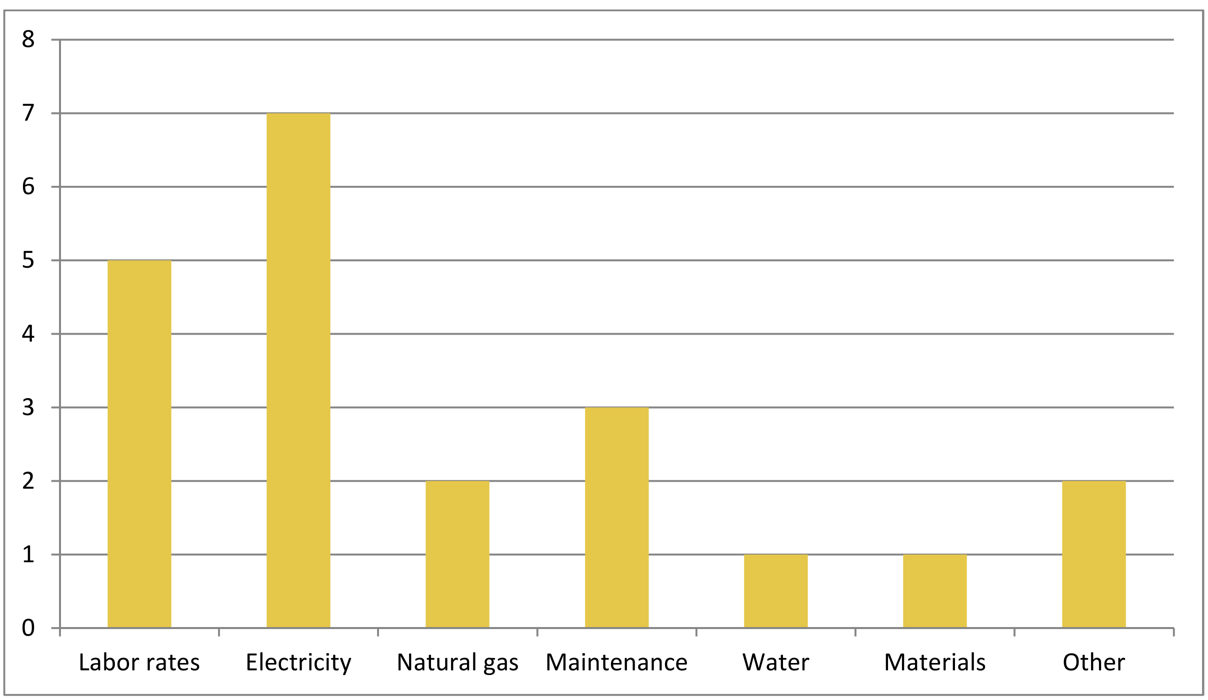
[101] On a scale of 1 to 10, how sensitive is [your operation] to interruptions in your water/electric supply?

Figure 9.14. Sensitivity to Interruption in Water Supply



Source: Technical Phone Survey, n = 7, "How sensitive is your operation to significant interruptions in your water supply?"

Figure 9.15. Greatest Productions Costs over Past Two Years



Source: Technical Survey, n = 7, multiple responses, "What are your top three production costs?"

9.6.1 Sources and Uses

Only one of the six in-person technical survey respondents took water from on-site wells while the other five relied upon local water utilities. Water use among the six facilities included cooling mechanisms (five mentions), condensing mechanisms (two mentions),and cleaning and landscaping (one each).

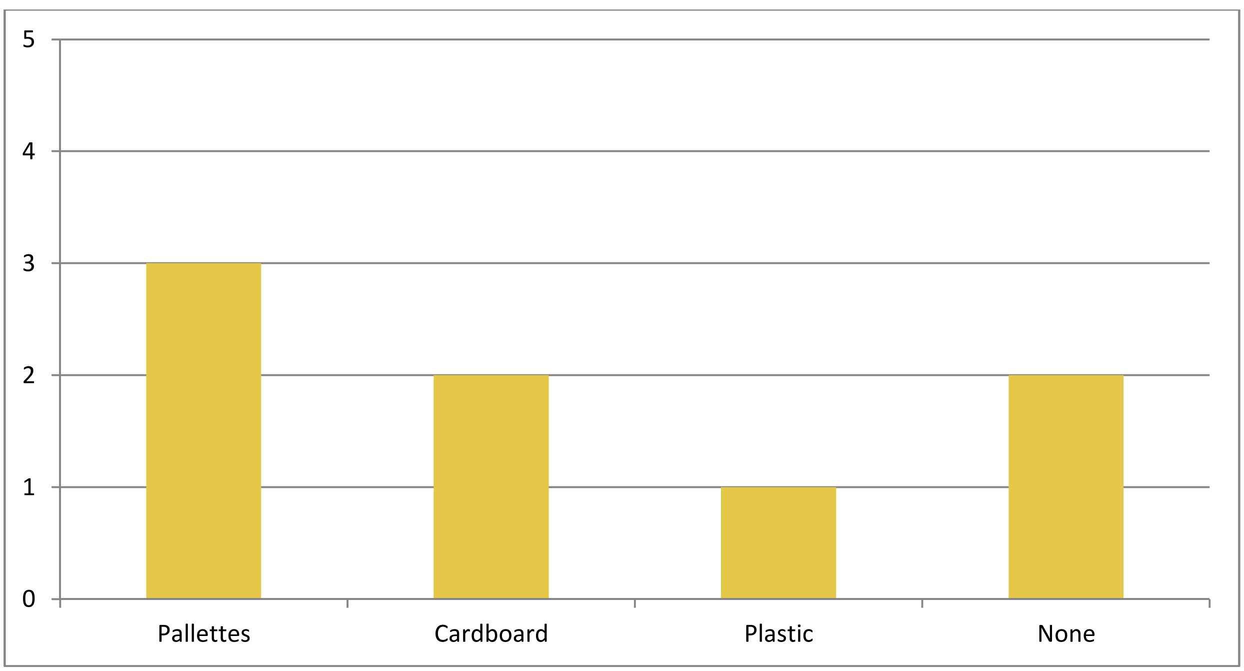
9.6.2 Management and Equipment:

Three of the six in-person technical survey respondents managed their water use by installing metering or tracking utility bills. The remaining three relied on recycling process water, rainwater collection or installation of low-flush or waterless bathroom fixtures.

9.7 Refrigerated Warehouse Waste Management

Unlike primary agricultural producers, refrigerated warehouses do not produce significant amounts of solid waste. When asked what type of solid waste they produced, two of the six technical field survey respondents cited cardboard, while two replied pallets (Figure 9.16). All four of these respondents claimed to recycle their pallets and cardboard, and respondents only adopted recycle bins and trash compactors in waste management practices (one mention each).

Figure 9.16. Solid Waste Generated by Refrigerated Warehouses



Source: Technical Field Survey, n = 6 - multiple responses, "What kind of solid waste is generated in your operation?"

9.8 *Refrigerated Warehouse Conclusions and Recommendations*

Conclusion 1: While refrigerated warehousing is technically similar across the board, not all refrigerated space falls in the agricultural sector. Cooler space, especially private and semi-private storage, is more directly associated with the agriculture customers of California utilities.

Recommendation 1: Program design for the agricultural sector should focus on the cooler space in private and semi-private refrigerated storage.

Conclusion 2: California utility programs have limited interaction with or influence over the communications and information materials offered by this segment's reference partners (trade associations). While individual operators may view local utilities as sources of information, the organizations that influence opinion throughout the segment have yet to benefit from the energy-related data, information, and experience developed by California utilities.

Recommendation 2: California utilities should conduct outreach activities with this segment's reference partners (trade associations) to promote existing conservation programs and measures, as well as to provide general information about energy management best practices. Utilities could also develop statewide energy management benchmarking opportunities to compare the relative energy efficiency of each participating warehouse. This could spur a general competition and drive down overall consumption in this segment.

Conclusion 3: In general, refrigerated warehouse operators have developed facility-level energy performance metrics, yet they lack an understanding of the impact from individual conservation measures. While there appears to be a general understanding that more energy-efficient equipment is beneficial, the operator's decision-making efforts do not appear to be as rigorous as might be expected.

Recommendation 3: In support of the previous recommendation, California utilities could offer energy engineering and verification expertise to warehouse operators, so that they could fully understand the impact of efficiency measures on their operations and optimize their efforts to manage energy use.

10 Post-Harvest Processing

10.1 Key Finding and Recommendations

Due to high demand growth for products such as nuts, **the Post-Harvest Processing segment is experiencing increasing production**. This suggests that **energy consumption in the market segment will increase**, as well. Given that much of the post-harvest roasting and hulling equipment dates to the 1970s or 1980s, there is an oppo**rtunity for utilities to promote energy-efficient equipment in this market segment**.

Respondents report that electricity constitutes one of the highest costs for all types of post-harvest processing. Because of this**, operators view energy costs as the most important determinant of production in future years**. Although post-harvest processors recognize their utilities as key sources of information, respondents felt that their **utility representatives could do more to help operators address barriers to energy efficiency**.

Navigant recommends that any program design **begin with an awareness of the differences between the various types** of post-harvest processing and refine offerings per the needs of each sub-segment rather than the segment as a whole. The **development of baselines for each sub-segment** would be an important foundational element for future programming.

Similarly, Navigant recommends that **future programming emphasize the financial benefits of saving energy through updating equipment**. By engaging individual customers and presenting programs in financial terms, utilities should be able to **appeal to a range of post-harvest operators**.

10.2 Methodology

10.2.1 Secondary Research and Literature Review

To understand the information that currently exists on the Post-Harvest Processing market segment, Navigant's research team began by conducting secondary research. Sources ranged from CEC reports to industry association publications, peer-reviewed publications, and research papers. Using this array of sources, Navigant conducted an extensive literature review, complete with an annotated bibliography. The findings from this research are located in the Post-Harvest Processing chapter in the *Literature Review for the 2010 – 2012 Statewide Agricultural Energy Efficiency Potential & Market Characterization Study.*

10.2.2 Primary Data Collection

Having gained an understanding of information that currently exists in the market, Navigant was able to identify the knowledge gaps to target in primary data collection. As illustrated in Table 10.1, this research included technical surveys – both via telephone and in-person – and qualitative interviews.

Table 10.1: Data Collection for the California Post-Harvest Processor Segment

	Number of Completed Interviews
Subject Matter Expert Interviews	2
Technical Surveys (Telephone/in-person)	13/13
Qualitative Interviews	9

10.2.2.1 Subject Matter Expert Interviews

The research team reached out to the Post-Harvest Technology Center at UC Davis and conducted two subject matter expert interviews with UC Davis staff researchers. These interviews served to give a high-level view of segment trends, drivers, market actors, energy, and technologies.

10.2.2.2 Technical Surveys

The research team conducted technical phone surveys with 13 individuals in the Post-Harvest Processing market segment. These surveys included topics such as operation firmographics, energy management and practices, waste and water issues, and business cycles. Each operator responded to an initial phone survey that covered these topics at a high level. If a respondent agreed to participate in a follow-up, in-person survey at their farm, a member of the research team would give one of three subsequent surveys based on their sophistication of energy metrics and history of energy-efficient measure implementation. These follow-ups included a General Technical Survey, an Intermediate Technical Survey, and a Detailed Technical Survey. Thirteen of the original 13 Post-Harvest Processing telephone respondents agreed to a subsequent technical survey.

NAVIGANT

Figure 10.1. Map of Post-Harvest Processing Technical Survey Respondent Locations

Source: Navigant analysis

10.2.2.3 *Qualitative Interviews*

The research team conducted nine qualitative interviews via telephone. The qualitative interviews were designed to complement the technical information, examining agricultural energy usage and efficiency potential. The qualitative interviews focused on market expectations, behaviors and practices, and potential barriers and opportunities related to increased efficiency.

10.2.2.4 *Firmographics*

Although Post-Harvest Processing operations fall under a single NAICS code, the segment is diverse in its operations. Because of the diversity within this market segment, each sub-segment has its respective key players who influence the market. The geographic distribution of these actors varies with each post-harvest subcategory.

The Fresh Fruit and Vegetable segment relies heavily on the pre-cooling process, which is highly consolidated among a small number of operators. The market leader in transportation refrigeration is Carrier Transicold, which, by nature, is frequently mobile. Western Pre-Cooling leads the cooling market, with over 100 sites in the major crop-growing regions throughout California, Arizona, and Mexico.

California's Dehydrated Fruit and Vegetable segment consists of dozens of dehydrating facilities that operate two to three months per year. Cooperatives like Sun Sweet Growers are the predominant players in the Dried Fruit segment, with ten facilities devoted to processing dried fruits in the Central Valley region.

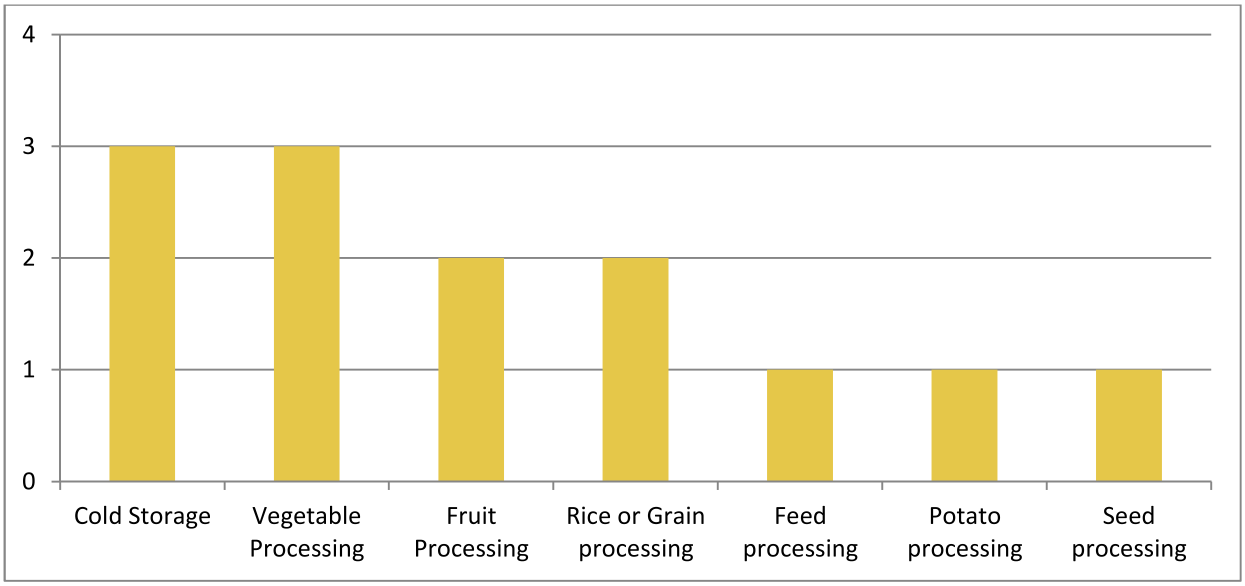
With regard to nut processing, the Post-Harvest Processing segment has a large infrastructure of small- and medium-size hulling and nut processing facilities, with a few large nut handlers that process almond and walnut crops. These include companies such as Blue Diamond for almonds and Woodside Electronics Corp for walnuts. For further information on market actors and distribution of processors, see Section 10.3.

Little information is publicly available on water use and consumption estimates in the Post-Harvest Processing market segment. As with energy, water use within this segment appears to be highly variable, depending on the operation. Both well water and utility-provided water are used, depending on the operation. Typical post-harvest water end uses, such as washing and cooling of produce, require water to be pumped. However, many producers also use water for irrigation, illustrating the fine line between crop production and post-harvest processing. Water use in post-harvest operations is detailed in Section 10.6.

To verify the trends occurring within the market, the research team conducted a number of technical and qualitative surveys with post-harvest processors. Of the 13 technical phone survey respondents, most had either been in operation for 25-50 years, although some were younger than 25 years. Primary operations included vegetable processing, rice or grains processing, and cold storage and pre-cooling. These operations typically accounted for 75-100% of their total production, indicating that many post-harvest processors specialize in processing one particular product rather than diversifying the products.

Of the 13 respondents, six reported to be in managerial positions, while two were owners. The remaining five included an agronomist, a controller, a director of facilities, a vice president of operations, and an energy analyst.

Figure 10.2. Post-Harvest Processor Primary Products



Source: Technical Survey, n = 13, "What do you consider your primary product?"

10.3 Structure of Post-Harvest Processing Market Segment

10.3.1.1 Definition of Market Segment

According to NAICS classification, Post-Harvest processing is a support activity for the agricultural and forestry market segments. The Post-Harvest Processing market segment falls under the 115114 NAICS category, a market segment that is "primarily engaged in performing services on crops, subsequent to their harvest, with the intent of preparing them for market or further processing. These establishments provide Post-Harvest activities, such as crop cleaning, sun drying, shelling, fumigating, curing, sorting, grading, packing, and cooling." This market segment specifically excludes cotton ginning, which falls under 115111. This study does not include cotton ginning in its research.

Post-harvest processing operations fall into three general subtypes: cooling activities for fresh market fruits and vegetables; fruit and vegetable drying practices; and nut processing, which includes drying, shelling, hulling, and roasting. These sub-segments differ greatly in terms of their energy end uses and overall processes. For instance, within the cooling sub-segment, fresh market fruits and vegetables require rapid cooling to preserve quality and shelf life. This process is vital to ensuring the safety and quality of produce. Any delay to cooling can result in the deterioration of produce's quality due to water loss, excessive respiration rates, and increased decay development.

In contrast to produce cooling, California's dehydrated fruit and vegetable segment consists of dozens of dehydrating facilities that operate two to three months per year. "Dehydrated" fruits and vegetables consist of food with a moisture content reduced to a level below which microorganisms can grow (8% to 18% moisture). These operations dry products such as apricots, plums, raisins, and other fruits and vegetables. After the harvest, post-harvest processors quickly clean, sort, and collect their crops in drying trays for a controlled drying process.

Post-harvest nut processing also requires drying, as well as hulling, shelling, and roasting. Walnuts are dried and stored in-shell at fumigated warehouses or non-fumigated refrigerated facilities. Pistachios are hulled, roasted, and stored in-shell.[102] Generally, the Post-Harvest Processing segment has a large infrastructure of small- and medium-size hulling and nut processing facilities, with a few large nut handlers that process almond and walnut crops. These include companies such as Blue Diamond for almonds and Woodside Electronics Corp for walnuts.

10.3.1.2 Description of Market Actors

Although post-harvest processing operations fall under a single NAICS code, the segment is diverse in its operations. For instance, this broad market segment can include crop cleaning, drying, shelling, packing, and a number of processes that are not typically carried out by a single operator. Because of the diversity within this market segment, each sub-segment has its respective key players who influence the market. According to market expert interviews, Carrier Transicold is currently the market leader in transport refrigeration, while Western Pre-Cooling leads the cooling market. Western Pre-Cooling rents their cooling equipment to the post-harvest market and transports food and equipment from location to location. Of the companies who own their pre-cooling machinery, most do not install their own equipment. Rather, one to two dozen firms in the market provide design, installation, and maintenance services for refrigeration. When reaching out to the post-harvest cooling market, utilities should target these design firms to promote energy efficiency through equipment installations and process optimization.

The leaders in shelling/husking and walnut dehydration include Woodside Electronics Corp (WECO) and Applied Instrumentation. Cooperatives like Sun Sweet Growers are the predominant players in the Dried Fruit segment, with ten facilities devoted to processing dried fruits in the Central Valley region. SunMaid Growers process grape raisins, while Gills Onions is the largest onion processor in the state. [103] In targeting operations for program design, utilities should be mindful of the differences between each market sub-segment and their respective energy usage patterns.

10.3.1.3 Description of Supply Chain

Post-harvest processors operate towards the end of the agricultural supply chain. Growers and wholesale suppliers provide their harvests to these facilities, often via truck. In turn, these operations

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[102] DRAFT Literature Review for 2010-2012 Statewide Agricultural Energy Efficiency Potential and Market Characterization Study.

[103] DRAFT Literature Review for 2010-2012 Statewide Agricultural Energy Efficiency Potential and Market Characterization Study, page 65.

further process the harvested materials, depending on which type of product in which they specialize. Once operators have processed the crops, they typically transport the product via truck, although rail and plane are also common methods of transportation. Processors generally sell their products through distribution centers, truck/haulers, handlers, and wholesalers, at both a national and international level. Each operation is distinct in terms of the timeline and energy requirements necessary for their production and transportation.

Vertical integration within the market further complicates the distinction between these sub-segments. For instance, large fruit and vegetable producers often operate their own processing systems year round in California, Arizona, and northern Mexico. The mobile trailer units that transport on-farm pre-cooling equipment are major energy end users, as these units use in-field refrigerated transport to ship to centralized cold storage facilities. All cooling activities demand high peak electricity loads and require significant hours of operation.[104]

10.3.1.4 Description of Market Reference Partners

To identify information channels in the market, Navigant's research team asked both qualitative and technical survey respondents about common sources of information in the market. Qualitative interview respondents identified the Agricultural Energy Consumers Association and the Western Area Power Administration as key trade associations. Although these organizations' services apply to post-harvest processors, they are power providers or energy advocacy groups that are not specific to this market segment. Their websites and missions are specific to energy, but it remains unclear whether their advocacy efforts are effectively reaching the agricultural market.

On the narrow subject of operational energy use, the technical surveys revealed that all 13 respondents work with their local utility representatives and, in four cases, outside consultants as well. Respondents' formal assessments included energy audits (six mentions), rate analyses (five mentions) and cost analyses (one mention), indicating that individual operators recognize utilities as a source of information. The qualitative interviews revealed that approximately a quarter of the respondents believed their suppliers were uninformed regarding energy efficiency, while four of seven applicable respondents believed that they were knowledgeable on the issue and kept them informed. This suggests that post-harvest processors receive their information from a number of sources, and that utilities should encourage suppliers to educate their customers on energy efficiency options.

