

New Opportunities for Energy Efficiency in California Agriculture

A Study Conducted by:



**A Navigant Consulting Program,
Sponsored by Southern California Gas Company,
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The California Sustainability Alliance (the Alliance) is an innovative market transformation program funded by California utility customers under the auspices of the California Public Utilities Commission. The Alliance leverages action on environmental initiatives such as climate, smart land use and growth, renewable energy, waste management, water use efficiency and transportation planning to help the State of California achieve its aggressive energy efficiency goals more effectively and economically. In partnership with public and private organizations throughout California, the Alliance precipitates widespread market transformation by tackling major barriers to sustainability.

For information about the California Sustainability Alliance, go to:

www.sustainca.org

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EXECUTIVE SUMMARY

The Alliance conducted primary and secondary research to determine the viability of utility-sponsored crop switching in California for the purpose of conserving energy and water resources. Based on the results of this research, the Alliance team determined that active market-based crop switching already exists, which would make any programmatic effort in this vein largely irrelevant.

At the direction of Southern California Gas Company (SCG), The Alliance took the opportunity provided by this project to identify other potential utility-sponsored program options that could benefit California growers. The most readily available options appear to be the following:

- Greenhouse retrocommissioning
- Rebates for condensing boilers for soil warming

However, other programmatic options—both individual measures and activities—exist that require an investment in research to become viable. These options include the following:

- Post-harvest processing audits
- Greenhouse-specific rebates
- Water treatment and recycling

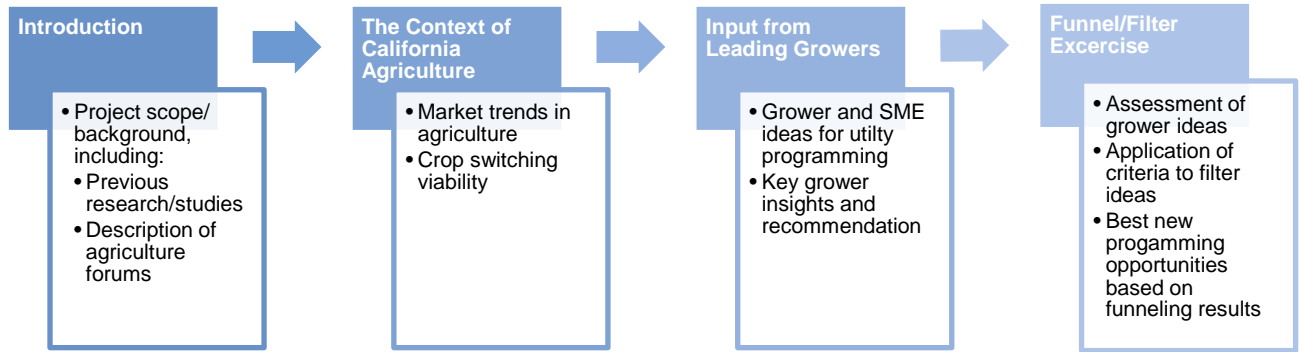
In addition, The Alliance identified outreach and marketing activities that do not have direct energy or water conservation benefits but would still enhance overall efficiency efforts in the California agriculture market:

- Update agriculture-related websites at local utilities
- Offer additional forums for specific agricultural market segments



Figure 1 describes the elements of this report and the key information contained within each section.

Figure 1. Elements of this Report



Source: Alliance analysis

INTRODUCTION

This project (also referred to as the Crop Switching Project) had a lifecycle of six months, starting in July 2015 and ending mid-December 2015. It was an aggressive project that focused on input from growers and other experts. For this project, the Alliance conducted four tasks:

1. Identify likely replacement crops
2. Scan for existing programming and estimate natural gas savings
3. Collect input from leading growers
4. Conduct a funnel/filter exercise to determine the most feasible approaches

This report begins with an overview of the initial project plan, related Alliance work, outcomes of the project tasks, and modifications made to the original study plan due to research and field discussion. The report then summarizes the processes and outcomes associated with the four tasks.

Initially, the Alliance focused on the feasibility of crop-switching as a water and energy conservation mechanism. Responses from growers and subject matter experts (SMEs) showed that this approach may not be viable as a utility-sponsored program so the emphasis shifted to other programmatic opportunities. Accordingly, the funnel/filter exercise assessed the value of current and potential Southern California Gas Company (SCG) program offerings and partnerships with growers and SMEs.