10.4 Status of Post-Harvest Processing Market Segment

The Post-Harvest Processing segment is seeing a number of trends, which vary given the respective sub-segment. The Dried Fruit market segment is encountering increasing international competition. Demand for nuts has been increasing significantly over the last decade, particularly for almonds, walnuts, and pistachios. The Fresh Fruit and Vegetable segment relies heavily on the pre-cooling process, which is highly consolidated among a small number of operators. According to market expert interviews, all Post-Harvest market segments have seen an increase in both exports and overseas competition. This

[104] DRAFT Literature Review for 2010-2012 Statewide Agricultural Energy Efficiency Potential and Market Characterization Study, page 65.

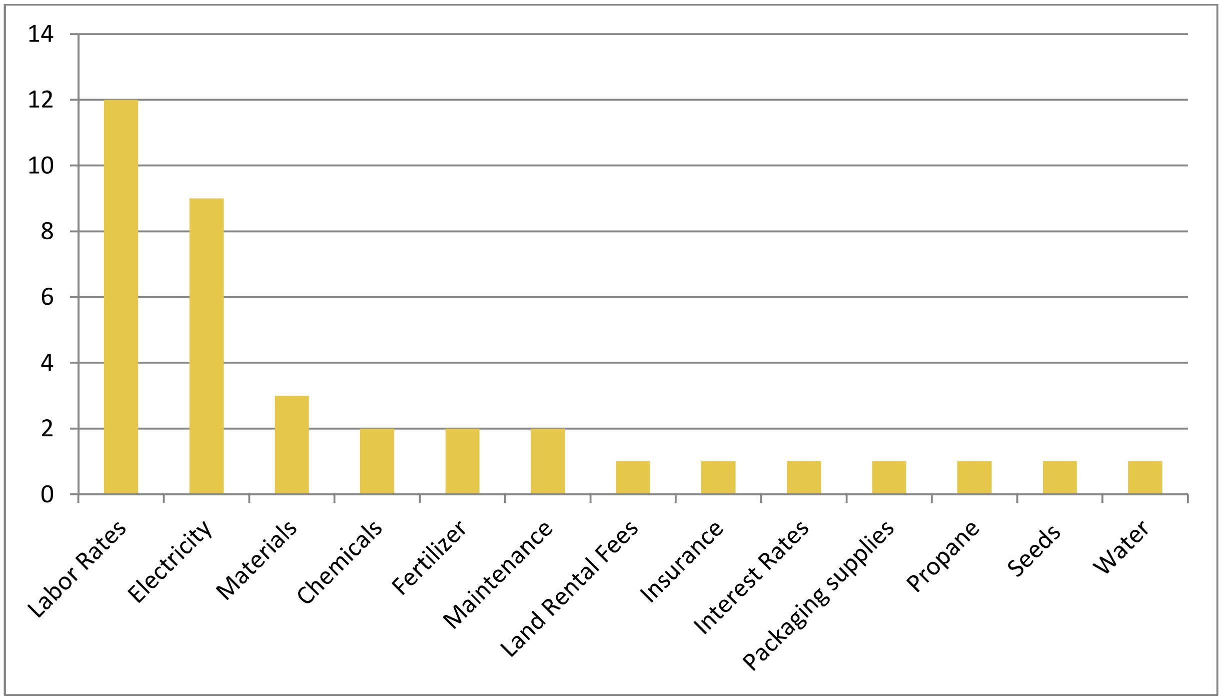
increase has led to growing concerns over labor costs, and subsequent trends toward automation. As Post-Harvest processors continue to automate their processes, they may be increasingly wary of the quality and sanitary safety of their products. Furthermore, increased mechanization will undoubtedly lead to growing energy consumption in this market segment, creating an opportunity for utilities to work with operators to minimize costs through energy-efficient equipment.

California's Post-Harvest Processing segment has also seen advancements in productivity in vine, fruit, and vegetable crop production. This is largely due to progressive disciplined adoption of improved varietals, best cultural practices, water management, and labor efficient harvest practices. The segment has partnered with the Land Grant University of California Cooperative Extension Service, which has allowed for the advancement of scientific business management practices for fruits, vegetables, nuts, and fiber crops. Because of the strong alliance between this program and the Post-Harvest segment, this could present an avenue through which utilities could promote energy efficiency.

10.4.1 Current Trends

To gauge market trends, Navigant asked technical survey respondents about their production over the last two years. Eight of the 13 respondents claimed that production had increased in this time, primarily due to an increase in consumer demand and market share. When asked about the greatest production costs over the last two years, the most frequently cited costs included labor, electricity, and materials (see Figure 10.3). Qualitative interview respondents corroborated these findings, listing labor, energy, and packaging among their key production costs. Five of the nine qualitative interview respondents and 12 of 13 technical survey respondents considered labor to be their largest cost. This indicates that while energy is a major cost for post-harvest processors, labor will be their first priority when prioritizing their cash flow.

Figure 10.3. Greatest Production Costs



Source: Technical Survey, n = 13 - multiple responses, "What are your top three production costs?"

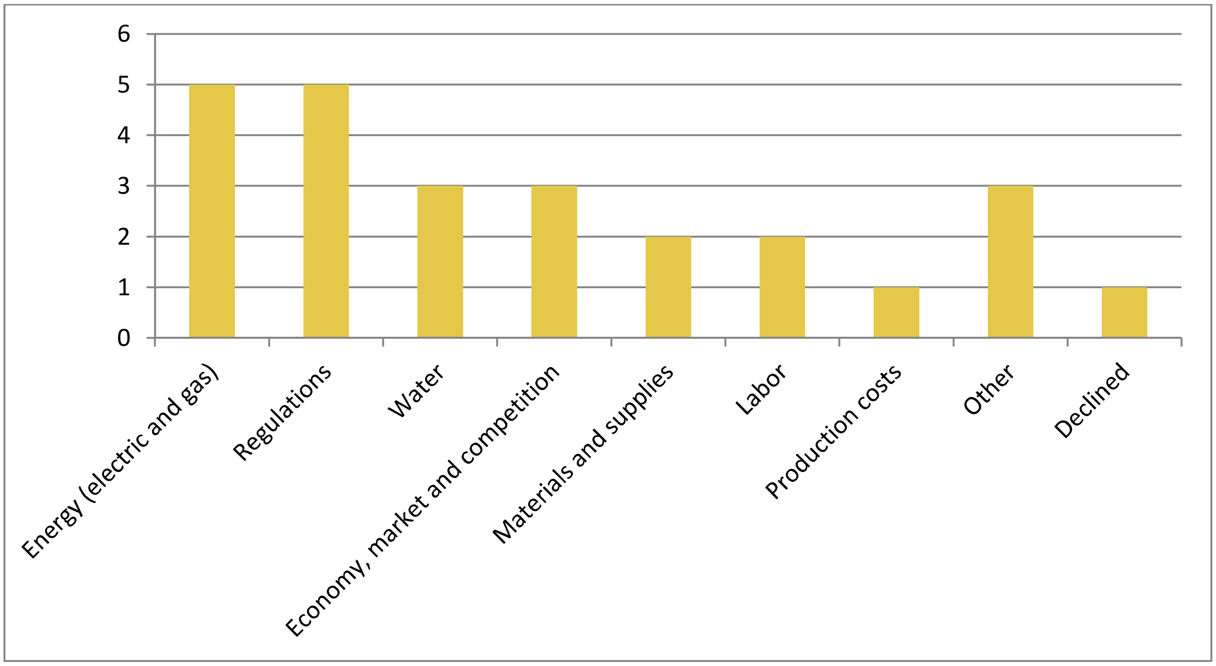
10.4.2 Future Prospects

When asked about future trends, the majority of qualitative interview respondents indicated that they anticipate demand to increase in the next three years, particularly for organic produce. One respondent noted that demand for row crops has been low, so growers have been planting more permanent crops, such as tree nuts. This, in turn, has led to a higher demand for processing these products. Other respondents credited population increases with the segment's demand growth.

As illustrated in Figure 10.4, technical survey respondents considered energy and regulations to be the primary factors affecting their future production costs. Respondents also mentioned water and the economy, market, and competition. It is important to note that although labor is a major production cost for processors, only two respondents listed this factor as a future concern. This suggests that respondents are more concerned with increasing energy costs than the availability or cost of labor. This presents an opportunity for utilities to work with post-harvest processors to increase their energy efficiency and combat increasing energy prices.

Navigant's expert interviews give additional detail to the above market trend findings. The interviews indicate that consolidation is the major industry trend in the refrigerator and cooling subsector, especially for the fresh produce business. The drying subsector is experiencing increasing international competition. The hulling subsector has been experiencing exploding demand over the last several years, and, according to one of the experts, producers have a "major need" for good control over drying energy systems. Respondents' concerns with future competition, energy costs, and regulation may give utilities more leverage in discussing energy efficiency as a means to dealing with all of these issues and innovating to stay ahead of the market.

Figure 10.4. Factors Influencing Future Production



Source: Technical Phone Survey, n = 13 - multiple responses, "What factors do you think will most impact your future production?"

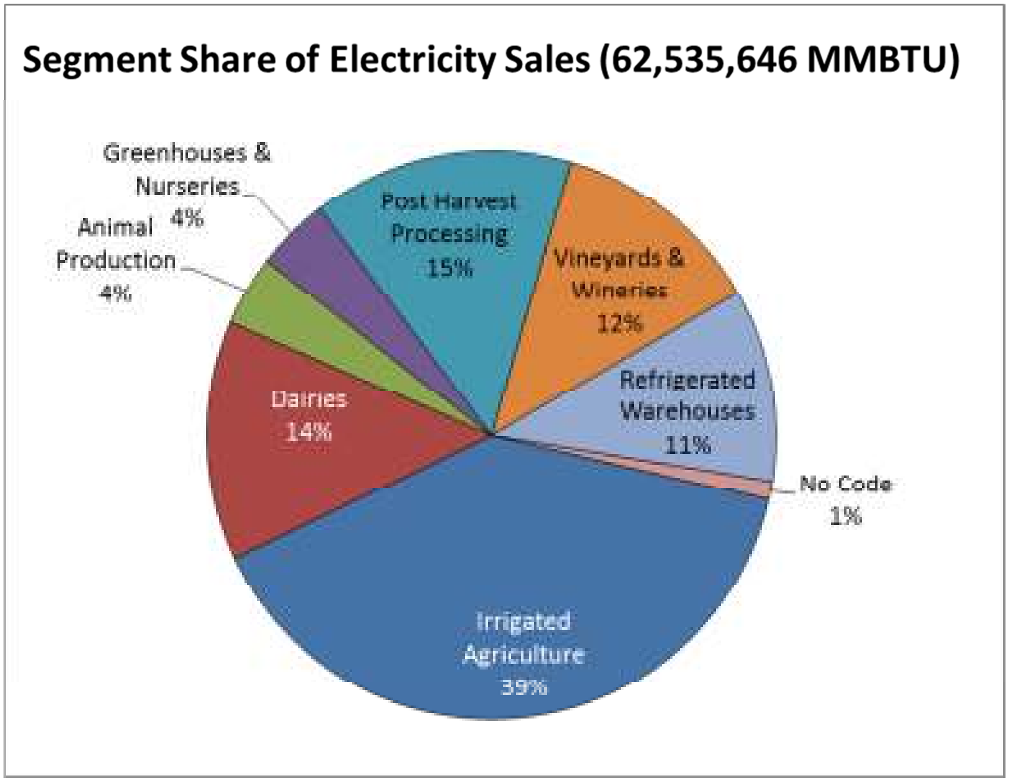
10.5 Energy Use and Efficiency in Post-Harvest Processing Segment

Post-Harvest Processing constitutes the second largest consumer of electricity of any agricultural market segment in the California IOU service territory, coming to 15% of all electricity consumption in the agricultural sector (see Figure 10.5. Agricultural Segment Share of Electricity Sales (MMBTU)).[105] In 2006, cooling and short-term storage of California's 17.7 million tons of fresh fruits and vegetables used 1.1 million kWh of electricity, representing 5.5% of California's total agricultural electricity usage and 0.4% of the state's total consumption.[106] Although the Post-Harvest Processing segment also includes drying practices and nut husking, shelling, and roasting, consumption estimates were not available specifically for these practices.

[105] 2011 QFER data provided by California IOUs through Market Characterization Data Request.

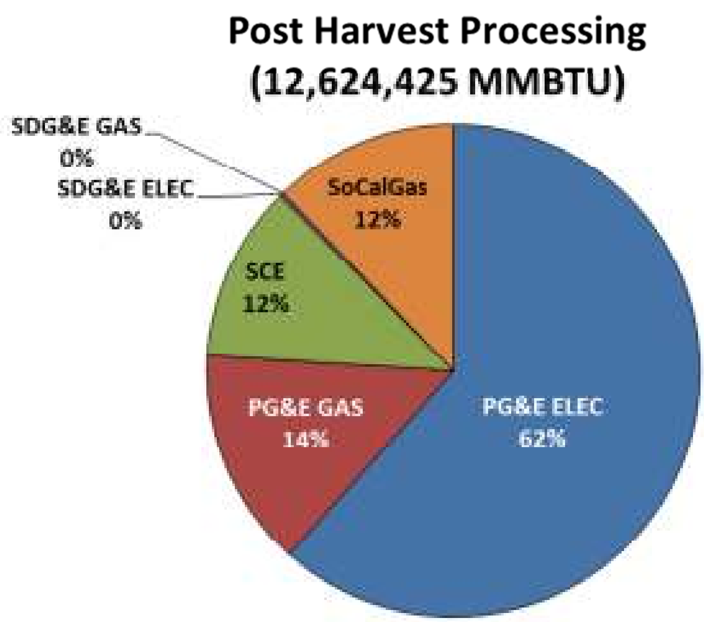
[106] James Thompson and Paul Singh (University of California, Davis), 2008, Status of Energy Use and Conservation Technologies Used in Fruit and Vegetable Cooling Operations in California. *California Energy Commission, PIER Program*. CEC-400-1999-00. http://ucce.ucdavis.edu/files/datastore/234-1165.pdf.

Figure 10.5. Agricultural Segment Share of Electricity Sales (MMBTU)



Source: Navigant analysis of CPUC electric consumption data

Figure 10.6. 2010 Post-Harvest Processing Energy Sales by IOU



Source: Navigant analysis of CPUC electric consumption data

Energy costs are important to individual operators, although they may not be the largest of their concerns. The subject matter experts agreed that post-harvest processors are more concerned with the speed, quality, and efficiency of their processes than with the energy costs behind these processes. For instance, post-harvest cooling operations must cool the fruit shortly after the harvest to ensure produce safety and quality. Any delay in achieving fast cooling can result in quality deterioration.[107] Because of this, companies in this segment would never entertain "delaying cooling to reduce peak period electricity use."[108]

As these costs increase, however, they become more of a concern for operators. Of the 13 technical survey respondents, five listed energy as a top concern for their future production, and ten listed electricity among their top costs. When further probed, all of the respondents who did not explicitly list electricity as a top cost agreed that it was, indeed, significant. When asked about natural gas, however, 11 of 13 respondents claimed that natural gas was *not* a significant production cost for them. Most respondents viewed natural gas as either a low-cost component or a fuel that operators rarely used, if at all. Both technical and qualitative respondents indicated that electricity represented up to 20% of costs, while natural gas came to less than 5% of operating costs. When designing energy programs for this market segment, utilities should focus on electricity, as there seems to be limited opportunity for gas savings among most post-harvest processors.

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[107] James Thompson and Paul Singh (University of California, Davis), 2008, Status of Energy Use and Conservation Technologies Used in Fruit and Vegetable Cooling Operations in California. *California Energy Commission*, *PIER Program*. CEC-400-1999-00. http://ucce.ucdavis.edu/files/datastore/234-1165.pdf.
[108] Thompson and Singh, 2008.

When asked about barriers to improving energy efficiency, most respondents listed costs and timing as the primary reasons for not upgrading their equipment and systems. However, half of respondents report that utilities and other entities could help to overcome these barriers. This suggests that post-harvest processors recognize their local utilities as valuable resources for energy efficiency information and financing. Utility representatives should therefore ensure that they are working closely with operators to gauge energy efficiency opportunities and helping processors to install efficient measures.

10.5.1 Energy End Uses

Energy end uses in this market segment vary widely with the type of operation. According to secondary research, general post-harvest processing equipment can include lighting, forklifts, coolers/freezers, tanks, and warehouses. However, operation-specific needs will determine end uses for individual processors. For instance, fruit and vegetable dehydration uses passive solar for dried tomatoes, blanching of vegetables, and forced air-drying of plums using heat tunnels. Much of the segment's current drying equipment dates to the 1960s and 1970s, when the Dried Fruit and Vegetable segment began. This could be an area of vast energy efficiency, as the equipment is presumably energy intensive and nearing its measure life.

When asked about their process and equipment electricity usage, technical field interview respondents pointed to lighting, refrigeration, and pumps as energy-using systems (see Table 10.2). Lighting was the most frequently cited energy end use, indicating that lighting is common among all industry sub-segments. However, lighting only accounted for an average of 12% of total electric consumption. Refrigeration was the most energy-intensive end use, accounting for an average of 64% of electric consumption. Pumping accounted for another 28%. Other end uses included cold storage, compressed air, palletizing, and condensing. All but one respondent based their estimates on the recollection of their financial records, indicating that operators in this segment are relatively familiar with their energy use and costs. Although a number of end uses exist in this particular market segment, utilities would presumably achieve the most savings from refrigeration or pumping-related measures.

Table 10.2. Self-Reported Estimates of Electric End Use among Post-Harvest Processors

End Use	Number of Mentions	Range of Consumption Estimates	Average Consumption Estimate
Lighting	8	3% - 30%	12%
Refrigeration	6	30% - 85%	64%
Pumps	4	15% - 60%	28%
Drying	2	10%	10%
Cold storage	2	25% - 80%	53%
Conveyors	2	40%	40%
Compressed air	2	12% - 60%	36%
Milling equipment	1	30%	30%
Conditioning line	1	50%	50%
Palletizing	1	60%	60%
Washing	1	20%	20%
Rail receiving line	1	40%	40%
Processing	1	20%	20%
Miscellaneous	1	13%	13%
Heating	1	NA	NA
Packing line	1	5%	5%
Condensers	1	10%	10%

Source: Technical Survey, n = 11 – multiple responses, "Which processes or equipment use the most electricity?"

Natural gas usage depends heavily on the type of operation. For instance, processes such as drying and roasting will use significantly more natural gas than cooling operations. Eight of the 13 technical field interview respondents reportedly did not use any natural gas in their operations. Of those who did use natural gas, major end uses included space heating, de-greening, boiler water heating, peeling, and juicing (see Table 10.3). Utilities should conduct further research into gas usage with the Post-Harvest segment. Accurate baseline equipment and usage information could be valuable in determining opportunities for natural gas programs in the segment.

Table 10.3. Self-Reported Estimates of Natural Gas End Use among Post-Harvest Processors

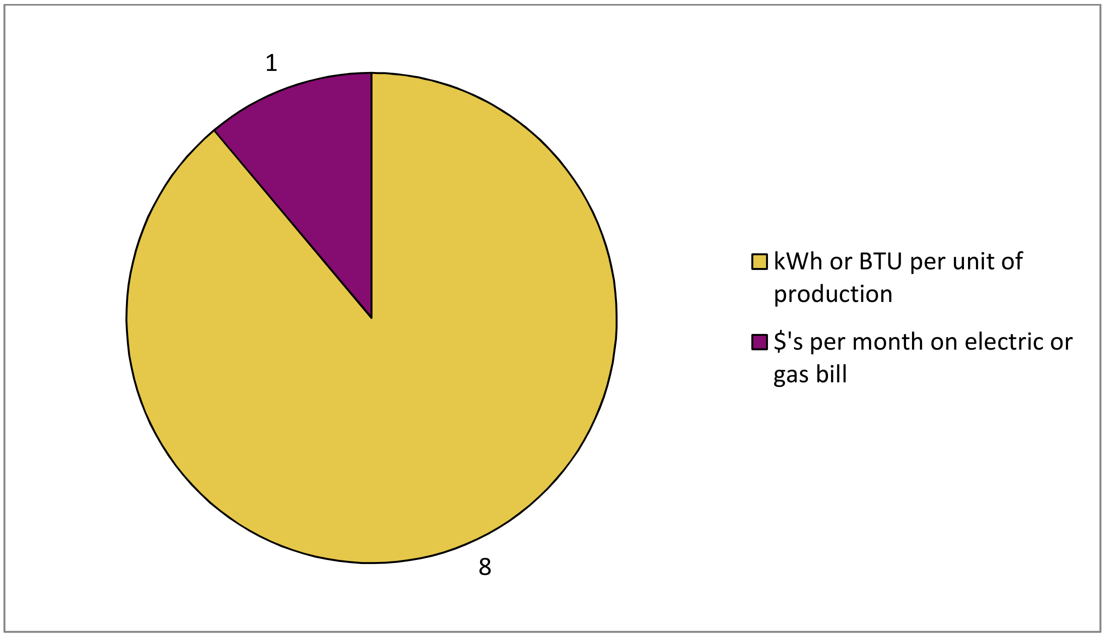
End Use	Number of Mentions	Range of Consumption Estimates	Average Consumption Estimate
Space heating	2	95%	95%
Boiler	1	100%	100%
Drying wax	1	85%	85%
Juicers	1	50%	50%
Peelers	1	30%	30%
De-greening	1	15%	15%
No natural gas	31	NA	NA

Source: Technical Field Survey, n = 5 - multiple responses, "Which processes or equipment use the most natural gas?"

10.5.2 Energy Management

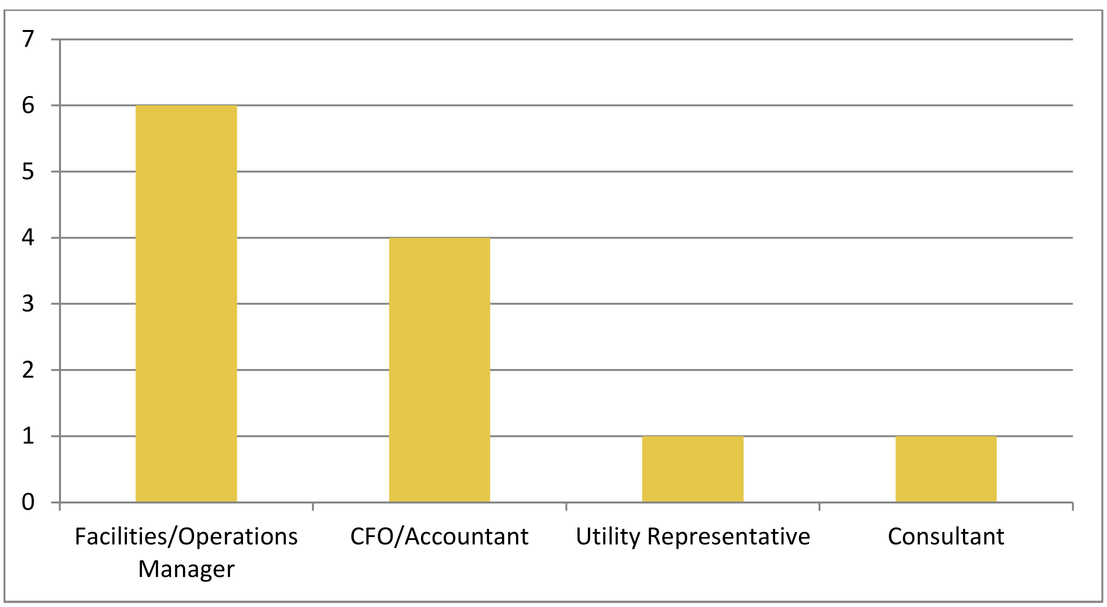
To understand their energy management practices, Navigant asked technical field survey respondents whether they had metrics or performance measures to track energy costs. Nine of ten respondents claimed that they had metrics, including kWh or Btu per unit of production (see Figure 10.7. Energy Metrics). The majority of the respondents had been tracking these metrics since the late 1990s and early 2000s, although one operation had been tracking since 1982. Respondents claimed to have developed these metrics as a result of cost accounting and cost reduction processes. Most respondents who tracked their metrics claimed to have developed them internally, using the staff and methods illustrated in Figure 10.7. Notably, while the technical surveys revealed that all 13 respondents work with their local utility representatives to assess operational energy use, only one respondent worked with a utility representative to develop their metrics. These findings suggest that respondents have a solid understanding of the energy usage in their operations. However, there is room for utilities to improve their communication with post-harvest processors to promote increased energy efficiency within the segment.

Figure 10.7. Energy Metrics



Source: Technical Field Survey, n = 9, "Do you have metrics or performance measures for energy costs?"

Figure 10.8. Source for Developing Metrics



Source: Technical Field Survey, n = 9 – multiple responses, "Who helped you to develop these metrics/performance measures?"

10.5.3 Equipment Installations and Utility Involvement

As with energy end uses, equipment in the Post-Harvest Processing segment can vary greatly with the operation, even within market sub-segments. For instance, post-harvest cooling methods can include room cooling, forced-air cooling, hydro-cooling, and top or liquid icing, among others.[109] Each of these methods uses different equipment, and the efficiency of each method can depend on whether the product is pre-cooled. It is important to note that approximately 70-80% of vacuum pre-cooling equipment is rented to the market. Western Pre-Cooling, a company based out of Fremont, California, owns the majority of this equipment and moves it from location to location. This makes it difficult for IOUs to support this type of operation. For the companies that do not use Western Pre-Cooling's services, most own their own equipment, although they do not install it. Rather, there are under 30 companies that provide design, installation, and maintenance of refrigeration services.

As a general guide, UC Davis and the CEC's PIER Program offered a number of energy-saving methods that could apply to most post-harvest cooling operations, as shown in Table 10.4. This study found that while equipment installations can lead to energy savings, processors could also achieve large savings at minimal cost by optimizing the use of their cooling space. Efficient equipment is also available for the segment, most of which includes controls for refrigeration systems and adjustments to refrigerant and water usage.

[109] L.G. Wilson et al., 1995, Post-Harvest Handling and Cooling of Fresh Fruits,Vegetables, and Flowers for Small Farms. North Carolina Cooperative Extension Service. http://www.ces.ncsu.edu/hil/hil-801.html.

Table 10.4. Electricity Conservation Methods for Fruit and Vegetable Cooling Facilities

Electricity Saving Methods	Savings Potential	Market Penetration
Install energy-efficient lighting	8 to 16%	<5%
Minimize amount of refrigerated space and use racks or stack pallets	Up to 70%	>50% use racks or stack pallets, variable use of minimizing refrigerated space
Implement controls to maximize suction pressure	No estimate available	Low
Speed control for screw compressors	Up to 37%	Common in new vegetable coolers, 5% of fruit coolers
Optimum Compressor Sequencing	No estimate available	90% of new installation, <50% of existing
Add condenser capacity and improved discharge pressure control	No estimate available	>80% of new facilities, 60% of existing
Use rapid-acting exterior doors	Small	Common in new facilities
Methods used for new installation and when replacing equipment: -Use high-efficiency motors -Add roof or wall insulation -Increase refrigerant piping diameter -Insulate refrigerant piping	No estimate available	No estimates available, but probably common in new facilities
Use high-reflectivity roofing and exterior paint	Up to 3-4%	20 to 30%
Install hydro-cooler in cold room	25%	10 to 20%
Minimize hydro-cooler reservoir volume	9%	No estimate available
Minimize water pump capacity	No estimate available	No estimate available
Harvest in predawn and early morning	10 to 25%	Rarely used

Source: James F. Thompson and R. Paul Singh, 2008, Status of Energy Use and Conservation Technologies Used in Fruit and Vegetable Cooling Operations in California. Davis, CA: UC Davis. http://ucce.ucdavis.edu/files/datastore/234-1165.pdf.

Post-harvest drying differs greatly from produce cooling in terms of equipment and energy use. To reduce labor and energy costs, fruit-drying operators have increasingly employed the method of sun drying or on-the-vine drying, which require little to no energy input as the heat comes directly from the sun. However, this method is only applicable to certain crops, such as fruit. Nut hulling and shelling also use drying in their processes, yet these operations require equipment that can be energy intensive. One subject matter expert identified the drying of nuts as an area in need of technological improvement; according to this expert, this industry subsection needs better controls for their dryer energy usage. Technologies appropriate for this particular market would include meters for moisture content, which utilities could promote and install through post-harvest-related programs.

When asked about their individual equipment installations, 12 of 13 technical field survey respondents reported to have installed energy-efficient measures for their operations (see Table 10.5). The most frequently mentioned installments included lighting, variable frequency drives, and fan motors. The oldest of these measures dated back to 1997, although most operators had installed this equipment in the last few years. Anticipated savings ranged from 2-75%, and five respondents claimed to have achieved the expected savings. When asked how they knew they had achieved the savings, three claimed to have tracked their monthly energy bills, while one measured savings. One respondent received checks from EnerNoc, and the final respondent was not sure how he knew he had achieved the savings. Eight respondents claimed that when they install new systems, they look to install energy- efficient measures.

Table 10.5. Energy Equipment Installations by Post-Harvest Processors

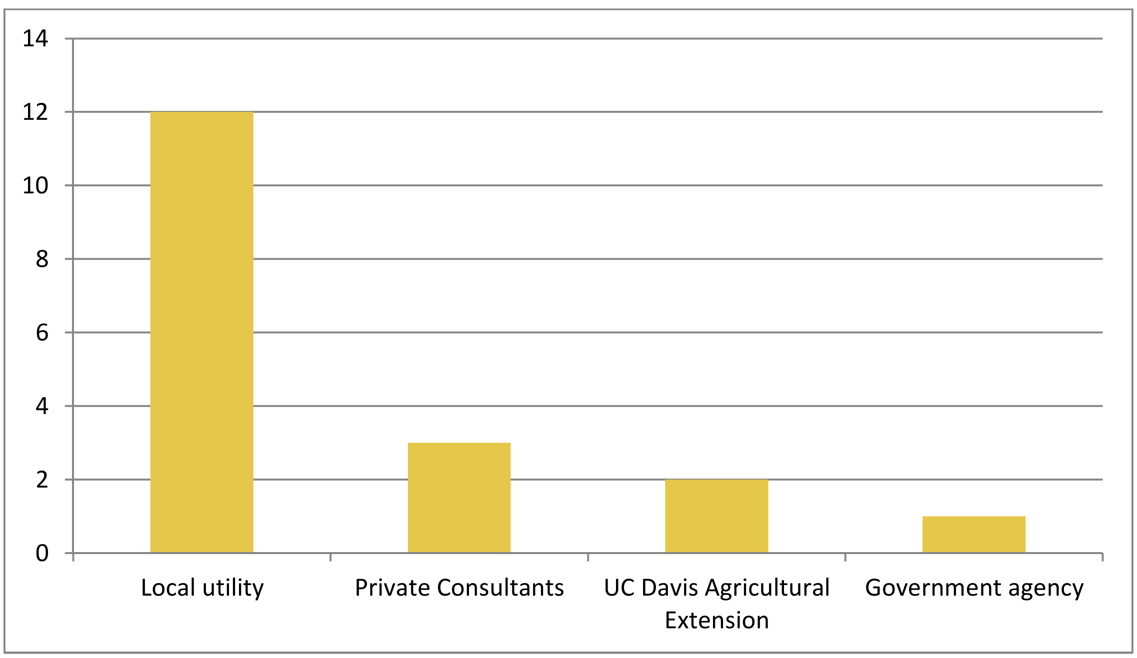
End Use	Number of Mentions	Range of Consumption Estimates	Average Consumption Estimate
Lighting	10	2% - 50%	20%
VFDs	5	12% - 50%	28%
Fan motors	4	20% - 50%	35%
PV	3	25% - 75%	50%
Premium efficiency motors	3	15%	15%
Conveyor motors	2	20% - 25%	23%
Refrigeration	1	5%	5%
Roofing insulation	1	NA	NA
Overhead doors	1	4%	4%
Cooling towers	1	NA	NA
PLC	1	40%	40%
Compressors	1	15%	15%

Source: Technical Survey, n = 12 - multiple responses, "What equipment or devices have you installed to reduce energy use?"

Seven of the 12 respondents claimed they heard about their equipment through their local utility, indicating that utility information is indeed reaching post-harvest processors (see Figure 10.9). When asked their most common sources of information regarding energy information, all but one field interview respondent mentioned their local utility. Qualitative interview findings support these findings, as two thirds of respondents claimed they did not feel that they needed education and training in energy efficiency opportunities.

These responses indicate that there are working communication channels between utilities and post-harvest processors. Indeed, all 13 technical phone survey respondents reported interacting with utility representatives in their role. Moreover, eight of 13 respondents claimed to have worked with their local utility representative to assess energy in their operations, most frequently via energy audits and rate analyses. Twelve of the 13 respondents also reported to have accepted rebates or incentives from their local utility, the most common of which were for energy-efficient installations such as those listed above. Given their propensity for energy efficiency and their openness to utility involvement, post-harvest processors appear to be self-motivated toward energy-efficient equipment installations, and increasingly proactive with utility support. Utilities should continue to foster relationships with their Post-Harvest customers and work with operators to optimize the segment’s energy-using systems. Moreover, utilities should work with post-harvest design and installation firms to ensure that they are aware of energy-efficient options at the design stage.

Figure 10.9. Post-Harvest Processing Energy Efficiency Information Channels



Source: Technical Survey, n = 12 - multiple responses, “What are your three most likely sources for gathering information about reducing energy use or generating energy?”

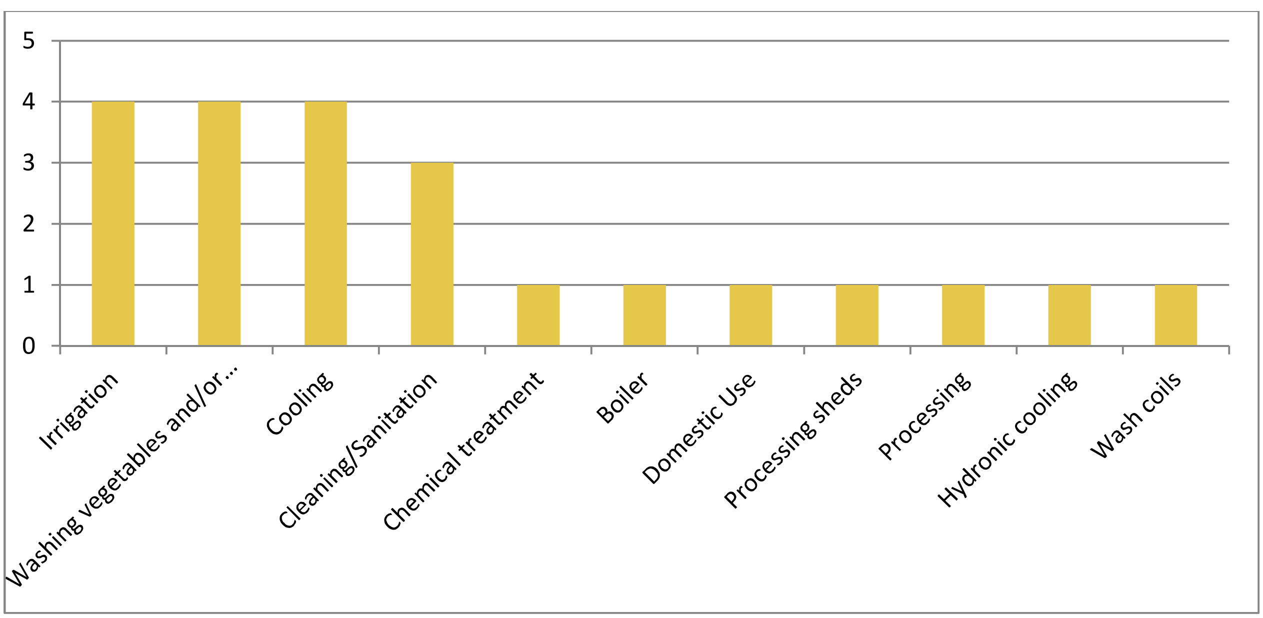
10.6 Post-Harvest Processing Water Management

Little information is publicly available on water use and consumption estimates in the Post-Harvest Processing market segment. As with energy, water use within this segment appears to be highly variable, depending on the operation. Differing operations use water for spraying, chilling, and blanching, among other end uses. Typically, washing and hydro-cooling of fresh fruits use high amounts of chilled water. Fruit-drying operations also use hot water in their processes. According to one subject matter expert, operators currently place more emphasis on the filtering of water for post-harvest processes, rather than on water use efficiency. However, when asked about the sensitivity of water availability to their operations, technical survey respondents gave an average score of 9.33, signifying that they are "extremely sensitive" to disruptions in their water supply. Furthermore, three of 13 technical survey respondents indicated that water will be one of the most influential factors in their future production. Given the importance of water and the lack of information that exists on its use in Post-Harvest operations, this segment would benefit from an in-depth analysis of current water usage practices and areas of potential water savings.

10.6.1 Sources and Uses

When asked about their water sources, eight technical field survey respondents used well water in their operations, while five received their water from a water utility. Nine of the 13 technical phone survey respondents claimed to use water for 100% of their processing operations. These respondents were typically processors in the cold storage or fresh produce processing segments. When asked about their water end uses, the field survey respondents claimed to use their water for irrigation, washing produce, and cooling (see Figure 10.10). Although produce cooling and washing are major water end uses, the frequent mention of irrigation illustrates the fine line between crop production and post-harvest processing. Although NAICS codes may distinguish between these practices, often producers will grow and harvest their own crops as well as carry out their own post-production. Utilities should be cognizant of these market intricacies when designing programs, noting that savings can be achieved not only through optimized post-harvest practices, but also through improved growing and harvest practices.

Figure 10.10. Water Usage in Post-Harvest Processing



Source: Technical Survey, n = 12 - multiple responses, "What are the major production or process applications that require water in your operation?"

10.6.2 Water Regulations

Post-harvest processors are subject to a number of local and state water-related regulations, including local, state, and regional water quality regulations. Two of the nine qualitative interview respondents claimed that the water quality regulations to which they were subject had a neutral effect on their operations. However, five of these respondents claimed that these regulations had a somewhat-to-strongly negative impact on their farms, while the two other respondents were unsure of the effect of these regulations. According to the qualitative interviews, some respondents complained about being required to fill out water discharge forms in operations that they felt did not require heavy water use, adding cost due to personnel time.

10.6.3 Management and Equipment

As mentioned above, Navigant found no publicly available data on water consumption estimates or management practices for the Post-Harvest Processing segment. To bridge this gap in information, Navigant asked the technical field survey respondents how they managed water use in their operations. Seven of the 13 respondents claimed to have adopted some form of water management practice in the last two years, as shown in Table 10.6. Most common of these was wastewater recycling, followed by water control systems, and efficient sprinklers. Because of the lack of information on water conservation potential, water utilities should further investigate water use in this segment to identify possible savings or practices.

Table 10.6. Equipment and Systems or Procedures Implemented to Reduce Water Usage

Water Management Practice	Number of Responses
Water Recycling	5
Water Control Systems	3
Efficient Sprinklers	3
Holding Tank	1
Cooling Tower Control System	1
Emitters	1
Bin Washer	1

Source: Technical Field Survey, n = 6, "What equipment, devices, systems or procedures have you installed/implemented to reduce water usage?"

10.7 *Post-Harvest Processing Waste Management*

Individual post-harvest operations produce a variety of waste products, depending on the crop and the process. Post-harvest drying operations generate significant low-moisture organic solid residues and limited wastewater discharges. Companies are increasingly adopting sustainability practices to reduce production waste by-products. For instance, processors can convert their solid residues to bioenergy using anaerobic digestion technologies. Packaging can constitute another form of waste; Sunsweet Growers, in particular, is working to reduce the amount of packaging used in their products by recycling all packaging waste, glass, fiber, and cans. They are also utilizing energy-efficient lighting and steam power in their factory facilities and developing ways to utilize production residues. Many producers currently use these residues for composting or feed for livestock.[110]

The process to hull and shell almonds generates significant low-moisture organic residues, which are a valued animal feed or animal bedding commodity to dairymen.[111] These residues are also usable for bioenergy production, as they can be burned at biomass power plants for energy, manufactured into fireplace logs, used as glue filler for laminate board, or used as raw material for other wood board production.

Producers do not use walnut hulls as animal feed, but rather supply residues to biomass power plants or use them for industrial abrasives. Walnut growers and processors are increasingly interested in the use of walnut shells to fuel distributed generation bioenergy systems using thermo-chemical conversion technologies.

When asked about their waste production, six of 13 technical field survey respondents reported producing some type of organic waste. The majority of this waste included crop residues, although two respondents also mentioned palettes and packaging materials (one mention each). Seven of these respondents reportedly disposed of their solid waste by recycling, composting, or using it as cattle feed. Two respondents also indicated that they sent their residues to a bioenergy generation facility. The management of this solid waste was virtually a non-issue for these operators; only one respondent had implemented any equipment to manage waste in the last two years, which included a tractor and dump truck. However, five of 13 technical survey respondents indicated that they had participated in a utility-sponsored, self-generation program such as solar or bio-digesters, indicating that a portion of this market is working with local utilities to reuse waste product. Utilities might consider offering further waste reuse programs to operators in the Post-Harvest market segment.

According to the qualitative interviews, business cycles had almost no effect on waste management costs. While some of the respondents are subject to state or local waste disposal regulations, all nine respondents felt that these regulations had no effect on their operations. The relatively low concern over waste management indicates that post-harvest processors are comfortable with the current means of waste disposal, as operators can use their residues as a supporting function of the production process, or sell them as a secondary means of income generation.

Although solid waste regulations have little impact on post-harvest process operations, operators are more concerned with air emissions regulations. Most operators' emissions fell within the California Green House Gas (GHG) regulations particle limit. However, one processor claimed that GHG regulations have a "huge effect" on his operation, as out-of-state and foreign competitors are not subject to the same high cost of regulation compliance. This particular respondent predicted that GHG

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[110] Sunsweet. "Sunsweet Growers: Green Efforts." Modified 2011. http://www.sunsweet.com/about/green.html.

[111] Ricardo Amon, 2011. "California Food Processing Industry Organic Residue Assessment." *California Biomass Collaborative.* Unpublished.

regulations will result in increased fuel costs, which in turn would increase shipping charges. These increased charges would fall on individual businesses that may not be able to recoup these added costs. The respondent indicated that processors would need to replace their loaders and burners with equipment that produced fewer emissions. Although this prediction represented the sentiments of only one operator, California's stringent emissions regulations do present an opportunity for utilities to promote low-emission equipment to nut processing facilities. Utilities could use this opportunity to promote state-of-the-art energy efficiency equipment, as well.

10.8 Post-Harvest Processing Conclusions and Recommendations

Conclusion 1: The Post-Harvest segment consists of a number of individual operation types. These include pre-cooling, drying, roasting, hulling and shelling, blanching, and sorting, among others. Although these options fall under one NAICS code, the segment is extremely diverse in terms of both production and energy use.

Recommendation 1: In developing programs, utilities should be aware of the differences between the various types of post-harvest processing. Programs should target a particular sub-segment, rather than the Post-Harvest segment as a whole. For instance, pre-cooling programs should incentivize cooling and refrigeration technologies, while hulling and shelling programs should incentivize VFDs on motors, and so forth. Further research into each market sub-segment could help to inform utilities about the equipment that would be most appropriate for each sub-segment.