This report presents a snapshot in time of what some growers and SMEs think it would be good for SCG to know and consider if they want to help sustain the agricultural sector in California, with particular focus on the growing areas in the southern third of the state.

Project Background

The Crop Switching Project is a natural extension of the California Statewide Agriculture Market Characterization study conducted by Navigant in 2012-2013, and the two subsequent agricultural forums held in 2013 and 2014. The Alliance conducted the first Agriculture Forum in the fall of 2013 for greenhouse, floriculture, and horticulture customers of SCG operating along the Southern California coast from Santa Maria to Camarillo; 14 growers attended this first forum. The Alliance held the second forum at the International Agri-Center located in Tulare in August 2014; 27 participants attended this forum



The goal of the 2012-2013 study was to help the state's investor-owned utilities gain a better understanding of the struggles of farmers, ranchers, agricultural processors, and dairymen in California. The subsequent 2013 and 2014 forums demonstrated that the agricultural community is interested in learning about technologies, programs, and practices to support their sustainability goals and welcomes opportunities to meet with and discuss opportunities to work with SCG more effectively.

Navigant based that seminal study conducted in 2012-2013 on more than 200 telephone and field-based interviews. The study's final report and executive summary pointed out the need to consider all of the agricultural segments in more depth, especially the many agricultural and post-harvest processing (PHP) customers operating in the southern part of the Central Valley serviced by SCG. Specifically, that study demonstrated the following:

- Irrigated agriculture, PHP, dairies, and animal production account for more than 50% of total gas sales within the agriculture sector; within that segment, the majority of gas is used for space heating, drying, and other PHP requirements.
- Relative to other customer segments, many growers and producers do not prioritize energy metrics or monitoring, presenting opportunities for increased deployment of energy management systems (EMSs) and greater uptake of related utility incentives; this is especially the case with small to midsize growers and operators.
- Growers commonly communicate through grassroots networks that often share information about new technologies. There is also a high value placed on county and academically linked agricultural extension experts. A few leaders within the agricultural community have educated themselves and implemented a number of basic to advanced energy efficiency measures; these leaders suggested that technology demonstrations and other collaborative programs might help the rest of the industry move forward.

The two subsequent agricultural forums provided an opportunity for growers, agricultural SMEs, and agricultural professional association leaders to do the following:

1. Identify and share best practices related to natural gas and water usage.
2. Discuss the need and opportunities for EMSs and other control systems.
3. Identify program and other emerging technology approaches to accelerate and deepen energy savings with targeted customer segments.

The 2012-2013 Market Characterization Study and the two subsequent forums demonstrated that the agricultural sector was experiencing dramatic stress on all fronts, from the impact of drought to shifts in market tastes, adoption of water and energy conservation systems and practices, and the exploration of new and diverse crop



approaches, especially organic production. These prior studies and forums set the stage for this Crop Switching Project.



THE CONTEXT OF CALIFORNIA AGRICULTURE

The Alliance commenced secondary research on crop replacement by identifying the most replaceable crops and their most suitable replacements. Primary research then commenced with SMEs and growers to vet these replacements. In the course of the secondary and primary research, the Alliance learned that powerful market conditions would inhibit any crop replacement strategy. The Alliance researchers also identified and examined alternative program options for future energy efficiency offerings.

Current Market Trends

Market-based crop replacement is already underway in Southern California. The Alliance confirmed this through interviews with SMEs and a review of current media reports. In addition to the mega drought, crop replacement is already underway because of three factors:

- 1. Declining dairy production:** The combination of drought conditions and California's regulatory regime has become so challenging that some dairy operations are either closing their doors or moving to nearby states. This has reduced demand for forage such as alfalfa and grass hay. As such, traditional hay producers are looking for new crops for their land.
- 2. A perception that tree nut prices will increase:** Demand for pistachios, almonds, and walnuts remains robust. Even so, some acreage has gone out of production due to the drought. The result is increased prices, with some existing operations generating revenue of \$10,000 per acre compared to \$1,000 per acre for many field or row crops.
- 3. Broadly available capital:** Food processors and hedge funds are purchasing cropland or leasing viable acreage for producing high-value vine and tree nut crops. Rarely, if ever, in the last half-century has capital on this scale been available for crop production in California.