Conclusion 2: There is currently a lack of consistent information on energy consumption and equipment usage in each market sub-segment. Much of the information that exists focuses on production best practices and energy end uses, to some extent. However, most of the energy-related publications date to the 1980s or 1990s, as few of them contain consumption or end-use data.

Recommendation 2: Utilities should consider conducting extensive research into the Post-Harvest market sub-segment, accounting for the distinctions between market sub-segments. Baseline studies and a formal classification of Post-Harvest Processing operation types could elucidate the energy practices in this market segment. Because little innovation has occurred in the last decade, the information gathered in studies such as these could inform future programs for years to come.

Conclusion 3: Due to high demand growth for products such as nuts, the Post-Harvest Processing segment is experiencing increasing production. This suggests that energy consumption in the market segment will increase, as well. Given that much of the post-harvest roasting and hulling equipment dates to the 1970s or 1980s, there is an opportunity for utilities to promote energy-efficient equipment in this market segment.

Recommendation 3: Utilities should prepare for increasing Post-Harvest production, and should promote energy-efficient technologies within this market segment. When working with post-harvest customers, utilities should be sure to emphasize the financial benefits of saving energy through updating equipment. By engaging individual customers and presenting programs in financial terms, utilities should be able to appeal to a range of post-harvest operators.

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11 Summary of Key Responses from All Segments

	Electricity	Fruit, Tree Nut, and Vine	Vineyards and Wineries	Dairies	Greenhouses and Nurseries	Mushrooms	Field Crops	Refrigerated Warehouses	Post-Harvest Processing
n =	Technical Phone Surveys	*20*	*13*	*13*	*7*	*8*	*14*	*7*	*13*
	Technical Field Surveys	*18*	*12*	*8*	*7*	*8*	*12*	*6*	*13*
	Qualitative Interviews	*6*	*6*	*6*	*6*	*6*	*6*	*3*	*9*
	Subject Matter Experts	*0*	*2*	*1*	*2*	*3*	*1*	*0*	*2*
Cost Rank - *Technical Phone Survey (based on three greatest production costs)*		2	2	2	2	1	2	1	2
Energy Cost Rank (E&NG) (# of mentions) - *Qualitative Interviews (based on rankings of top 4 production costs)*		1st (2), 2nd (2), 4th (1)	3rd (2), 4th (1)	3rd (1)	3rd (3)	2nd (2), 3rd (2)	2nd (1), 3rd (1)	2nd (2)	1st (2), 2nd (3), 3rd (2)
Impact on Future Production? (x/n) - *Technical Phone Survey*		2/20	1/13	2/13	No mentions	3/8	3/14	4/7	5/13
SME Mention - Current Availability		N/A	No mention	No mention	No mention	No mention	No mention	N/A	No mention
SME Mention - Future Availability		N/A	No mention	No mention	No mention	No mention	No mention	N/A	No mention

Electricity	Fruit, Tree Nut, and Vine	Vineyards and Wineries	Dairies	Greenhouses and Nurseries	Mushrooms	Field Crops	Refrigerated Warehouses	Post-Harvest Processing
SME Mention - Cost	N/A	Energy prices are a concern	No mention	Costs are high	Increasing costs	No mention	N/A	Increasing costs
Significant Cost? (x/n) - *Technical Phone Survey (asked if not listed in top 3 production costs, assumed to be significant cost if top cost)*	17/20	11/13	11/13	4/7	8/8	13/14	7/7	13/13
Percentage of Total Production Cost - *Technical Phone Survey*	13%	10%	14%	6%	8%	12%	35%	17%
Costs Increasing, Decreasing, or Stable? - *Technical Phone Survey*	Increasing (12), Stable (7), Decreasing (1)	Increasing (7), Stable (5), Decreasing (1)	Increasing (12), Stable (1)	Decreasing (3), Increasing (2), Stable (2)	Increasing (5), Stable (3)	Increasing (10), Stable (2), Decreasing (1)	Increasing (5), Decreasing (1)	Increasing (6), Stable (6), Decreasing (1)
Greatest Usage Months - *Technical Field Survey*	July, June, May/October	October, September, August	July/August, June, September	January, February/July, December/August	July/August, September	July, August, September	August, June, July/September	August, July/November, September
Sensitivity to Electricity Disruption (average rating, 0-10 scale) - *Technical Phone Survey*	8.85	8.92	8.85	7.71	9.75	8.21	7.7	9.92
Processes/Equipment Using Most Electricity (Avg. % of total electric bill, does not add up to 100%) - *Technical Field Survey*	Pumping (73%), Shops/Homes (8%), Refrigeration (40%)	Pumping (46%), Refrigeration (48%), Lighting (13%)	Pumping (51%), Milking (26%), Refrigeration (39%)	Pumping (31%), Lighting (24%), Cooling (52%)	Cooling (61%), pumping (23%), lighting (22%)	Pumping (72%), Processing equipment (17%), lighting (8%)	Refrigeration/Cooling (68%), Lighting (25%)	Refrigeration (61%), Lighting (12%), Pumping (28%)

Natural Gas		Fruit, Tree Nut, and Vine	Vineyards and Wineries	Dairies	Greenhouses and Nurseries	Mushrooms	Field Crops	Refrigerated Warehouses	Post-Harvest Processing
n =	Technical Phone Surveys	*20*	*13*	*13*	*7*	*8*	*14*	*7*	*13*
	-Natural Gas Users	*8*	*5*	*3*	*6*	*6*	*5*	*4*	*6*
	Technical Field Surveys	*18*	*12*	*8*	*7*	*8*	*12*	*6*	*13*
	-Natural Gas Users	*6*	*5*	*2*	*6*	*5*	*5*	*3*	*5*
	Qualitative Interviews	*6*	*6*	*6*	*6*	*6*	*6*	*3*	*9*
	Subject Matter Experts	*0*	*2*	*1*	*2*	*3*	*1*	*0*	*2*
Cost Rank - *Technical Phone Survey (based on three greatest production costs)*		4	7	6	2	3	6	4	6
Impact on Future Production? (x/n) n = natural gas users - *Technical Phone Survey*		1/8	No mentions	No mentions	1/6	1/6	No mentions	2/4	2/6
SME Mention - Current Availability		N/A	No mention	No mention	No mention	No mention	No mention	N/A	No mention
SME Mention - Future Availability		N/A	No mention	No mention	No mention	No mention	No mention	N/A	No mention
SME Mention - Cost		N/A	No mention	No mention	Costs are high	Rising costs, gas is cheaper than electricity	No mention	N/A	Natural gas prices have dropped

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Natural Gas	Fruit, Tree Nut, and Vine	Vineyards and Wineries	Dairies	Greenhouses and Nurseries	Mushrooms	Field Crops	Refrigerated Warehouses	Post-Harvest Processing
Significant Cost? (x/n) n = natural gas users - *Technical Phone Survey (asked if not listed in top 3 production costs, assumed to be significant cost if top cost)*	5/8	2/5	1/3	3/6	5/6	2/5	3/4	2/6
Percentage of Total Production Cost - *Technical Phone Survey*	7%	6%	1%	11%	6%	3%	3%	3%
Costs Increasing, Decreasing, or Stable? - *Technical Phone Survey*	Increasing (5), Stable (2), Decreasing (1)	Stable (3), Increasing (1), Decreasing (1)	Decreasing (2), Increasing (1)	Decreasing (4), Increasing (1), Stable (1)	Increasing (5), Decreasing (1)	Decreasing (3), Increasing (1)	Stable (2), Increasing (1), Decreasing (1)	Stable (3), Decreasing (3)
Greatest Usage Months - *Technical Field Survey*	October, September	October, September, June - August	July/August/ September	January, December/ February, March	January, February, December	July/August	August/ September	October/ November /January
Processes/Equipment Using Most Natural Gas (Avg. % of total gas bill, does not add up to 100%) - *Technical Field Survey*	Drying (93%), Pumping (50%), Heating/Boilers (100%)	Boilers (100%), all others with one mention	Well pumps (75%), water heating (50%)	Heating/Boilers (97%)	Heating (42%)	Pumping (75%), Boilers/Water Heating (50%)	Space heating (53%), Boilers (90%), Chillers (90%)	Space heating/Boilers (97%), Drying wax (85%)
Natural Gas Pumping? n = natural gas users - *Technical Field Survey*	2/6	1/5	2/2	No mention	No mention	3/5	No mention	No mention

Energy Efficiency		Fruit, Tree Nut, and Vine	Vineyards and Wineries	Dairies	Greenhouses and Nurseries	Mushrooms	Field Crops	Refrigerated Warehouses	Post-Harvest Processing
n =	Technical Phone Surveys	*20*	*13*	*13*	*7*	*8*	*14*	*7*	*13*
	Technical Field Surveys	*18*	*12*	*8*	*7*	*8*	*12*	*6*	*13*
	Qualitative Interviews	*6*	*6*	*6*	*6*	*6*	*6*	*3*	*9*
	Subject Matter Experts	*0*	*2*	*1*	*2*	*3*	*1*	*0*	*2*
Previous Energy-Efficient Measure Installation (x/n) - *Technical Field Survey*		16/18	10/12	7/8	6/7	8/8	12/12	6/6	12/13
Received Rebates in Past? - *Technical Phone Survey*		14/20	8/13	8/13	4/7	6/8	10/14	6/7	12/13
Knowledge Source for Equipment/ Measure - *Technical Field Survey*		Vendor (15), Utility (8), Internet (1)	Vendor (13), Utility (4)	Vendor (7), Utility (2)	Internet (5), Vendor (4)	Utility (7), vendor (4), Internet (3), other grower (3)	Utility (14), Vendor (12)	Vendor (12), Utility (4), Corporate (3)	Utility (18), Vendor (7)
Metrics (x/n) - *Technical Phone Survey*		12/20	10/13	6/13	3/7	4/8	9/14	6/7	10/13
Systems/ Procedures to Manage Energy Costs - *Technical Field Survey*		Track Utility Bills, Energy Management System, Demand Response	Green Committee	Timers/controls, cost management tools	Climate control systems	Demand Response, education, track utility bills, behavioral policies	Track utility bills	Monitoring, demand response, management system, controllers	Track utility bills, energy management system, Demand Response

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Energy Efficiency	Fruit, Tree Nut, and Vine	Vineyards and Wineries	Dairies	Greenhouses and Nurseries	Mushrooms	Field Crops	Refrigerated Warehouses	Post-Harvest Processing
Reference Partners – *Qualitative Interviews*	California Farm Bureau Federation, Western Growers, Local farm bureau	National Resources Conservation Services, California Assoc. of Wine Growers, Napa Valley Vintners	California Dairy Campaign, Milk Producers Council, Western United Dairymen	California Farm Bureau Federation, Nursery and Floriculture Alliance (UC Davis), Western Growers	American Mushroom Institute	Calif. Farm Bureau Federation, Western Growers, Calif. Dept. of Food and Ag., Grower-Shipper Assoc.	The Warehousing Education and Research Council, Council of Supply Chain Mgmt. Professionals, IRAW Los Angeles	The Agricultural Energy Consumers Association, Western Area Power Administration
Barriers to Energy-Efficient Measures - *Technical Field Survey*	First cost (14), Financing (10), Lack of awareness (2)	Financial reasons (12), lack of awareness (3)	Financial reasons (7), lack of awareness (3)	Financial reasons (6), lack of awareness (3)	Financial reasons (8), lack of awareness (2)	financial reasons (9), regulations (1), timing (1)	Financial reasons (4)	Financial reasons (12), rapid change in technology (1), lack of qualified installer (1)
Top Ranked Measure - *Technical Field Survey*	Pumps/Motors	Lighting	Lighting	Lighting	VFDs	Lighting	VFDs	Lighting
Average Savings	14%	12%	8%	25%	18%	19%	28%	20%
2nd Ranked Measure - *Technical Field Survey*	Lighting	Pumps (tied for 1st)	VFDs	Heat Curtains	Insulation (tied for 1st)	VFDs	Lighting (tied for 1st)	Motors
Average Savings	15%	12%	14%	20%	5%	30%	29%	26%
3rd Ranked Measure - *Technical Field Survey*	VFDs	Compressor equipment & Solar PV (tied)	HVAC	Rest w/ 1 mention	Lighting (tied for 1st)	Pumps & PVs (tied)	PLC	VFDs
Average Savings	27%	12% & 18%	10%	N/A	13%	15% & 50%	35%	28%

Water		Fruit, Tree Nut, and Vine	Vineyards and Wineries	Dairies	Greenhouses and Nurseries	Mushrooms	Field Crops	Refrigerated Warehouses	Post-Harvest Processing
n =	Technical Phone Surveys	*20*	*13*	*13*	*7*	*8*	*14*	*7*	*13*
	Technical Field Surveys	*18*	*12*	*8*	*7*	*8*	*12*	*6*	*13*
	Qualitative Interviews	*6*	*6*	*6*	*6*	*6*	*6*	*3*	*9*
	Subject Matter Experts	*0*	*2*	*1*	*2*	*3*	*1*	*0*	*2*
Source - Well (x/n) - *Technical Field Survey*		9/18	9/12	7/8	2/7	4/8	10/11	1/6	7/12
Source - Water Utility (x/n) - *Technical Field Survey*		4/18	1/12	0	3/7	2/8	0	3/6	3/12
Source - Both (x/n) - *Technical Field Survey*		4/18	2/12	1/8	2/7	2/8	0	0	1/12
Source - Other (x/n) - *Technical Field Survey*		1/18	0	0	0	0	1/11	2/6	1/12
Cost Rank - *Technical Phone Survey (based on three greatest production costs)*		4	7	6	3	5	5	5	5
Cost Rank (# of mentions) - *Qualitative Interviews (based on rankings of top 4 production costs)*		1st (1), 2nd (1)	2nd (1), 3rd (1)	3rd (1)	2nd (1)	Not ranked	2nd (1)	Not ranked	Not ranked

Water	Fruit, Tree Nut, and Vine	Vineyards and Wineries	Dairies	Greenhouses and Nurseries	Mushrooms	Field Crops	Refrigerated Warehouses	Post-Harvest Processing
SME Mention - Current Availability	N/A	Competition for water	No mention	Water wars	Availability of water is a concern	Irrigation district water availability, droughts affect availability	N/A	Availability is a concern
SME Mention - Future Availability	N/A	No mention	No mention	Quality of water	No mention	No mention	N/A	Availability is a concern
SME Mention – Cost	N/A	No mention	Water costs are important to dairies.	No mention	No mention	Water quality is an issue; farmers will pay more for quality water	N/A	Supply is a bigger concern than cost
Impact on Future Production? (x/n) - *Technical Phone Survey*	9/20	3/13	2/13	2/7	No mentions	6/14	No mention	3/13
Major Production/Process Applications - *Technical Field Survey*	Irrigation (16/18), Cleaning (4/18), Processing (3/18)	Irrigation (10/12), Cleaning (5/12), Production (5/12)	Water for cattle (6/8), Irrigation (4/8), Dairy (3/8)	Irrigation/ Watering (7/7), Washing/ Maintenance (2/7)	Cleaning (5/8), Irrigation (4/8)	Irrigation (11/12), processing (3/12), Cleaning (2/12)	Cooling (5/6), Condensers (2/6)	Cleaning (7/13), Cooling (4/13), Irrigation (4/13)
Greatest Production Cycle Water Use - *Technical Field Survey*	Irrigation (17/18)	Irrigation (6/12), Cleaning (4/12)	Irrigation (4/8)	Irrigation/ Watering (5/7)	Irrigation (3/8)	Irrigation (10/12)	Cooling (3/6)	Washing (4/12)
Sensitivity to Water Disruption (average rating, 0-10 scale) - *Technical Phone Survey*	8.75	9.27	9.62	8	9.38	9	8	9.23

Water	Fruit, Tree Nut, and Vine	Vineyards and Wineries	Dairies	Greenhouses and Nurseries	Mushrooms	Field Crops	Refrigerated Warehouses	Post-Harvest Processing
Water Management Methods - *Technical Field Survey*	Monitor Moisture Levels, Irrigation Methods, Track Usage	Recycling, Sub-metering, Track usage	Recycling, manual water management, track usage	Irrigation, Water recycling, track water bills	Recycling, moisture monitors, timers	Monitors/controls, recycling, drip irrigation, drought-resistant plants	Recycling, rest 1 mention	Recycling, irrigation, controls
Water Reducing Equipment/ Devices - *Technical Field Survey*	Sprinklers, Drip Irrigation, Emitters	Drip Irrigation, rest 1 mention	Flush systems, manure separator, emitters, return system	Irrigation equipment, Recycling equipment, pumps	Lined reservoirs, timers	Emitters, drip irrigation, low-flow devices	Metering, rest 1 mention	Sprinklers, solar-operated valves, low-flow water heads
Water Reducing Systems/ Procedures - *Technical Field Survey*	Water Recycling, Irrigation Methods	Employee training, Alter irrigation patterns, monitor moisture content	Recycling, ground leveling, off-peak pumping, float valves	Irrigation, recycling, training, pumps	Meters, improved wash-down techniques, rainwater collection	Recycling, water timing/patterns	Green committee, metering, flow restrictors, rainwater collection	Recycling, timers, pressure sensors

Labor		Fruit, Tree Nut, and Vine	Vineyards and Wineries	Dairies	Greenhouses and Nurseries	Mushrooms	Field Crops	Refrigerated Warehouses	Post-Harvest Processing
n =	Technical Phone Surveys	*20*	*13*	*13*	*6*	*8*	*14*	*7*	*13*
	Technical Field Surveys	*18*	*12*	*8*	*7*	*8*	*12*	*6*	*13*
	Qualitative Interviews	*6*	*6*	*6*	*6*	*6*	*6*	*3*	*9*
	Subject Matter Experts	*0*	*2*	*1*	*2*	*3*	*1*	*0*	*2*
Cost Rank - *Technical Phone Survey (based on three greatest production costs)*		1	1	3	1	2	1	2	1
Cost Rank (# of mentions) - *Qualitative Interviews (based on rankings of top 4 production costs)*		1st (3), 3rd (1)	1st (2), 2nd (2), 3rd (1)	2nd (4), 4th (1)	1st (4), 2nd (1)	1st (4), 2nd (2)	1st (5)	1st (2)	1st (5), 2nd (2), 3rd (1)
Mentioned by SMEs?		N/A	No mention	Big challenge	Availability (illegal immigration), cost	Lack of labor availability, immigration concerns	No mention	N/A	Labor costs are a concern
Impact on Future Production? (x/n) - *Technical Phone Survey*		3/20	1/13	No mention	2/6	2/8	2/14	No mention	2/13
Mechanization Mentioned? - *SME*		N/A	Yes	No mention	No mention	Yes	No mention	N/A	Yes

11.1 UC Davis Cost and Return Studies

The following table compares the treatment of electricity and natural gas versus labor and water in the cost and return studies (also known as farm budgets) prepared by the University of California, Davis. In all cases, the studies provide considerable detail regarding labor and water but little to no information about expected energy costs.

UC Davis Cost Study Crop	Segment	Mention Electric	Value Electric	Mention Natural Gas	Value Natural Gas	Mention Labor	Value Labor	Mention Water	Value Water	Comment
Alfalfa	Field Crops	No	-	No	-	Yes	$96 per acre (20% of cost/acre)	Yes	$100 per acre	
Broccoli	Field Crops	No	-	No	-	Yes	$151 per acre (<1% of cost/acre)	Yes	$175 per acre	Water cost includes pumping
Corn	Field Crops	No	-	No	-	Yes	$48 per acre (4% of cost/acre)	Yes	$240 per acre	
Dry Beans	Field Crops	No	-	No	-	Yes	$75 per acre (10% of cost/acre)	Yes	$100 per acre	
Oat Hay	Field Crops	No	-	No	-	Yes	$13 per acre (5% of cost/acre)	No	-	
Onions	Field Crops	No	-	No	-	Yes	$626 per acre (27% of cost/acre)	Yes	$215 per acre	
Safflower	Field Crops	No	-	No	-	Yes	$41 per acre (20% of cost/acre)	Yes	$11 per acre	Water cost includes pumping

UC Davis Cost Study Crop	Segment	Mention Electric	Value Electric	Mention Natural Gas	Value Natural Gas	Mention Labor	Value Labor	Mention Water	Value Water	Comment
Almonds	Fruit, Tree Nut, and Vine	Yes	See water costs	No	-	Yes	$331 per acre (14% of cost/acre)	Yes	$123 per acre	Water cost includes electric pumping and frost protection
Avocados	Fruit, Tree Nut, and Vine	No	-	No	-	Yes	$2,764 per acre (60% of cost/acre)	Yes	$812.4 per acre	Water cost includes pumping
Lemons	Fruit, Tree Nut, and Vine	No	-	No	-	Yes	$255 per acre (2% of cost/acre)	Yes	$379 per acre	Water cost includes frost protection
Mandarins	Fruit, Tree Nut, and Vine	No	-	No	-	Yes	$314 per acre (3% of cost/acre)	Yes	$323 per acre	
Olives	Fruit, Tree Nut, and Vine	No	-	No	-	Yes	$331 per acre (18% of cost/acre)	Yes	$228 per acre	Water cost includes pumping
Peaches	Fruit, Tree Nut, and Vine	No	-	No	-	Yes	$1,484 per acre (36% of cost/acre)	Yes	$115 per acre	
Pears	Fruit, Tree Nut, and Vine	No	-	No	-	Yes	$494 per acre (5% of cost/acre)	Yes	$253 per acre	Water cost includes pumping and frost protection
Pomegranates	Fruit, Tree Nut, and Vine	No	-	No	-	Yes	$1,278 per acre (27% of cost/acre)	Yes	$180 per acre	Water cost includes pumping

UC Davis Cost Study Crop	Segment	Mention Electric	Value Electric	Mention Natural Gas	Value Natural Gas	Mention Labor	Value Labor	Mention Water	Value Water	Comment
Prunes	Fruit, Tree Nut, and Vine	Yes	See water costs	No	-	Yes	$532 per acre (17% of cost/acre)	Yes	$115 per acre	Water cost includes electric pumping
Strawberries	Fruit, Tree Nut, and Vine	Yes	See water costs	No	-	Yes	$14,808 per acre (41% of cost/acre)	Yes	$500 per acre	Water cost includes electric pumping
Sweet Cherries	Fruit, Tree Nut, and Vine	No	-	No	-	Yes	$839 per acre (7% of cost/acre)	Yes	$150 per acre	Water cost includes pumping
Walnuts	Fruit, Tree Nut, and Vine	Yes	See water costs	No	-	Yes	$101 per acre (5% of cost/acre)	Yes	$196 per acre	Water cost includes electric pumping
Wine Grapes	Vineyards and Wineries	No	-	No	-	Yes	$3,178 per acre (56% of cost/acre)	Yes	$95 per acre	Water cost includes pumping

Source: http://coststudies.ucdavis.edu/current.php

Appendix A. 2012 California Agriculture Technical Survey Screening, Expertise and Energy Awareness for All Respondents

Date: ______________________________

Respondent Name: ______________________________

Agriculture Sector: ______________________________

<u>Expertise and Rapport</u>

EX1. How long have you been in your current role at [NAME OF FARM, RANCH OR OTHER]?