The combination of drought conditions and the three factors described above have resulted in market-induced crop replacement within SCG's service territory. Examples include the following:

- Cultivation of vineyards on land that previously grew alfalfa for dairy cows. The planting and management of new vines is a considerable investment, but the production value per acre will increase and the water consumption will decrease. However, new raisin and wine production will, in turn, increase natural gas consumption from expanded processing capacity.

- New planting of tree nut acreage will replace trees already taken out of the ground. While new trees consume less water than mature trees, new cultivation will be a net step backwards for water conservation and will eventually lead to increased natural gas consumption.

Crop Switching Viability

In the context of these market trends, programming that attempts to induce the replacement of a water-intensive crop with a less water-intensive crop may not be viable on a widespread basis. The worldwide demand for specific crops may be a stronger force than program dollars or sponsored education. However, programs that promote new cropping systems that leverage existing market trends may still have value to customers of SCG.

Further, crop switching has been taking place for decades, mostly driven by market changes. Today, water shortages and new water laws throughout California are making it difficult for some farmers to maintain water-intensive crops. Most of the current crop switching includes the conversion of rangeland/alfalfa to high-value fruit and nut crops, some of which require more water and deeper pumping but produce larger economic returns. In the past decade, walnut, almond, pistachio, and vineyard crops dominated as go-to crops. Market trends toward these thirsty crops, the increased costs of obtaining groundwater through deep wells, and increased frequency of deficit irrigation from poor water quality led one expert to predict that growers will move north, outside of SCG territory, in the next 5-10 years.

Because market-based crop switching is already underway in California, the Alliance refined its examination to two specific subcategories of crop switching: transition of land from traditional farming practices to organic farming practices and early orchard tree replacement. Gas and water savings would accrue from the non-use of farmland during the transition or initial grow out of the crops. Unfortunately, the Alliance's back of the envelope calculations indicate that the financial costs of not growing crops for three to five years outweigh the benefits by more than any reasonable incentive amount. The — transition to organic growing reduces yields and early tree replacement eliminates harvest would incur costs that utility incentives would be unlikely to offset.

INPUT FROM LEADING GROWERS

The Alliance research team arranged meetings with two growers of high value crops and one SME in the coastal region of California with the intent to identify existing or proposed practices and strategies that would foster natural gas conservation. The selection favored those individuals and/or companies that are either significant users of natural gas or are engaged in practices that may rely heavily on natural gas in the future. The SME interviewed is actively engaged with scores of small to midsize farmers throughout the coastal region and has a 40-year history of agricultural research. Both of the growers and the majority of agricultural clients advised by the SME are SCG customers.

SME No. 1: Greenhouse Grower

The Alliance team interviewed a grower operating large-scale greenhouse nursery operations for 43 years and who follows a tradition inherited from his father and extended family in Europe and the United States. He was interviewed in 2011 as part of the large agricultural study conducted in 2011-2012. This grower and his family are highly respected in the regional and national greenhouse segment, active in professional associations, and familiar with traditional SCG programs and services.

The company's owner estimates that that at least 10% of their operating expense consists of natural gas expenses, which the company primarily uses for heat generation in their greenhouses. The company owner believes that SCG could contribute to energy savings and energy efficiency by doing the following:

- Provide more financial support and incentives to install and replace lining cloth and heat curtains for greenhouses.
- Provide support not just for lining (lifecycle of about 5-6 years) but also for the hardware, which can represent 80% of the total costs and has a lifecycle of about 20 years.
- Provide support for the installation of a second lining system at approximately six inches from the first to implement energy savings (SCG does not currently support more than one lining system).
- Promote and support innovation concerning heat storage and energy generation, such as systems that capture carbon dioxide (CO₂) during the day and circulate hot water at night (this is being done at European locations).
- Provide financial and technical support for software updates that would allow for more efficient control of energy and water usage across systems and would reduce manpower (current systems are more than a decade old and do not benefit from technical/software upgrades).

- Provide support and technology to implement soil using steam blankets, which have been proven to reduce energy use in half—such blankets have a lifecycle of 3-5 years (more research on this application should be conducted and could be the basis for a pilot).
- This grower believes that he and his greenhouse colleagues epitomize the sustainable/green movement in agriculture as they are fully organic—to the point of growing their own bacteria to enhance greenhouse production.