[RECORD NUMERIC RESPONSE IN # OF YEARS]

EX2. What is your role in the operation?

[RECORD RESPONSE]

EX3. In this role, do you track production costs?

a) Yes
b) No [ASK WHO DOES TRACK PRODUCTION COSTS]
c) Don't know [ASK WHO DOES TRACK PRODUCTION COSTS]
d) Refused

EX4. In this role, do you interact with your local utility representative?

a) Yes
b) No [ASK WHO WOULD BE THE PERSON WHO DOES INTERACT WITH THE LOCAL UTILITY]
c) Don't know [ASK WHO WOULD BE THE PERSON WHO DOES INTERACT WITH THE LOCAL UTILITY]
d) Refused

[FOR RESPONDENTS THAT ANSWER "b, c or d" TO EITHER EX3 AND EX4, ATTEMPT TO SPEAK TO ANOTHER, MORE APPROPRIATE, EMPLOYEE AT THAT OPERATION]

EX5. How many years has [NAME OF FARM, RANCH OR OTHER] been in operation?

[RECORD NUMERIC RESPONSE]

EX6. What are the main products that [NAME OF FARM, RANCH OR OTHER] *produces?*

[RECORD RESPONSE]

a) What do you consider to be your primary/main product?

b) Do you produce this same main product yearly or do you rotate or change the product seasonally or for any other reasons?
[RECORD RESPONSE]
c) No
d) Refused [SKIP TO EX9]

EX7. *On average, over the last two years, what percentage of your production has been* [ANSWER FROM EX6a]?

[RECORD NUMERIC RESPONSE]

EX8a. *To what extent would you say that you are a "typical"* [INSERT RESPONSE FROM EX 6 OR EX7 AS APPLICABLE] *producer in the State of California?*

a) Typical [SKIP TO EX10]
b) Not Typical
c) Don't know [SKIP TO EX10]
d) Refused [SKIP TO EX10]

EX8b. *How do your production practices differ from the "typical"* [INSERT RESPONSE FROM EX 6 OR EX7 AS APPLICABLE] *producer in the State of California?*

a) Record Response
b) Don't know
c) Refused

EX9 and EX10 [READ PER ANSWER TO EX6a AND EX6b]

Field Crops and Fruit, Tree, Vine Crops and Vineyards & Wineries
EX9. How many acres do you have under cultivation?
EX10. Of these acres, how many do you irrigate?
Dairies
EX9a. How many head of cattle do you maintain?

EX9b. Do you grow your own fodder or silage?
EX9c. If so, how many acres do you have under cultivation?
EX10. How many of these do you irrigate?

Floriculture (Greenhouses & Nurseries)
EX9a. How many square feet of greenhouse operations do you manage?
EX9b. How many acres of nursery stock you have under cultivation?
EX10. Of these acres, how many do you irrigate?

Mushroom Production (Greenhouses & Other)
EX9a. How many pounds of product do you produce per year?
EX9b. How many square feet of production do you manage?
EX10. What percentage of your production requires pumped water?

Post-Harvest Processing
EX9. How many pounds of product do you process per year?
EX10. What percentage of your processing requires pumped water?

Refrigerated Warehouses
EX9. How many square feet of refrigerated warehouse space do you manage?
EX10. How many square feet of controlled atmosphere warehouse space do you manage?

EX11. In what month or months is your production greatest?

a) Record month _____
b) Production is constant all year _____
c) Don't know _____
d) Refused _____

EX12. On a scale of 1 to 10, where 1 is not at all sensitive and 10 is extremely sensitive, how sensitive is the production of [INSERT ANSWERS FROM EX6a AND EX6b] to interruptions in your water supply?

a) Record Response _____
b) Don't know _____
c) Refused _____

EX13. On a scale of 1 to 10, where 1 is not at all sensitive and 10 is extremely sensitive, how sensitive is the production of [INSERT ANSWERS FROM EX6a AND EX6b] to interruptions in your electricity supply?

a) Record Response _____
b) Don't know _____
c) Refused _____

EX14. Over the last two years, has your production been increasing, decreasing or remaining stable?

a) Increased _____
b) Decreased _____
c) Remained stable _____
d) Don't know [SKIP TO EX16] _____
e) Refused [SKIP TO EX16] _____

EX15. What have been the primary reasons that your production has [INCREASED, DECREASED OR REMINED STABLE]?

[RECORD RESPONSE]

EX15a. What factors do you think will most impact your production in future years?

[RECORD RESPONSE]

EX16. Does your operation participate in utility-sponsored self-generation programs such as solar or bio-digesters?

a) Yes _____
b) No [SKIP TO EA1] _____
c) Don't know [SKIP TO EA1] _____
d) Refused [SKIP TO EA1] _____

EX17. What kind of self-generation does your operation run?

a) Photovoltaic / Solar _____
b) Bio-Digester _____
c) Wind generation _____
d) Other (Specify)____
e) Don't know [SKIP TO EA1] _____

f) Refused [SKIP TO EA1] _____

EX18. What is the size of your operation's self-generation in kilowatts?

a) Record numeric response _____
b) Other measure of size (Specify)____
c) Don't know _____
d) Refused _____

ENERGY AWARENESS

EA1. What have been the three greatest production costs in your operation over the last two years? [DO NOT READ, CHECK ALL THAT APPLY. IF THEY MENTION MORE THAN THREE RESPONSES, ASK THEM TO IDENTIFY THE THREE GREATEST.]

a) Electricity Greatest: _____
b) Natural Gas Greatest: _____
c) Water Greatest: _____
d) Solid waste management Greatest: _____
e) Other waste management Greatest: _____
f) Diesel fuel Greatest: _____
g) Gasoline Greatest: _____
h) Labor rates Greatest: _____
i) Regulation/Paperwork Greatest: _____
j) Interest rates Greatest: _____
k) Land rental fees Greatest: _____
l) Equipment rental fees Greatest: _____
m) Other (specify)____
n) Don't know _____
o) Refused _____

EA2. [READ ONLY IF THE REPSPONDENT DOES NOT MENTION ELECTRICITY, OTHERWISE, SKIP TO EA4]

I noticed that you did not mention ELECTRICITY. Do you see your ELECTRICITY expenses as a significant production cost?

a) Yes _____
b) No _____
c) Don't know? _____

EA2a. Please tell me the reasons that your ELECTRICITY expenses [ARE/ARE NOT] significant production costs.

[RECORD RESPONSE]

EA3. [READ ONLY IF THE REPSPONDENT DOES NOT MENTION GAS, OTHERWISE, SKIP TO EA4]

I noticed that you did not mention NATURAL GAS. Do you see your NATURAL GAS expenses as a significant production cost?

a) Yes _____
b) No _____
c) Don't know? _____

EA3a. Please tell me the reasons that your NATURAL GAS expenses [ARE/ARE NOT] significant production costs.

[RECORD RESPONSE]

EA4. As you might imagine, since I am asking these questions on behalf of your local utility, I would like to know more about your energy use. What percentage of your total production costs in the last two years was taken up by your electric bill? [PROMPT WITH SCALE IF NECESSARY]

a) Electricity takes up ____% of total production costs
b) Electricity takes of less than ____% of total production costs
c) Electricity expenses amounted to $______________ per year
d) Electricity expenses amounted to less than $_________________ per year
e) Don't know [SKIP TO EA6] _____
f) Refused [SKIP TO EA6] _____

EA5. What methods did you use to estimate your answer to my last question? [DO NOT READ, CHECK ALL THAT APPLY]

a) This is my best guess _____
b) This is my recollection of my financial records _____
c) This estimate comes from an engineering or cost accounting study _____
d) This estimate comes from an energy management system _____
e) Other (Specify)____
f) Don't know _____
g) Refused _____

EA6. What percentage of your total production costs was taken up by your gas bill in the last two years? [PROMPT WITH SCALE IF NECESSARY]

a) Natural gas is not used in my operation _____
b) Natural gas has taken up ____% of total production costs over the last two years
c) Natural gas has taken up of less than ____% of total production costs over the last two years
d) Natural gas expenses amounted to $______________ per year over the last two years
e) Natural gas expenses amounted to less than $_________________ per year over the last two years
f) Don't know _____
g) Refused _____

EA7. Over the last two years, have your electricity costs been an increasing, decreasing or stable cost of production?

a) Increasing _____
b) Decreasing _____
c) Stable _____
d) Don't know _____
e) Refused _____

EA8. What methods did you use to estimate your answer to my last question? [DO NOT READ, CHECK ALL THAT APPLY]

a) This is my best guess _____
b) This is my recollection of my financial records _____
c) This estimate comes from an engineering or cost accounting study _____
d) This estimate comes from an energy management system _____
e) Other (Specify)_________________________
f) Don't know _____
g) Refused _____

EA9. [ONLY ASK IF RESPONDED THAT NATURAL GAS USED IN EA6] Over the last two years, have your natural gas costs been an increasing, deceasing or stable cost of production?

a) Increasing _____
b) Decreasing _____
c) Stable _____
d) Don't know _____
e) Refused _____

EA10. Do you work with your local utility representatives or outside consultants to assess energy use in your operations?

a) Yes; utility reps _____
b) Yes; consultants _____
c) Yes; both _____
d) No [SKIP TO EA12] _____
e) Don't know [SKIP TO EA12] _____
f) Refused [SKIP TO EA12] _____

EA11. Would you please describe the energy assessment to me?

[RECORD]

EA12. Has your operation accepted incentives or rebates from your local utility or a government agency for energy efficiency work?

a) Yes _____
b) No [SKIP TO EM14] _____
c) Don't know [SKIP TO EM14] _____
d) Refused [SKIP TO EM14] _____

EA13. In which type of local utility or government agency program did you participate in order to receive a rebate or incentive? [DO NOT READ, CHECK ALL THAT APPLY]

a) Energy-efficient equipment installation _____
b) Demand response _____
c) Energy audits _____
d) Other (specify)____
e) Don't know _____
f) Refused _____

EA14. Do you have metrics or performance measures for energy costs in your operation? [IF NECESSARY, EXPLAIN THAT METRICS ARE]

a) Yes _____
b) No _____
c) Don't know _____
d) Refused _____

EA15. Please describe these metrics or performance measures. [DO NOT READ, CHECK ALL THAT APPLY]

a) kWh or BTU per unit of production _____
b) kWh per irrigated acre _____
c) $'s per month on electric or gas bill _____
d) Other (specify)____
e) Don't know _____
f) Refused _____

ASSIGNMENT

FOR RESPONDENTS THAT ANSWERED FOR "a" FOR EA14, USE "DETAILED" GUIDE.

FOR RESPONDENTS THAT ANSWERED FOR "b, c or d" for EA14 AND ANSWERED "a, b, or c" FOR EA10, USE "INTERMEDIATE" GUIDE.

FOR ALL OTHER RESPONDENTS, BEGIN "GENERAL" GUIDE.

Appendix B. Technical Survey for Respondents with Detailed Energy Management Awareness

Initial Telephone Qualification Date: __________

Interview Date: _________

Interviewer: **Dan** _____ **John**_____

Start Time: __________ **End Time:** _________

Respondent Name: ____

Segment: ____

As briefly noted in our telephone call our goal I am working with a research team to conduct a *Statewide Agriculture Market Assessment & Energy Efficiency Potential Study.* This study is being undertaken by Navigant Consulting who in turn is working with Pacific Gas & Electric, Southern California Edison, the Southern California Gas, Company, and San Diego Gas & Electric (IOUs) and the California Public Utilities Commission (CPUC). The purpose of the study is to provide the IOUs and CPUC with an informed understanding of the customers' energy use, trends in energy use, energy related issues and how the utilities can improve their programs to work with customers to improve their energy efficiency and reduce costs.

<u>Energy Management</u>

EA14. Do you have metrics or performance measures for energy costs in your operation? [IF NECESSARY, EXPLAIN WHAT METRICS ARE]

a) Yes _____
b) No [SKIP TO EM4] _____
c) Don't know [SKIP TO EM4] _____
d) Refused [SKIP TO EM4] _____

EA15. Please describe these metrics. [DO NOT READ, CHECK ALL THAT APPLY]

a) kWh or BTU per unit of production _____

b) kWh per irrigated acre _____
c) $'s per month on electric or gas bill _____
d) Other (specify)______________________________ _____
e) Don't know [SKIP TO EM4] _____
f) Refused [SKIP TO EM4] _____

EM1. When did you begin to track these metrics? (Record Year)

EM2. Did you develop these metrics on your own or did you have assistance from another company or organization?

a) Internal Development [SKIP TO AP1] _____
b) External Assistance _____
c) Don't know [SKIP TO AP1] _____
d) Refused [SKIP TO AP1] _____

EM3. Who helped you develop these metrics? (Check all referenced)

Facilities/Operations Manager _____

CFO/Accountant _____

Utility Representative _____

Consultant _____

Professional Association _____

Another Grower/Producer _____

Others (Specify) ____

EM3a. What was the process that led you [or your company] to develop these metrics/performance measures?

[RECORD RESPONSE]

EM3b. What could your local utility have done to help you develop these metrics/performance measures?

[RECORD RESPONSE]

EM4. Earlier, I asked in which month your operation's production was greatest and you said [INSERT ANSWER TO EX12]. In what month do you think your electric usage is greatest?

a) Record month _____
b) Electric usage is constant all year _____
c) Don't know _____
d) Refused _____

EM5. In what month do you think your natural gas usage is greatest?

a) Record month _____
b) Natural gas usage is constant all year _____
c) Don't know _____
d) Refused _____

EM6. Which processes and equipment use the most electricity in your operation?

[RECORD RESPONSE]

Process/Equipment A: ______________________________

Process/Equipment B: ______________________________

Process/Equipment C: ______________________________

Process/Equipment D: ______________________________

[FOR EACH PROCESS AND PIECE OF EQUIPMENT IDENTIFIED ABOVE ASK THE FOLLOWING]

EM6a. What percentage of your total electric consumption for the year does each process/equipment represent?

Record numeric response in percentage form; indicate if respondent does not know or refused to respond

Process/Equipment A: ______________________________

Process/Equipment B: ______________________________

Process/Equipment C: ____________________

Process/Equipment D: ____________________

EM6b. [ASK ONLY IF REPSONDED PROVIDES A NUMERIC AMOUNT IN ANSWER TO EM6a] How did you determine this usage?

a) This is my best guess _____
b) This is my recollection of my financial records _____
c) This estimate comes from an engineering or cost accounting study _____
d) This estimate comes from an energy management system _____
e) Other (Specify)____________________
f) Don't know _____
g) Refused _____

EM7.Which processes or equipment in your operation use the most natural gas?

Process/Equipment A: ____________________

Process/Equipment B: ____________________

Process/Equipment C: ____________________

Process/Equipment D: ____________________

[RECORD RESPONSE]

[FOR EACH PROCESS OR PIECE OF EQUIPMENT ASK THE FOLLOWING]

EM7a. What percentage of your total natural gas consumption for the year does each usage does each process/equipment represent?

Record numeric response in percentage form; indicate if respondent does not know or refused to respond

Process/Equipment A: ____________________

Process/Equipment B: ____________________

Process/Equipment C: ____

Process/Equipment D: ____

EM7b. [ASK ONLY IF REPSONDED PROVIDES A NUMERIC AMOUNT IN ANSWER TO EM7a] How did you determine this usage?

a) This is my best guess _____
b) This is my recollection of my financial records _____
c) This estimate comes from an engineering or cost accounting study _____
d) This estimate comes from an energy management system _____
e) Other (Specify)____
f) Don't know _____
g) Refused

<u>Adoption, Practices & Payback</u>

AP1. Please tell me about how you manage your energy costs in general. Check all that apply

- I install/buy more energy-efficient equipment when I need replacements _____
- I track my monthly energy bills to notice changes _____
- I rely on my Operations/Field manager to let me know what needs to be done or changed _____
- I rely on my utility account representative to help me identify energy cost savings _____
- I use an energy management system _____
- Other ____

[RECORD RESPONSE]

AP2. What equipment or devices have you installed to reduce energy costs?

[RECORD RESPONSE]

Equipment/Device A: ____

Equipment/Device B: ____

Equipment/Device C: ______________________________

Equipment/Device D: ______________________________

[FOR EACH PIECE OF EQUIPMENT OR DEVICE ASK THE FOLLOWING]

AP2a. What criteria did you use to decide to implement this [EQUIPMENT OR DEVICE]?

[RECORD RESPONSE]

Equipment/Device A: ______________________________

Equipment/Device B: ______________________________

Equipment/Device C: ______________________________

Equipment/Device D: ______________________________

AP2b. When did you install the [EQUIPMENT OR DEVICE]?

[RECORD DATE BY MONTH/YEAR)]

Equipment/Device A: ______________________________

Equipment/Device B: ______________________________

Equipment/Device C: ______________________________

Equipment/Device D: ______________________________

AP2c. How much, as a percentage of your total energy cost did you expect to reduce energy costs by installing the [EQUIPMENT OR DEVICE]?

[RECORD NUMERIC RESPONSE]

Equipment/Device A: ______________________________

Equipment/Device B: ______________________________

Equipment/Device C: ______________________________

Equipment/Device D: ______________________________

AP2d. Did you achieve that cost reduction?

Record response as yes, no, does not know or refused to respond

Equipment/Device A: ______________________________

Equipment/Device B: ______________________________

Equipment/Device C: ______________________________

Equipment/Device D: ______________________________

AP2e. How do you know that you achieved/did not achieve the cost reduction?

[RECORD RESPONSE]

Equipment/Device A: ______________________________

Equipment/Device B: ______________________________

Equipment/Device C: ______________________________

Equipment/Device D: ______________________________

AP3f. Where did you learn about this [EQUIPMENT OR DEVICE] prior to installation?

[RECORD RESPONSE]

Equipment/Device A: ______________________________

Equipment/Device B: ______________________________

Equipment/Device C: ______________________________

Equipment/Device D: ______________________________

AP3. Apart from equipment, what systems or procedures do you use to manage energy costs?

[RECORD RESPONSE]

System/Procedure A: ____

System/Procedure B: ____

System/Procedure C: ____

System/Procedure D: ____

[FOR EACH PIECE OF SYSTEM OR PROCEDURE ASK THE FOLLOWING]

AP3a. What non- financial criteria did you use to decide to implement this [SYSTEM OR PROCEDURE]?

[RECORD RESPONSE; CHECK ALL THAT APPLY FOR EACH SYSTEM/PROCEDURE]

Improved reliability of the process System/Procedure A ____; B_____; C_____; D_____

Better product quality System/Procedure A ____; B_____; C_____; D_____

Increased throughput System/Procedure A ____; B_____; C_____; D_____

Environmental considerations System/Procedure A ____; B_____; C_____; D_____

Regulatory considerations System/Procedure A ____; B_____; C_____; D_____

Other [RECORD RESPONSE]

System/Procedure A: ____

System/Procedure B: ____

System/Procedure C: ____

System/Procedure D: ____

AP3b. When did you implement the [SYSTEM OR PROCEDURE]? (Note Year for each response)

[RECORD NUMBERIC RESPONSE]

System/Procedure A: ____

System/Procedure B: ____

System/Procedure C: ____

System/Procedure D: ____

AP3c. How much did you expect to reduce energy costs by installing the [SYSTEM OR PROCEDURE]?

(Ask for dollar figure)

[RECORD NUMERIC RESPONSE]

System/Procedure A: ____

System/Procedure B: ____

System/Procedure C: ____

System/Procedure D: ____

AP3d. Did you achieve that cost reduction?

a) Yes System/Procedure A ____; B_____; C_____; D_____
b) No System/Procedure A ____; B_____; C_____; D_____
c) Don't know [SKIP TO AP3f] System/Procedure A ____; B_____; C_____; D_____
d) Refused [SKIP TO AP3f] System/Procedure A ____; B_____; C_____; D_____

AP3e. How do you know that you achieved/did not achieve the cost reduction?

[RECORD RESPONSE]

We measured it System/Procedure A ____; B_____; C_____; D_____

We sub metered it System/Procedure A ____; B_____; C_____; D_____

We tracked via monthly bills System/Procedure A ____; B_____; C_____; D_____

It's my best guess System/Procedure A ____; B_____; C_____; D_____

Other

[RECORD RESPONSE]

System/Procedure A: ______________________________

System/Procedure B: ______________________________

System/Procedure C: ______________________________

System/Procedure D: ______________________________

AP5. What method do you use to calculate return on investment form investments to manage energy costs?

a) Simple Payback _____
b) Internal Rate of Return _____
c) Net Present Value _____
d) Other (Specify) ______________________________
e) Don't know _____
f) Refused _____

AP5a. What is the threshold limit for the metric selected in AP5? [RECORD]

AP6. What are the barriers that might prevent you from installing or implementing measures to manage energy costs? (Check all that are referenced; ask what is the top barrier)

a) Lack of awareness of additional programs TOP: _____
b) Lack of financing TOP: _____
c) First cost too high TOP: _____
d) Lack of qualified installer or implementer TOP: _____
e) Other (Specify) ______________________________
f) Don't know [AS DISTINCT FROM "UNAWARE" OF OTHER PROGRAMS] _____
g) Refused _____

<u>Information</u>

IF1. When it comes to gathering information about reducing energy use or generating energy, what are the three most likely sources? [DO NOT READ, CHECK THE FIRST THREE THAT THE RESPONDENT MENTIONS]

a) UC Davis Agricultural Extension _____
b) USDA Extension Service _____
c) State Agriculture College _____
d) Agriculture Trade Group [RECORD NAME] _____
e) Private Consultants [RECORED NAME AND TYPE OF CONSULTANT] ____________________
f) Local utility [RECORD NAME] ____________________
g) Government agency [RECORD NAME] ____________________
h) Utility Demonstration/Research Center ____________________
i) Other (Specify) ____
j) Don't know _____
k) Refused

<u>Water & Waste</u>

WW1. From what source do you receive your water?

[RECORD RESPONSE]

WW2. What are the major production or process applications that require water in your operation?

Production/Process A: ________________________________

Production/Process B: ________________________________

Production/Process C: _______________________________

WW3. At what point in your production cycle do you use the most water?

[RECORD RESPONSE]

WW4. Please tell me how you manage water usage in your operation.

[RECORD RESPONSE]

WW5. What equipment or devices have you installed to reduce water usage in your operation?

[RECORD RESPONSE]

Equipment/Device A: ______________________________

Equipment/Device B: ______________________________

Equipment/Device C: ______________________________

Equipment/Device D: ______________________________

WW6. What systems or procedures have you implemented to reduce water usage in the last two years?

[RECORD RESPONSE]

System/Procedure A: ______________________________

System/Procedure B: ______________________________

System/Procedure C: ______________________________

System/Procedure D: ______________________________

WW7. What kind of solid waste, if any, is generated in your operation? [IF NO SOLID WASTE IS PRODUCED OR RESPONDENT REFUSES, SKIP TO ENDING]

[RECORD RESPONSE]

WW8. How do you currently dispose of solid waste?

[RECORD RESPONSE]

WW9. What equipment or devices have you implemented to manage solid waste in the last two years?

[RECORD RESPONSE]

Equipment/Device A: ______________________________

Equipment/Device B: ______________________________

Equipment/Device C: ______________________________

Equipment/Device D: ______________________________

WW10. What systems or procedure have you implemented to manage solid waste in the last two years?

[RECORD RESPONSE]

System/Procedure A: ______________________________

System/Procedure B: ______________________________

System/Procedure C: ______________________________

System/Procedure D: ______________________________

WW11. Is this solid waste used for energy generation?

a) Yes _____
b) No [SKIP TO ENDING] _____
c) Don't know [SKIP TO ENDING] _____
d) Refused [SKIP TO ENDING] _____

WW12. How much energy does the solid waste generate (in kWh)?

[RECORD NUMERIC RESPONSE]

Ending

FQ1. Two final questions, if I have follow-up questions, may I contact you again?

a) Yes
b) No

FQ2: Would be interested in a receiving a summary of the findings?

a) Yes
b) No

Thank you for your time and discussion. Your input will help improve the delivery of energy efficiency program in this area.

Appendix C. Technical Survey for Respondents with Intermediate Energy Management Awareness

Initial Telephone Qualification Date: __________

Interview Date: _________

Interviewer: **Dan** _____ **John**_____

Start Time: __________ **End Time:** _________

Respondent Name: ____

Segment: ____

As briefly noted in our telephone call our goal I am working with a research team to conduct a *Statewide Agriculture Market Assessment & Energy Efficiency Potential Study*. This study is being undertaken by Navigant Consulting who in turn is working with Pacific Gas & Electric, Southern California Edison, the Southern California Gas, Company, and San Diego Gas & Electric (IOUs) and the California Public Utilities Commission (CPUC). The purpose of the study is to provide the IOUs and CPUC with an informed understanding of the customers' energy use, trends in energy use, energy related issues and how the utilities can improve their programs to work with customers to improve their energy efficiency and reduce costs.

<u>Energy Management</u>

EM1. Which processes and equipment use the most electricity in your operation?

[RECORD RESPONSE]

Process/Equipment A: ____

Process/Equipment B: ____

Process/Equipment C: ____

Process/Equipment D: ____

[FOR EACH PROCESS AND PIECE OF EQUIPMENT IDENTIFIED ABOVE ASK THE FOLLOWING]

EM2. What percentage of your total electric consumption for the year does each process/equipment represent?

Record numeric response in percentage form; indicate if respondent does not know or refused to respond

Process/Equipment A: ____________________

Process/Equipment B: ____________________

Process/Equipment C: ____________________

Process/Equipment D: ____________________

EM3. [ASK ONLY IF RESPONDENT PROVIDED A NUMERIC AMOUNT IN ANSWER TO EA6 = "a": NO NATURAL GAS IS USED IN THIS OPERATION] Which processes or equipment in your operation use the most natural gas?

[RECORD RESPONSE]

Natural Gas for Process/Equipment A: ____________________

Natural Gas for Process/Equipment B: ____________________

Natural Gas for Process/Equipment C: ____________________

Natural Gas for Process/Equipment D: ____________________

EM4. Earlier, I asked in which month your operation's production was greatest and you said [INSERT ANSWER TO EX12]. In what month do you think your electric usage is greatest?

a) Record month _____
b) Electric usage is constant all year _____
c) Don't know _____

d) Refused _____

EM5. [SKIP IF EA6 = "a"] In what month do you think your natural gas usage is greatest?

a) Record month _____
b) Natural gas usage is constant all year _____
c) Don't know _____
d) Refused _____

Adoption, Practices & Payback

AP1. Please tell me about how you manage your energy costs in general. Check all that apply

- I install/buy more energy-efficient equipment when I need replacements _____
- I track my monthly energy bills to notice changes _____
- I rely on my Operations/Field manager to let me know what needs to be done or changed _____
- I rely on my utility account representative to help me identify energy cost savings _____
- I use an energy management system _____
- Other ______________________________

AP2. What equipment or devices have you installed to reduce energy costs?
[RECORD RESPONSE]

Equipment/Device A: ______________________________

Equipment/Device B: ______________________________

Equipment/Device C: ______________________________

Equipment/Device D: ______________________________

[FOR EACH PIECE OF EQUIPMENT OR DEVICE ASK THE FOLLOWING]

AP2a. What criteria did you use to decide to implement this [EQUIPMENT OR DEVICE]?
[RECORD RESPONSE]
Equipment/Device A: ______________________________

Equipment/Device B: ______________________________

Equipment/Device C: ______________________________

Equipment/Device D: ______________________________

AP2b. When did you install the [EQUIPMENT OR DEVICE]?

[RECORD DATE BY MONTH/YEAR)]

Equipment/Device A: ______________________________

Equipment/Device B: ______________________________

Equipment/Device C: ______________________________

Equipment/Device D: ______________________________

AP2c. How much, as a percentage of your total energy cost did you expect to reduce energy costs by installing the [EQUIPMENT OR DEVICE]?

[RECORD NUMERIC RESPONSE]

Equipment/Device A: ______________________________

Equipment/Device B: ______________________________

Equipment/Device C: ______________________________

Equipment/Device D: ______________________________

AP2d. Did you achieve that cost reduction?

[RECORD RESPONSE AS YES, NO, DOES NOT KNOW, OR REFUSED TO RESPPOND]

Equipment/Device A: ______________________________

Equipment/Device B: ______________________________

Equipment/Device C: ______________________________

Equipment/Device D: ______________________________

AP2e. How do you know that you achieved/did not achieve the cost reduction?

[RECORD RESPONSE]

Equipment/Device A: ______________________________

Equipment/Device B: ______________________________

Equipment/Device C: ______________________________

Equipment/Device D: ______________________________

AP2f. Where did you learn about this [EQUIPMENT OR DEVICE] prior to installation?

[RECORD RESPONSE]

Equipment/Device A: ______________________________

Equipment/Device B: ______________________________

Equipment/Device C: ______________________________

Equipment/Device D: ______________________________

AP3. What payback period do you use to decide to install or implement measures to manage energy costs?

[RECORD RESPONSE]

AP4. What method do you use to calculate return on investment form investments to manage energy costs?

a) Simple Payback _____
b) Internal Rate of Return _____
c) Net Present Value _____
d) Other (Specify) ______________________________

e) Don't know _____
f) Refused _____

AP5. What are the barriers that might prevent you from installing or implementing measures to manage energy costs? (CHECK ALL THAT ARE REFERENCED; ASK WHAT IS THE TOP BARRIER)

a) Lack of awareness of additional programs TOP: _____
b) Lack of financing TOP: _____
c) First cost too high TOP: _____
d) Lack of qualified installer or implementer TOP: _____
e) Other (Specify) ____
f) Don't know [AS DISTINCT FROM "UNAWARE" OF OTHER PROGRAMS] _____
g) Refused _____

Information

IF1. When it comes to gathering information about reducing energy use or generating energy, what are the three most likely sources? [DO NOT READ, CHECK THE FIRST THREE THAT THE RESPONDENT MENTIONS]

a) UC Davis Agricultural Extension _____
b) USDA Extension Service _____
c) State Agriculture College _____
d) Agriculture Trade Group [RECORD NAME] _____
e) Private Consultants [RECORED NAME AND TYPE OF CONSULTANT] ______________
f) Local utility [RECORD NAME] ______________
g) Government agency [RECORD NAME] ______________
h) Utility Demonstration/Research Center ______________
i) Other (Specify) ____
j) Don't know _____
k) Refused

Water & Waste Water

WW1. From where do you receive your water?

[RECORD RESPONSE]

W2. What are the major production or process applications that require water in your operation?

Production/Process A: ______________________________

Production/Process B: ______________________________

Production/Process C: _____________________________

WW3. At what point in your production cycle is the most water used?

[RECORD RESPONSE]

WW4. Please tell me how you manage water usage in your operation.

[RECORD RESPONSE]

WW5. What equipment or devices have you installed to reduce water usage in your operation?

[RECORD RESPONSE]

Equipment/Device A: ____

Equipment/Device B: ____

Equipment/Device C: ____

Equipment/Device D: ____

WW6. What systems or procedures have you implemented to reduce water usage in the last two years?

[RECORD RESPONSE]

System/Procedure A: ______________________________

System/Procedure B: ______________________________

System/Procedure C: ______________________________

System/Procedure D: ______________________________

WW7. What kind of solid waste, if any, is generated in your operation? [IF NO SOLID WASTE IS PRODUCED OR RESPONDENT REFUSES, SKIP TO ENDING]

[RECORD RESPONSE]

WW8. How do you currently dispose of solid waste?

[RECORD RESPONSE]

WW9. What equipment or devices have you implemented to manage solid waste in the last two years?

[RECORD RESPONSE]

Equipment/Device A: ______________________________

Equipment/Device B: ______________________________

Equipment/Device C: ______________________________

Equipment/Device D: ______________________________

WW10. What systems or procedure have you implemented to manage solid waste in the last two years?

[RECORD RESPONSE]

System/Procedure A: ______________________________

System/Procedure B: ______________________________

System/Procedure C: ______________________________

System/Procedure D: ________________________

WW11. Is this solid waste used for energy generation?

a) Yes _____
b) No [SKIP TO ENDING] _____
c) Don't know [SKIP TO ENDING] _____
d) Refused [SKIP TO ENDING] _____

WW12. How much energy does the solid waste generate? (in kWh)?

[RECORD NUMERIC RESPONSE]

Ending

FQ1. Two final questions, if I have follow-up questions, may I contact you again?

a) Yes
c) No

FQ2: Would be interested in a receiving a summary of the findings?

a) Yes
b) No

Thank you for your time and discussion. Your input will help improve the delivery of energy efficiency program in this area.

NAVIGANT

Appendix D. Qualitative Interview Questions Map

Primary Focus	Data Collection Strategy	Primary Research Topics	Question Number (customer & expert, unless otherwise noted)
Qualitative	Focus Groups Market Actor Interviews Customer Interviews	1. Who are the players in each sector coming / going?	A2, A3
		2. Are there trade associations that would partner with the utilities to lead their members to pro-actively address energy use issues, tie-ins to environmental issues, etc.	E5
		3. What are the market drivers, market barriers, competition issues and business cycle factors faced by these players in the 2011 to 2014 period?	C1
		4. What are the cost drivers?	B1
		5. What are the supply chain connections?	A2, A3
		6. What is the business cycle for these businesses?	B3
		7. What is the regulatory environment? Are they subject to AB32? GHG mandates? Water quality issues? Waste disposal issues? Other?	D1-D6
		8. What are the workforce education & training needs to identify and tap energy efficiency opportunities?	F1
		9. Are there supporting actors that are important decision-makers that need training or education that will funnel through (services and underlying decisions and equipment) to the sector's direct consumers?	F2
		10. How do the players view energy efficiency? Determine level of relative importance (costs, better operations, regulatory mandates for emissions reduction, etc.	E1, B2
		11. How much of a role do operating and energy costs play in this segment's decision making, daily operations, and decisions to operate their business in California?	B2
		12. Are there non-financial elements that affect decision-making that can be addressed, improved, enhanced, demonstrated, etc. through the PPP or IOU programs?	D6, E2
		13. Where applicable, how does having two IOUs servicing the customer impact the customer? Are there overlaps? What about irrigation districts?	E3-E4 (customers only)
Technical	Customer Surveys (80)	What are the criteria that customers use to evaluate whether to adopt an energy efficiency measure?	
		What are acceptable payback periods?	
		Where do they get their information, products, and services related to energy efficiency, renewable energy technologies, distributed generation and demand response?	
		Without program interventions, does this segment view energy as a high priority?	
		What are best practices for energy and resource management?	
		How is the energy consumed:	

Primary Focus	Data Collection Strategy	Primary Research Topics	Question Number (customer & expert, unless otherwise noted)
		• End use • Time of day/year • Systems • Processes	
		What equipment is typically used How equipment is used (controls, manually operated, etc.)	
		What changes/innovations related to energy usage have been adopted in the past 10 years and are expected in the next 5 years?	
		1. Water issues a) What sources of water are being used? b) Where and how is water being used? c) What efforts are underway, if any, to optimize water use? d) What are best practices to reduce water consumption? 2. Waste issues a) What waste issues exist, if any? b) How is waste disposed of? Is waste used for energy generation? If so, where, when, how and how much	

Appendix E. Qualitative Interview Guide - Grower

DRAFT QUALITATIVE AGRICULTURAL SURVEY –

1. CUSTOMER, GROWER VERSION

(vineyards / wineries; dairies, field crops, fruit/tree/vine; mushroom, floriculture, post harvesting / processing)

Interviewer Name: ________________
Respondent Name: ________________
Segment: ________________
Date: ________________
Start time: _____ End time: _____

A) INDUSTRY / SUPPLIERS / CONTEXT

A1. Contact information

Name:
Firm:
Address / City / State / Zip:
County:
Phone:
Email:
Title:
Role:

A2. We are interested in understanding the "supply chain" in the warehousing industry. First, who sells your various inputs to you?

A2a. What are your inputs?
A2b. What equipment is used?
A2c. Other?

A3. Next, to whom do you sell your warehousing services?

A3a. Where are your markets? Who uses your service?
A3b. How do deliveries / transportation TO YOU happen?
A3c. How do deliveries / transportation FROM YOU happen?
A3d. Who else is involved in getting your product / service to the buyer?

B) COSTS, BUSINESS FLUCTUATIONS / DRIVERS

B1. I'd like to ask about your 3 key cost drivers – what are your three **biggest** operating costs? (edit list for specific industry; note 1, 2, and 3; leave the others blank)

Lgst (1-3)	Fill in % of operating costs for those identified as "top 3"	Lgst	

	Labor		Transportation
	Equipment purchase		Fuel
	Equipment maintenance		Testing and compliance
	Water		Marketing / advertising
	Energy		Fertilizer & other chemicals
	Waste management		Land payments
	Staff training		Building payments
	Packaging		Other (specify)

B1a. What percentage of your costs does electricity represent on average over the year? What about natural gas?

B2. Are there significant seasonal business cycles in your business?

1. Yes / Describe:
2. No
3. Don't know / refused

B2a. IF YES, to what degree do the business cycles affect your use of the following resources (Circle 1-7 where 7 represents major variation with business cycles):

a) Energy 1 2 3 4 5 6 7 Describe:
b) Water 1 2 3 4 5 6 7 Describe:
c) Waste management costs. 1 2 3 4 5 6 7 Describe:

C) NEAR TERM MARKET CHANGES / EXPECTATIONS / IMPLICATIONS

C1. Compared to the last year or two, where do you expect to see changes in the next 3 years in terms of:

	Y/N/DNK	Describe
a. Demand for your service?	Y N DNK	

b. The way your business operates?	Y N DNK	
c. Market situation underlying these trends (a&b)?	Y N DNK	
d. Barriers to doing business? ➔ Which have changed (in "describe"). Are they old / new barriers … seen before?	Y N DNK	
e. Competitive issues – locally or at state level? ➔ Which have changed (in "describe"). Are they old / new issues … seen before?	Y N DNK	
f. Competitive issues – national and/or international level? ➔ Which have changed (in "describe"). Are they old / new issues … seen before?	Y N DNK	
g. Business cycle issues?	Y N DNK	
h. Other factors / influences you see over this time period?	Y N DNK	

D) IMPACTS / EFFECTS / LIMITATIONS IMPOSED BY THE REGULATORY ENVIRONMENT

D1. Are you subject to any particular local, state, or national waste disposal regulations?
1. Yes local
2. Yes state
3. Yes national
4. No
5. Don't know / refused

D1a. If yes, which materials and which regulations?

D1b. Does it affect your operations?
1. Yes / Describe how:
2. No
3. Don't know

D2. As far as you know, are you legally subject to AB 32 (the Global Warming Solutions Act) requiring reporting of GHG emissions in the State?

1. Yes
2. No (skip to D3)
3. Don't know (skip to D3)

If D2=Yes
D2a. Some analysts say it (AB32) has the potential to impact agricultural energy, transportation, and processing costs. Does it affect your operations?

1. Yes, / Describe how:
2.
3. No
4. Don't know

D3. Is your business / your operations subject to local, state, or national greenhouse gas mandates?

1. Yes local
2. Yes state
3. Yes national
4. No
5. Don't know / refused

Ask only if Yes at D3
D3a. Does this affect your operations?

1. Yes / Describe how:
2. No
3. Don't know

D4. Are you subject to local, state, or national regulations related to water quality, effluent, discharge or other factors ?

1. Yes local
2. Yes state
3. Yes national
4. No (Skip to D5)
5. Don't know / refused

Ask only if Yes at D4
D4a. What regulations? ________________________________

D4b. Does this regulation affect your operations?

1. Yes / Describe how:
2.
3. No
4. Don't know

D5. Are there any other regulations that significantly affect your operations? (list) How do they affect your operations?

D6. Are there other non-financial, non-regulatory factors that significantly affect your operations? (list) How do they affect your operations?

E) ENERGY / RESOURCE EFFICIENCY CONSIDERATIONS

E1. How important, if at all, is energy efficiency in how you think about and operate your business? Please answer on a scale of 1 to 5 where 1 means energy efficiency is not at all important, and 5 means it is very important.

1 2 3 4 5 DNK

Briefly, why?

E1a. I'd like to ask the same question about other colleagues in your industry… How important, if at all, do you think energy efficiency is in how most of your colleagues think about and operate their businesses? Please answer on the same scale from 1 to 5.

1 2 3 4 5 DNK

Briefly, why?

E2. What are the barriers that you face in improving energy efficiency or resource use in your business? (If they say "costs" or "financial", make sure to prompt for other options as well.)

E2a. Do you think any of these barriers could be addressed with some kind of assistance from programs by (electric or water) utility companies or other entities (third party programs)? (If they say incentives or rebates, probe for other types of assistance for non-financial barriers.)

1. Yes Describe:
2. No
3. Don't know

E2b. Have you heard of any programs or assistance for energy efficiency? (Ask them to specify what they heard, where they heard it and whose program it is) Where?

E2c. Have you participated in programs or received assistance for energy efficiency? Which program(s)? Why did/didn't you participate?

E3. Are you served by more than one utility?

1. Yes
2. No
3. Don't know

E3a. If so, has that:

a) Caused you any problems (for instance, affected service quality or other problems)? Y N DNK If yes, specify.
b) Led to overlaps of any kind? Y N DNK If yes, specify.

E5. Are there trade associations that you know of that have been active in providing information on
  a) energy use issues? (List)
  b) on other environmental issues? (List)

E6. Which industry associations have good credibility and outreach in your industry? (list)

F) OTHER ISSUES

F1. Are there education and training needs you or your staff might need before you could take advantage of energy efficiency opportunities, equipment or changes?

1. Yes
2. No
3. Don't know / refused

Describe those education/training needs:

F2. Do you think your suppliers (equipment or other) are knowledgeable on energy efficiency options and developments? Do you think they keep you well-informed of new developments? (check all that apply)

1. Yes, they are knowledgeable
2. Yes they are knowledgeable AND keep me informed
3. No
4. Don't know / refused

Explain:

F3. Any other comments you would like to make about your industry, energy issues, or other topics we discussed?

CLOSING / THANK YOU

Appendix F. Qualitative Interview Guide – Service

DRAFT QUALITATIVE AGRICULTURAL SURVEY –
2. CUSTOMER, SERVICE VERSION
(refrigerated warehouses)

INTRODUCTION / RECRUITMENT SCRIPT (to be developed)

Interviewer name ___________ Sector ____________
Date / time of interview ___________

A) INDUSTRY / SUPPLIERS / CONTEXT

A1. Contact information
Name:
Firm:
Address / City / State / Zip:
County:
Phone:
Email:
Title:
Role:

A2. We are interested in understanding the "supply chain" in the warehousing industry. First, who sells your various inputs to you?
A2a. What are your inputs?
A2b. What equipment is used?
A2c. Other?

A3. Next, to whom do you sell your warehousing services?
A3a. Where are your markets? Who uses your service?
A3b. How do deliveries / transportation TO YOU happen?
A3c. How do deliveries / transportation FROM YOU happen?
A3d. Who else is involved in getting your product / service to the buyer?

B) COSTS, BUSINESS FLUCTUATIONS / DRIVERS

B1. What are your 3 or 4 key cost drivers? (edit list for specific industry)
- ❑ Labor
- ❑ Equipment purchase
- ❑ Equipment maintenance
- ❑ Water
- ❑ Staff training
- ❑ Packaging
- ❑ Transportation
- ❑ Fuel
- ❑ Testing and compliance
- ❑ Marketing / advertising
- ❑ Fertilizer & other chemicals
- ❑ Land payments

- ❑ Energy
- ❑ Waste management
- ❑ Building payments
- ❑ Other (specify)

B1a. For the top 3, about what percentage of your operating costs is represented by each?

Highest ranked: ________________ % of operating costs ____________

2nd ranked: ________________ % of operating costs ____________

3rd ranked: ________________ % of operating costs ____________

B2. For each of the following items, how much does each play in your decision-making about… (Score each responses with a 1-7 where 7 is a very major role / extremely important, 1 is no role).

How much does each play in decisions about …➔	a) Changes to daily operations	b) Changes to processes used	c) Changes to equipment used	d) Locating in California
Up front cost	1 2 3 4 5 6 7	1 2 3 4 5 6 7	1 2 3 4 5 6 7	1 2 3 4 5 6 7
Operating cost	1 2 3 4 5 6 7	1 2 3 4 5 6 7	1 2 3 4 5 6 7	1 2 3 4 5 6 7
Labor	1 2 3 4 5 6 7	1 2 3 4 5 6 7	1 2 3 4 5 6 7	1 2 3 4 5 6 7
Energy	1 2 3 4 5 6 7	1 2 3 4 5 6 7	1 2 3 4 5 6 7	1 2 3 4 5 6 7
Water	1 2 3 4 5 6 7	1 2 3 4 5 6 7	1 2 3 4 5 6 7	1 2 3 4 5 6 7
Waste	1 2 3 4 5 6 7	1 2 3 4 5 6 7	1 2 3 4 5 6 7	1 2 3 4 5 6 7
Emissions reductions	1 2 3 4 5 6 7	1 2 3 4 5 6 7	1 2 3 4 5 6 7	1 2 3 4 5 6 7
Regulatory environment / mandates	1 2 3 4 5 6 7	1 2 3 4 5 6 7	1 2 3 4 5 6 7	1 2 3 4 5 6 7
Other factors ________________ (describe)	1 2 3 4 5 6 7	1 2 3 4 5 6 7	1 2 3 4 5 6 7	1 2 3 4 5 6 7

B2e. Explain "other" factors; any comments you'd like to make (especially about energy or most important)?

B3. Are there significant seasonal business cycles in your business?

1. Yes / Describe:
2. No
3. Don't know / refused

B3a. IF YES, to what degree do the business cycles affect your use of the following resources (Circle 1-7 where 7 represents major variation with business cycles):

a) Energy 1 2 3 4 5 6 7 Describe:

b) Water 1 2 3 4 5 6 7 Describe:

c) Waste management costs. 1 2 3 4 5 6 7 Describe:

C) NEAR TERM MARKET CHANGES / EXPECTATIONS / IMPLICATIONS

C1. Compared to the last year or two, where do you expect to see changes in the next 3 years in terms of:

	Y/N/DNK	Describe
a. Demand for your service?	Y N DNK	
b. The way your business operates?	Y N DNK	
c. Market situation underlying these trends (a&b)?	Y N DNK	
d. Barriers to doing business? ➔ Which have changed (in "describe"). Are they old / new barriers … seen before?	Y N DNK	
e. Competitive issues – locally or at state level? ➔ Which have changed (in "describe"). Are they old / new issues … seen before?	Y N DNK	
f. Competitive issues – national and/or international level? ➔ Which have changed (in "describe"). Are they old / new issues … seen before?	Y N DNK	
g. Business cycle issues?	Y N DNK	
h. Other factors / influences you see over this time period?	Y N DNK	

D) IMPACTS / EFFECTS / LIMITATIONS IMPOSED BY THE REGULATORY ENVIRONMENT

D1. Are you subject to any particular local, state, or national waste disposal regulations?

6. Yes local
7. Yes state
8. Yes national
9. No
10. Don't know / refused

D1a. If yes, which materials / which regulations?

D1b. Does it affect / drive / limit your operations?

4. Yes / Describe how:
5. No
6. Don't know

D2. Are you subject to AB 32 (the Global Warming Solutions Act) requiring reporting of GHG emissions in the State? (If needed...Some analysts say it has the potential to impact agricultural energy, transportation, and processing costs.)

4. Yes
5. No
6. Don't know

D2a. Does it affect / drive / limit your operations?

5. Yes / Describe how:
6. No
7. Don't know

D3. Is your business / your operations subject to local, state, or national GHG mandates?

6. Yes local
7. Yes state
8. Yes national
9. No
10. Don't know / refused

D3a. Does it affect / drive / limit your operations?

4. Yes / Describe how:
5. No
6. Don't know

D4. Are you subject to regulations related to local / state / national water quality, effluent, discharge or other factors?

6. Yes local
7. Yes state
8. Yes national
9. No
10. Don't know / refused

D4a. Does it affect / drive / limit your operations?

5. Yes / Describe how:
6. No
7. Don't know

D5. Are there any other regulations that significantly affect your operations? (list)

D6. Are there other non-financial, non-regulatory factors that significantly affect your operations? (list)

E) ENERGY / RESOURCE EFFICIENCY CONSIDERATIONS

E1. How do you view energy efficiency or resource conservation?

1. Very positive
2. Somewhat positive
3. Neutral
4. Somewhat negative
5. Very negative
6. Don't know / refused

Briefly, why?

E1a. How do you think other warehouse owners like you view energy efficiency / conservation?
1. Very positive
2. Somewhat positive
3. Neutral
4. Somewhat negative
5. Very negative
6. Don't know / refused

E2. Other than rebates or financial incentives, are there other barriers that could be addressed, or assistance that could be provided, through programs from (electric or water) utility companies or other entities (third party programs)?
4. Yes Describe:
5. No
6. Don't know

E2a. Have you heard of good / interesting programs or assistance elsewhere? (specify)

E3. Are you served by more than one utility?
4. Yes
5. No
6. Don't know

E3a. If so, has that:
c) Caused you any problems? Y N DNK If yes, specify.
d) Led to overlaps of any kind? Y N DNK If yes, specify.

E5. Are there trade associations that you know of that have been active in providing information on
a) energy use issues? (List)
b) on other environmental issues? (List)
c) can you suggest industry associations that have good credibility and outreach in your industry? (list)

F) OTHER ISSUES

F1. Are there education and training needs you or your staff might need in order to feasibly take advantage of energy efficiency opportunities, associated equipment or process changes, etc.?

4. Yes
5. No
6. Don't know / refused

Describe:

F2. Do you think your suppliers (equipment or other) are knowledgeable on energy options and developments? Do you think they keep you well-informed of new energy options and efficiencies? (check all that apply)

5. Yes, they are knowledgeable
6. Yes they keep me informed
7. No
8. Don't know / refused

Describe:

F3. Any other comments you would like to make about your industry, energy issues, or other topics we discussed?

CLOSING / THANK YOU

Appendix G. Subject Matter Expert Interview Guides

G.1 Dairies

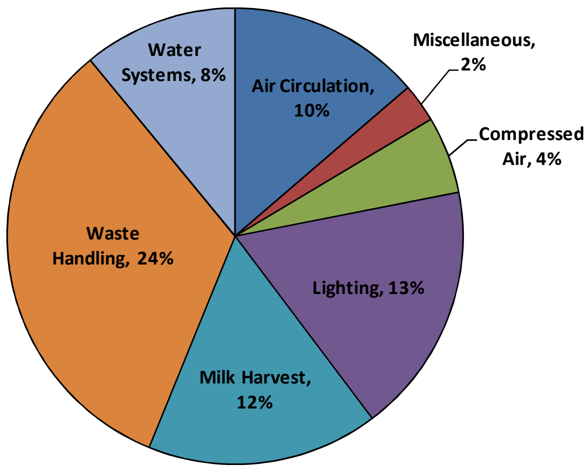
DAIRY Segment Experts – Interview Guide

A. Overall industry trends and drivers
    1. What are the most significant trends and drivers in the California dairy market?
    2. What are the biggest challenges?
    3. How do these trends/drivers/challengers affect grower/operators; sales/production; growth?
    4. How will this segment respond to these trends/drivers or overcome these barriers going forward? Is there likely to be a movement out of state?

B. Market/actors
    1. Who are the market leaders?
       California Dairies, Inc., Land O'Lakes, Dairy Farmers of America (DFA), and Humboldt Creamery
    2. How much of the California market do these coops control?
    3. What is the most effective way to approach the industry leaders? What contact names might they give to us to lead on the right track?
    4. What is considered small in this market? How many small/independent operators are there?

C. Energy and other cost concerns
    1. Are operators concerned about energy costs? Water use?
    2. Where do utility costs rank on their list of operational expenditures?
    3. What do operators currently do to mitigate energy and water use, if anything?
    4. Pie chart depicts electrical energy use on a typical California dairy farm (from 2004). Is this still accurate?

Figure G.1. Electrical Energy Use on a Representative California Dairy Farm[112]



D. Technologies and EE drivers and barriers
    1. Technologies in use and saturations (See Table G.1)

Table G.1. Results of 1994-1995 Baseline Equipment Survey of Dairies in San Joaquin Valley

Equipment	Penetration by Technology Type
Vacuum Pumps	Water ring: 95% Lobe Blower: 3% Turbine: 2% Average horsepower per milking unit: 1.02 ± 0.28 hp
Precoolers	Heat exchangers (typically plate type coolers): 58% Heat exchanges (with well water & chilled water): 36% No precooling: 5%
Water Heaters (fuel)	Propane: 68% Natural gas: 26% Electricity: 5% Vacuum pump heat exchanger: 1 dairy

    2. Anaerobic digesters
    3. EE drivers/barriers

E. Other issues or concerns that did not come up as part of our questions that the SME wants us to know about?

[112] Southern California Edison, *Dairy Farm Energy Efficiency Guide*, http://www.sce.com/b-sb/design-services/dairy-farm-energy-efficiency-guide.htm

G.2 Greenhouses and Nurseries

Greenhouse and Nursery Segment Experts – Interview Guide

A. Overall industry trends and drivers
   1. What are the most significant trends and drivers in the California floriculture market?
   2. What are the biggest challenges?
   3. How do these trends/drivers/challengers affect grower/operators; sales/production; growth in the industry?
   4. Is the market for California's floriculture production domestic only, or is there an international market as well?
   5. How will this segment respond to these trends/drivers or overcome these barriers going forward?

B. Market/actors
   1. Who are the market leaders? How large are these companies in terms of annual production value?
   2. How much of the California market do the market leaders control?
   3. Where is the market concentrated geographically?
   4. What is the most effective way to approach the industry leaders? What contact names might they give to us to lead on the right track?
   5. What is considered small in this market? How many small/independent operators are there?

C. Energy and other cost concerns
   1. What are the processes common in floriculture production?
   2. Are operators concerned about their energy costs? Water use?
   3. Where do utility costs rank on their list of operational expenditures?
   4. What do operators currently do to mitigate energy and water use, if anything?

D. Technologies and EE drivers and barriers
   1. Technologies in use and saturations
   2. EE drivers/barriers

E. Other issues or concerns that did not come up as part of our questions that the SME wants us to know about?

G.3 Mushrooms

MUSHROOM Segment Experts – Interview Guide

A. Overall industry trends and drivers
   1. What are the most significant trends and drivers in California's mushroom production?
   2. What are the biggest challenges?
   3. How do these trends/drivers/challengers affect grower/operators; sales/production; growth in the industry?

4. Is the market for California's mushroom production in-state only or does the product travel outside of California? What percentage remains in state versus out of state?
5. How will this segment respond to these trends/drivers or overcome these barriers going forward?

B. Market/actors
1. Who are the market leaders? How large are these companies in terms of annual production value?
2. How much of the California market do the market leaders control?
3. Where is the market concentrated geographically?
4. What is the most effective way to approach the industry leaders? What contact names might they give to us to lead on the right track?
5. What is considered small in this market? How many small/independent operators are there?

C. Energy and other cost concerns
1. How are mushroom crops produced (ask them to walk through process, and ask for more information on anything that appears to have energy implications)?
2. Are operators concerned about their energy costs? Water use?
3. Where do utility costs rank on their list of operational expenditures?
4. What do operators currently do to mitigate energy and water use, if anything?

D. Technologies and EE drivers and barriers
1. Technologies in use and saturations
2. EE drivers/barriers

E. Other issues or concerns that did not come up as part of our questions that the SME wants us to know about?

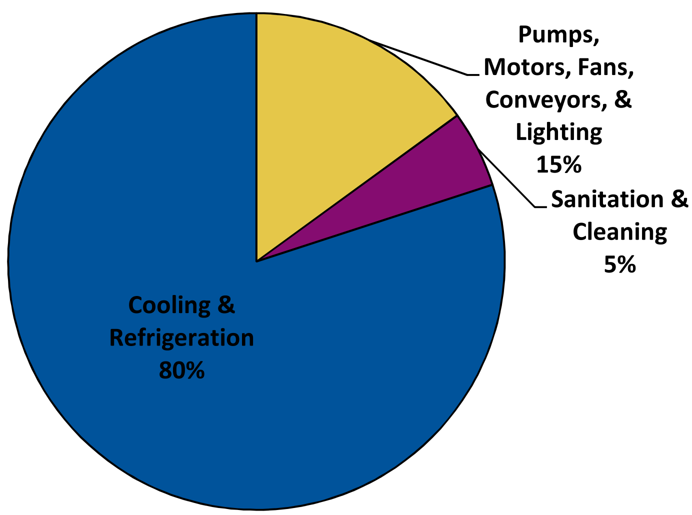
G.4 Field Crops

1) Comments on the literature review
2) Major trends and drivers in terms changes in energy and water usage within the segment
3) Similarity in energy use across establishments with segment.
   a. What are the major sub-segments with relatively homogenous energy use equipment and practices?
   b. Insights as to changes in technology and practices that will significantly affect energy/water intensity within the segment
4) Growth trends – decrease/increase, shift to other crops (an indicator of willingness to make capital improvements)
5) Major vendors of energy using equipment – for example are there three vendors of irrigation equipment that supply 80% of the irrigation systems?
6) Concentration of ownership. While there are many establishments, do many of them have the same owner, or are there a few owners that dominate the production within this sector

G.5 Refrigerated Warehouses

Refrigerated Warehouse Segment Experts – Interview Guide

A. Overall industry trends and drivers
    1. What are the most significant trends and drivers in the California refrigeration market?
    2. What are the biggest challenges?
    3. How do these trends/drivers/challengers affect grower/operators; sales/production; growth?
    4. How will this segment respond to these trends/drivers or overcome these barriers going forward? Is there likely to be a movement out of state?
B. Market/actors
    1. Who are the market leaders?
    2. How much of the California market do they control?
    3. What is the most effective way to approach the industry leaders? What contact names might they give to us to lead on the right track?
    4. What is considered small in this market? How many small/independent operators are there?
C. Energy and other cost concerns
    1. How concerned are operators about energy costs? Water use?
    2. Where do utility costs rank on their list of operational expenditures?
    3. What do operators currently do to mitigate energy and water use, if anything?
    4. Pie chart depicts typical energy use in a representative California refrigerated warehouse.



D. Technologies and EE drivers and barriers
    1. Technologies in use and saturations
    2. Anaerobic digesters
    3. EE drivers/barriers

E. Other issues or concerns that did not come up as part of our questions that the SME wants us to know about?

G.6 Post-Harvest Processing (Cooling)

POSTHARVEST PROCESSING (COOLING) Segment Experts – Interview Guide

This study includes activities that occur soon after harvest, i.e., cooling, drying, hulling/shelling. We want to understand all of these activities.

A. Overall industry trends and drivers
    1. How common is on-farm cooling?
    2. What are trends and drivers in postharvest cooling? How will this segment respond to these trends/drivers or overcome these barriers going forward?
    3. Cooling equipment can be rented out and moved across California or even out of state. What portion of the cooling equipment is rented vs. owned? What is a typical pattern of movement for rented equipment?
B. Market/actors
    1. How concentrated is the ownership of cooling equipment? Are there any market leaders?
    2. What is the typical equipment lifetime? How often is it replaced?
    3. What proportion of California's farms require cooling equipment? What types of crops?
    4. What is the most effective way to approach equipment owners? What contact names might they give to us to lead on the right track?
C. Energy and other cost concerns
    1. Are operators concerned with the energy use of the equipment they buy or rent?

D. Technologies and EE drivers and barriers
    1. Technologies in use and saturations
    2. EE drivers/barriers

E. Other issues or concerns that did not come up as part of our questions that the SME wants us to know about?

G.7 Post-Harvest Processing (Drying)

POSTHARVEST PROCESSING (DRYING) Segment Experts – Interview Guide

This study includes activities that occur soon after harvest, i.e., cooling, drying, hulling/shelling. We want to understand all of these activities.

A. Overall industry trends and drivers

1. How common is on-farm drying?
2. What are trends and drivers in postharvest drying? Will specialized facilities replace on-farm drying operations or do crops require on-farm drying?
3. Who owns the equipment used in on-farm postharvest drying? Is this equipment typically rented, leased or loaned to other farmers?

B. Market/actors
   1. What is the typical equipment lifetime? How often is it replaced? How well is it maintained?
   2. What proportion of California's farms require drying equipment? What kinds of crops must be dried soon after harvest?
   3. What is the most effective way to approach equipment owners/operators (if not owned by the farmers themselves)? What contact names might they give to us to lead on the right track?

C. Energy and other cost concerns
   1. Are operators concerned with the energy use of the equipment they buy or rent?
   2. What are the major barriers to equipment replacement?

D. Technologies and EE drivers and barriers
   1. Technologies in use and saturations
   2. EE drivers/barriers
   3. Have solar drying technologies been adopted in any niche markets?

E. Other issues or concerns that did not come up as part of our questions that the SME wants us to know about?

Appendix H. Renewable Energy Production in California Agriculture

Of the 82 technical survey respondents, 19 reported installation of photovoltaic generation, as detailed in Table H.1. The total PV installation, for the 17 respondents that could quantify their installation, was 7.597 MW with an average of 0.447 MW per respondent.

Table H.1. Photovoltaic Installations among Study Participants

Respondent's Utility	Segment	Capacity
PGE	Field Crops	50 kW
PGE	Fruit Trees and Vine Crops	50 kW
PGE	Fruit Trees and Vine Crops	100 kW
PGE	Vineyards & Wineries	100 kW
PGE	PHP	125 kW
SCG	Field Crops	200 kW
PGE	Vineyards & Wineries	225 kW
PGE	Vineyards & Wineries	385 kW
PGE	Field Crops	393 kW
PGE	Post-Harvest Processing	393 kW
SCE	Refrigerated Warehouses	550 kW
PGE	Vineyards & Wineries	585 kW
PGE	Field Crops	761 kW
SCE	PHP	840 kW
SCE	Refrigerated Warehouses	840 kW
SDGE	Refrigerated Warehouses	1000 kW
PGE	Vineyards & Wineries	1000 kW
PGE	Dairy	Don't know
PGE	Mushrooms	Don't know

Source: Navigant Analysis of 82 Technical Field Interview Responses

These respondents consistently reported that one of the motivations for PV installation was to limit demand charges on their electric bills. Vineyard & Winery segment respondents viewed PV installation as a sustainability statement or element of their corporate image in addition to an opportunity to offset consumption or demand charges.

These findings appear to be consistent with the 2009 USDA On-Farm Renewable Energy Production Survey, which found 1,825 PV panels on 1,906 California farms.[113] These panels constituted 25% of the nation's on-farm PV installation as estimated by the survey.

In terms of other on-site generation, the technical survey respondents identified one bio-digester and one fuel cell. The On-Farm Renewable Energy Production Survey,[114] however, reported the following:

Table H.2. Non-Photovoltaic On-Farm Generation in California

	California	Per Cent of National Average
Farms with Small Wind Turbine Installation	134	9.5%
On-Farm Small Wind Turbines	160	8.7%
Farms with Methane Digesters	14	11.6%
On-Farm Digesters	14	10%

Source: 2009 USDA On-Farm Renewable Energy Production Survey

[113] On-Farm Renewable Energy Production Survey, Census of Agriculture, US Depart of Agriculture, 2009. Table 3 - http://www.agcensus.usda.gov/Publications/2007/Online_Highlights/On-Farm_Energy_Production/energy09_1_03.pdf . Accessed February 25, 2013.

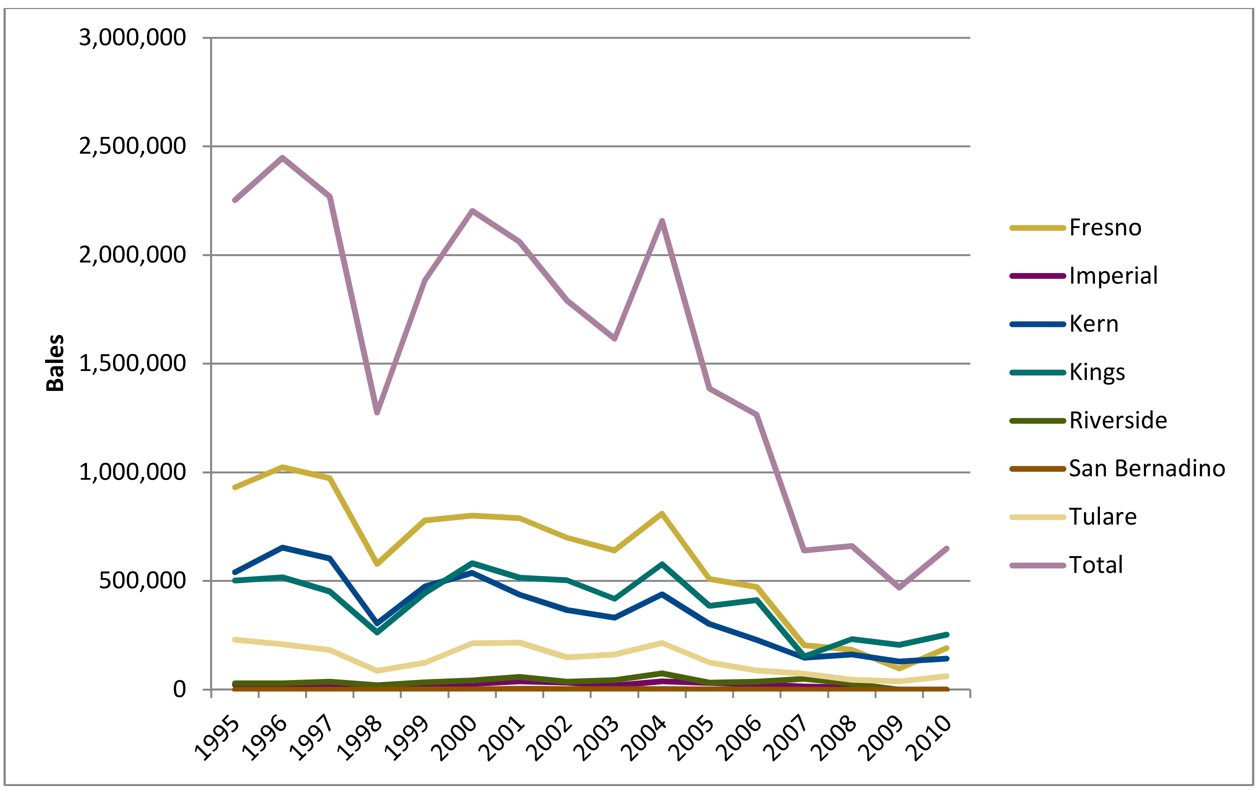
[114] Ibid. Tables 1 and 2 - http://www.agcensus.usda.gov/Publications/2007/Online_Highlights/On-Farm_Energy_Production/energy09_1_01_02.pdf . Accessed February 25, 2013.

Appendix I. California Cotton Ginning

Cotton ginning is a form of post-harvest processing that separates cotton fibers from cotton seeds, hulls and field debris prior to spinning into manufactured products. Since it the only type of non-food post-harvest processing, Navigant did not include its secondary research or subject matter interview on this subject in Chapter 10. Instead, this appendix provides market trend data and the subject matter expert's assessment of this processing type's market trends, challenges, actors.

As shown in Figure I.1, California's cotton production has declined significantly over the last 17 years. The number of cotton gins (post-harvest processing facilities) has declined from a peak of 299 in 1963 to only 30 in 2011.[115] California's production of ELS or Pima cotton represents over 90% of the total U.S. pima cotton production. Production of upland types represents about 4% of U.S. annual production on average.[116]

Figure I.1. California Cotton Production by County



Source: California Cotton Growers and Ginners Association

[115] California Cotton Growers and Ginners Association, http://www.ccgga.org/cotton_information/ca_cottonfacts.html, accessed February 25, 2013.
[116] Ibid.

As suggested by these figures, consolidation of ginning facilities is the leading trend in this industry. Production has decreased and cotton has become one part of the crop rotation rather than its traditional monoculture. In terms of overall acreage, cotton is losing out to other crops that yield more dollars and recent water shortages have affected production.

In terms of energy consumption, this type of post-harvest processing relies on electricity for conveyance and materials handling and natural gas for drying. According the USDA research specialist who provided subject matter expert interview, ginning in the West is uses 20% less energy now than 35 years ago. Some of this efficiency comes from consolidation, but some comes from the more efficient equipment when a post-harvest processor invests in a gin plan, they expect to run the gin for 20 or 30 years, which can make the innovation slow. In terms of energy management, ginners have decreased natural gas use through control and measurement. In terms of electrical consumption, increased mechanization and automation may increase load as ginners seek to reduce labor costs.

Reference partners for California cotton ginners include:

- National Cotton Council – made up of all segments of the industry; producers, ginners, mills, etc. They work on national priorities
- California Cotton Ginners and Growers Association – the state trade association for these post-harvest processors
- Cotton Incorporated – the national and international promotion agency of U.S. cotton producers
- JT Boswell – the California market leader in cotton production and ginning that controls approximately one third of the market in California.

Appendix J. Effects of Climate Change on California's Agricultural Market

J.1 Climate Change Definition

As defined by the United Nations Framework Convention on Climate Change, climate change is "a change of climate…that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods"[117]. The phenomenon is typically characterized by changes in the statistical distribution of weather patterns over periods of time. The causes of climate changed have been heavily debated on a global scale; however, they are outside of the scope of this work and will not be discussed in this report.

Climate change may refer to either a lasting and significant change in average weather conditions, or the frequency and intensity of extreme weather events around the average condition. Numerous academic and scientific studies have highlighted significant changes in both average weather conditions and the extreme weather events surrounding them. The US Environmental Protection Agency (EPA) has noted that the average annual temperature in the Southwestern United States has increased by 1.5˚F over the last century and is expected to rise by another 2.5-8˚F by the end of this century[118]. Although seemingly small, these changes in temperature can have drastic effects on many aspects of global, regional, and local weather patterns, as well as trickle-down effects. For instance, climate change over the past century has led to:

- **Extreme weather conditions**: In the last century, California and the Southwest have seen increasing average ambient temperatures and a decline in the number of winter chill hours.[119] This is particularly true in the Bay Delta region and the mid-Sacramento Valley, which have seen greatest rates of change since the 1950s[120]. In general, cold extremes have become less frequent, while heat waves are becoming increasingly prominent in the region. Indeed, studies have shown that in extreme scenarios, heat waves such as the one experienced in July 2006 may occur as frequently as once a year in many parts of California[121].
- **Atmospheric changes**: Both a cause and effect of climate change, the region – and, indeed, the world – is seeing increases in atmospheric greenhouse gasses such as carbon dioxide (CO_2).

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[117] *Climate Change : a glossary by the Intergovernmental Panel on Climate Change (1995)* http://www.ipcc.ch/pdf/glossary/ipcc-glossary.pdf

[118] EPA, Southwest Impacts and Adaptation, http://www.epa.gov/climatechange/impacts-adaptation/southwest.html#impactsagriculture

[119] Chill hours are the number of hours below a certain temperature that a plant requires for dormancy before springtime growth (http://www.climatechange.ca.gov/adaptation/documents/Statewide_Adaptation_Strategy_-_Chapter_8_-_Agriculture.pdf)

[120] EPA, Southwest Impacts and Adaptation, http://www.epa.gov/climatechange/impacts-adaptation/southwest.html#impactsagriculture

[121] California Statewide Adaptation Strategy, http://www.climatechange.ca.gov/adaptation/documents/Statewide_Adaptation_Strategy_-_Chapter_8_-_Agriculture.pdf

Although this compound can serve as a fertilizer for many plants, it also further exacerbates atmospheric warming, potentially enhancing extreme weather conditions and water shortages.

- **Water shortages**: Already, the Southwestern US has seen regular decreases in precipitation, as well as spring snowpack and river flow. Each of these represents a critical supply of water for the region. The Southwest's natural susceptibility to drought further amplifies these water shortages, and the EPA anticipates that the current water scarcity will be "compounded by the region's rapid population growth, which is the highest in the nation"[122].

J.2 Effects on Market Segments

Crop Segments

Fruit, Tree Nut & Vine; Greenhouses & Nurseries; Mushrooms; Field Crops

Both fluctuations in degree days and the shortage of reliable water will negatively impact the production of many of California's most crucial crops. In particular, increasing temperatures are leading to the decline in winter chill hours, or the number of hours below a certain temperature in which a plant remains dormant before spring growth (see Figure J.1). This trend has the most significant impact on fruit and tree nuts, which depend on winter chill hours to properly set fruit. Insufficient chill hours can result in late blooming, which in turn decreases fruit quality and economic yield[123]. A 2008 study commissioned by the California Energy Commission found that declining chill hours has had the greatest negative impact on cherries, while high spring temperatures have brought the most harm to the production of almonds – California's most valuable perennial crop[124]. None of the studies identified benefits to increased temperatures, indicating that the warming climate will only negatively impact crop yield and quality, and in turn, California's agricultural market.

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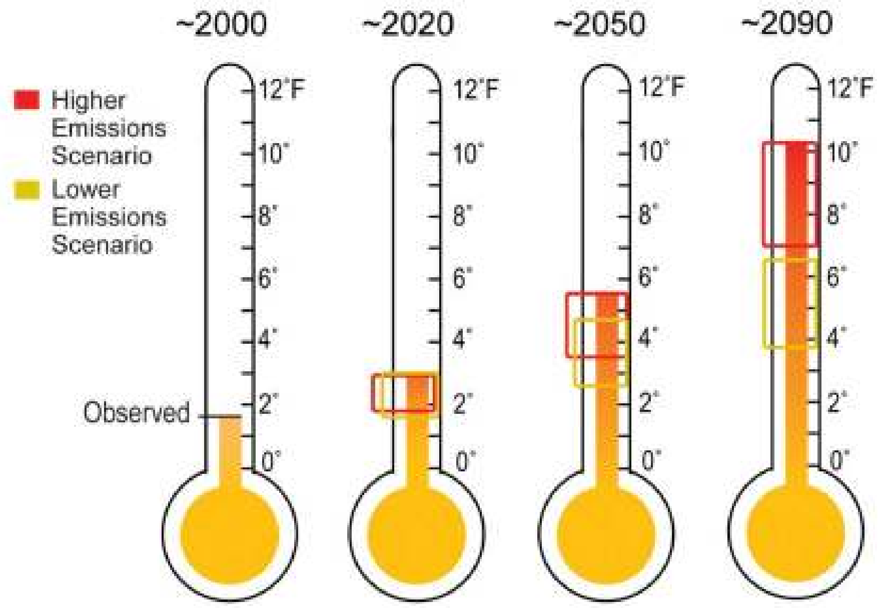
[122] EPA, Southwest Impacts and Adaptation, http://www.epa.gov/climatechange/impacts-adaptation/southwest.html#impactsagriculture

[123] California Climate Change Center, 2008, http://www.energy.ca.gov/2008publications/CEC-500-2008-077/CEC-500-2008-077.PDF

[124] California Climate Change Center, 2009, *California Perennial Crops in a Changing Climate*. http://www.energy.ca.gov/2009publications/CEC-500-2009-039/CEC-500-2009-039-F.PDF

Figure J.1. Observed and Projected Temperature Change in the Southwest, Compared to a 1960-1979 Baseline Period

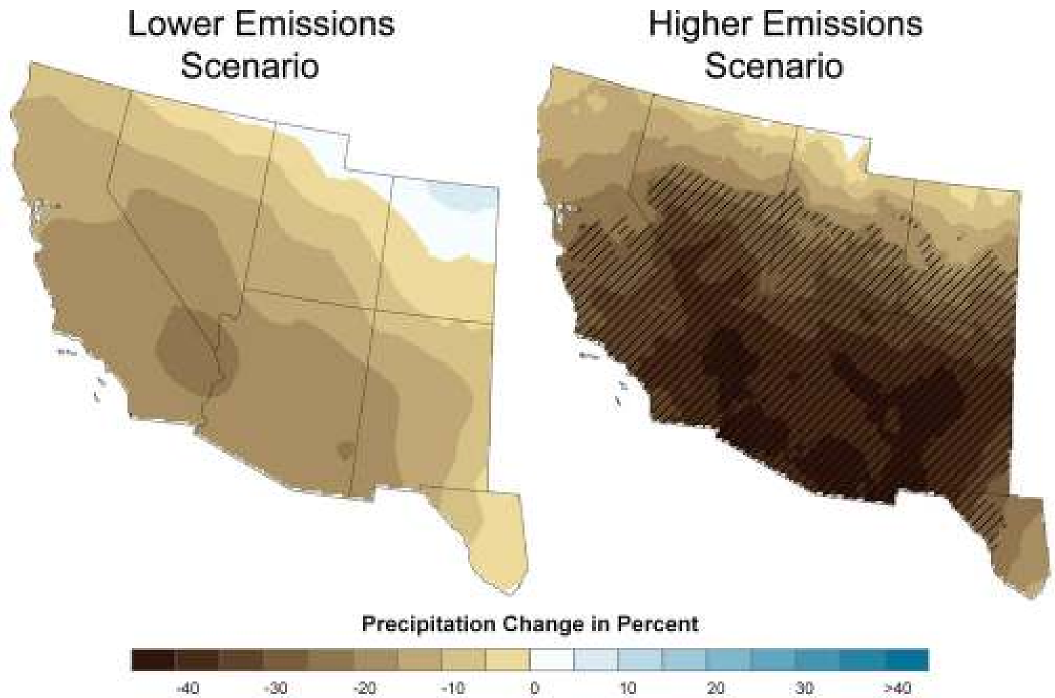


Source: http://www.epa.gov/climatechange/impacts-adaptation/southwest.html#impactsagriculture

Water scarcity will further harm crop yields in these market segments. Climate change studies across the board identify a drying trend throughout California, as available water from both the Sierra Nevada snow packs and from precipitation has declined (see Figure J.2). These factors can lead to extreme water shortages or drought, effectively limiting the water available for irrigation. Moreover, warming temperatures across the globe are leading to sea level rise. At a localized level, this is resulting in saltwater intrusion in the Delta region, which could further restrict fresh water resources[125]. The climate-induced trends discussed here may direct crop selection toward row crops, which are less dependent on long-term water supplies and winter temperatures. However, crops of all types will likely suffer from the effects of climate change.

[125] California Statewide Adaptation Strategy, http://www.climatechange.ca.gov/adaptation/documents/Statewide_Adaptation_Strategy_-_Chapter_8_-_Agriculture.pdf

Figure J.2. Spring Precipitation Change for 2080-2099 Compared to 1961-1979 Under Two Emissions Scenarios



Source: http://www.epa.gov/climatechange/impacts-adaptation/southwest.html#impactsagriculture

Water scarcity will not only harm crop yields, but could also result in financial losses and further trickle-down effects for the California's crop-producing market segments. Population growth in urban areas is notably increasing throughout California, creating further competition for water resources between urban and agricultural customers. Research has found that droughts, competition for resources, and water delivery constraints have "led to losses in excess of $1 billion annually to Central Valley agriculture, translating to tens of thousands of lost jobs, and a reduction in world food supply"[126]. Studies estimate that if fresh water availability were more than 20% below demand, the agricultural market would incur annual costs of $200 million[127]. Liabilities such as these could inhibit lending from financial institutions in the future, which could further limit growers' abilities to invest in their businesses or in energy efficient technologies.

Vineyards & Wineries

Due to the nature of the winegrape crop, the Vineyards & Wineries market segment will see slightly different effects on their production as compared to other crop segments. Because grape growth requires less water than other crops, water shortages will have less of an impact on this particular segment.

[126] Ibid.
[127] Ibid.

Rather, the change in ambient temperature will have the most significant effect on California winegrape production.

Premium winegrape production requires moderate climate and weather conditions, including adequate heat, low risk of severe frost damage, and a lack of extreme heat[128]. Given the needed conditions, winegrape production will presumably decrease with the higher prevalence of hot days. According to a 2006 study on the effects of extreme heat on premium wine production[129], certain regions in the US could see as many as 60 extreme hot days per season. The most heat-tolerant winegrapes can only withstand about 14 days of extreme heat, suggesting that much of California's premium wine production will not be able to withstand the rising temperatures[130]. Noah Diffenbaugh, the study's co-author, stated during an interview: "We see production disappearing essentially in what are the prime producing areas, which is Napa Valley, Sonoma Valley, the Santa Barbara area [California] and the Willamette Valley [Oregon]"[131]. Future production will likely be limited to coastal and northern areas, predominantly in Oregon and Washington, to the detriment of the California wine market.

Livestock Segments: Dairies

Both water scarcity and increased temperatures can harm dairy production. Livestock such as dairy cows cannot withstand extreme heat, as cows under heat stress will produce between 10-25% less milk, depending on the level of heat stress[132]. During a 2005 heat wave, New York herds reportedly experienced a decline in milk production from 5-15 pounds per cow per day[133]. Heat stress can also decrease reproduction in livestock, inhibiting the breeding of dairy cows. If the heat stress is sufficiently extreme, the decline in both productivity and reproduction could be prolonged and continue for months after heat exposure[134]. To combat rising temperatures, dairy farms will likely increase their space cooling and refrigeration usage to ensure optimal productivity, which will undoubtedly lead to increasing energy costs.

Limitations in water availability will also have a negative impact on this market segment. In addition to providing drinking water for cattle, dairy farms also use water for cleaning and irrigating their feed crops. These crops will be susceptible to the effects of climate change that are listed in the earlier sections. A reduction in both feed and water could have detrimental effects on dairy farms. Indeed, research conducted at the University of California, Santa Barbara indicated that the effects of climate change could increase dairy farm production costs by up to 18% in all of California's dairy-producing

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128 M. White, N. Diffenbaugh, G. Jones, J. Pal, and F. Giorgi, 2006, *Extreme heat reduces and shifts United States premium wine*
production in the 21st century. http://www.pnas.org/content/103/30/11217.abstract
129 Ibid.
130 Zabarenko, Deborah, 2006,"Climate Change Could Slash U.S. Wine Industry."
http://www.enn.com/top_stories/article/4644
131 Ibid.
132 Chase, Larry E., *Climate Change Impacts on Dairy Cattle*,
http://www.climateandfarming.org/pdfs/FactSheets/III.3Cattle.pdf
133 Ibid.
134 Ibid.

regions[135]. These increasing costs will be particularly detrimental to smaller operations that do not benefit from economies of scale. Moreover, other livestock production operations are facing similar issues as a result of climate change. This indicates that beef cattle farms and other feedlots will see similar increases in operating costs and face similar challenges in the near future.

Processing Segments: Postharvest Processing; Refrigerates Warehouses

Little information exists on the specific effects of climate change on the Postharvest Processing and Refrigerated Warehouse market segments. Notable effects pertain to the increased risk of food spoilage and poisoning if the industry does not adopt advanced refrigeration technologies to combat rising temperatures. Stable and reasonable temperatures are vital to postharvest operations, as they are devoted to maintaining food quality and prolonging shelf life. Processes such as rapid cooling and forced ripening of fresh produce will be particularly affected by warmer temperatures. Rapid cooling, for instance, is carried out on the premise that shelf-life is "extended 2- to 3-fold for each 10˚C decrease in pulp temperature"[136]. As climate change increases ambient temperature, fruit will likely have a higher pulp temperature when harvested, thus requiring more energy to cool it properly in the postharvest and refrigeration stages.

In addition to the effects of higher temperatures, increased exposure to carbon dioxide and ozone (both byproducts of climate change) can alter ripening periods, change the enzymatic activity within the produce, and decrease the quality of some fruits and vegetable[137]. When combined, each of these factors can significantly alter the energy use and the processes needed in the postharvest and refrigerated warehouse segments. This could lead to uncertainty as to future technologies and processes that are needed to maintain the quality of produce.

There is a dearth of information regarding the effects of climate change on postharvest processing segments aside from postharvest cooling and forced ripening. Further research should be conducted on the effects of climate change on roasting and drying, particularly for the nut-related segments.

J.3 Energy Implications

Climate change will have the most significant impacts on the California agricultural market through water shortages and higher temperatures. Because of these factors, the industry will likely increase energy usage for irrigation, space cooling and refrigeration. Water shortages and increasing resource competition with urban populations could potentially force agricultural customers to pump water from new sources such as aquifers and potentially desalination efforts. Market segments such as refrigerated

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135 J. Calil, A. Silvester, K. Stelzl, C. Wissel-Tyson, 2012, *The Effect of Climate Change on the Production Costs of the Dairy Industry in the United States*. .http://www.bren.ucsb.edu/research/2012Group_Projects/documents/gotmilk_report.pdf

136 C.L. Moretti, L.M. Mattos, A.G. Calbo, S.A. Sargent, 2009, *Climate changes and potential impacts on postharvest quality of fruit and vegetable crops: A review*. https://www.uni-hohenheim.de/fileadmin/einrichtungen/klimawandel/Literatur/Moretti-etal-FRI2010.pdf

137 Ibid.

warehousing, postharvest processing, and dairies will increase energy use for refrigeration to ensure the quality of their products. Livestock-related segments such as dairies and feedlots will devote more energy toward the cooling of their livestock to promote high levels of productivity and reproduction. The majority of increased energy usage is likely to be electrical in nature. Potential increases in natural gas usage may come from increased irrigation using natural gas-fired pumps.

Utilities can help manage these increases in energy use by working with agricultural customers to implement high efficiency technologies in key areas. High efficiency pumps, advanced refrigeration technologies, and cooling and ventilation technologies should be the focal points for utilities looking to combat the effects of climate change. Moreover, utilities can promote the use of proper irrigation scheduling, particularly for market segments with older equipment and crops that require heavy watering. By properly scheduling irrigation patterns, growers may simultaneously manage water usage while using electricity during off-peak hours.