He also commented that his operation, like those of his fellow greenhouse/nursery colleagues, is stressed by low-cost imports that are invariably not “green” or certified organic. The greenhouse/nursery growers along the coastal route from Camarillo to Santa Maria represent a large and threatened group of SCG customers and should be considered as an opportunity for SCG, to help pilot and support current and advanced technologies or systems that could help this segment survive and even prosper.

SME No. 2: Innovative Agribusiness Owner

The next company the Alliance team visited applies novel technologies and state-of-the-art growing systems to its new greenhouse structures and primarily uses natural gas for heating. The company is a privately owned (40 investors) horticulture firm that provides millions of seedlings to growers throughout California. A representative of this company also served as one of the Alliance team’s guest speakers at the Tulare forum in 2014.

Among the over 200 agricultural customers interviewed by the Alliance in 2011-2012, this company operated the most advanced field operation. For example, the company uses a sophisticated water pumping/recycling system, a condensing boiler for heating subsurface water lines for frost protection, ground-mounted double-blowers to warm surface air, and retractable roofs with small motors to move warm air. The company has also invested in state-of-the-art direct-fired heaters from Italy to warm enclosed nursery areas and has built the system from the ground floor up (seven years old) to make use of the most efficient and effective energy and water technologies. The Alliance team interviewed the operations manager at this company.

The operations manager indicated that SCG could contribute to energy savings by doing the following:

- Work with growers in developing and implementing water treatment (including addition of organic nutrients) and recycling systems (the company believes that one or more El Niños may lull stressed-out growers into thinking that everything

- is okay but that the reality of climate change is that more must be done with less or agribusiness will not be able to economically survive in the near term).
- Work with growers in developing and implementing technologies that lead to greater heat retention potential.
 - Work with growers in developing and implementing strategies aimed at the mechanization of production phases, such as at the end of the seeding line, where natural gas-powered loading systems (i.e., robotics) would take place in the field (compressed natural gas in conjunction with tractor motor power), thus reducing the need for labor.
 - Work with growers in developing and implementing infrared technologies aimed not just at heating greenhouses for growth but also for pest control, especially in organic production; this may become more and more relevant as organic seed production at the company will likely grow from the current 10% to an estimated 30% of total production over next five years.
 - Work with oil producers from nearby drilling sites (many drilling sites can be found in all agricultural areas of California) to redirect and use natural gas that would otherwise be flared; the company has signed an agreement in this area and would welcome SCG cooperation to craft an operation that makes sense for the company, the drilling companies, and SCG.

SME No. 3: Organic Agriculture Specialist

The SME interviewed by the Navigant team is a specialist in organics and a 40-year-plus veteran of agriculture consulting. He primarily works with small to midsize growers throughout the coastal region. He believes that one of the most significant opportunities that SCG should consider is partnering with the new generation of small (primarily organic) farmers that typically generate less than \$500,000 of product per year and that have smaller parcels (3-25 acres). He is a champion of a new and growing production system that introduces varieties of coffee in existing or newly planted orchards to maximize water and nutrient use while gaining a second crop. The field of organic agriculture is growing and will lead to a greater need for energy to support the PHP of coffee beans. SCG may see this as a new and relatively unexplored sector in which to claim a new and substantial presence.

This SME is a highly respected professional committed to working with the smaller growers, especially growers typically focused on organic operations and striving to maximize production from relatively small acreage. He thinks that SCG could make a big difference by providing consulting support from a new generation of account executives who are green/sustainability focused and who can help provide both the technological and financial support to make Southern California a leader in innovative, organic, and non-traditional crop production.

Common Grower Opinions

Current issues that all growers seem to have in common concerning their relationship with energy providers include the following:

- Support from energy providers primarily benefits large growers with energy/water operations staff, while the smaller grower does not have the time or interest to pursue opportunities in these areas.
- Utilities (including SCG) do not provide back-office or automated support to qualify for and submit applications for rebates and incentives.
- A need exists for professional consultant visits (utility and vendors) tailored to address specific concerns.
- There is a lack of support for innovative strategies from energy providers.
- A need exists for recognition and support from SCG and other utilities for small growers that are committed to organic practices and who are not currently supported in any consistent fashion.

While crop switching may not prove viable, the Alliance's interactions with the agricultural community provided insights that could still prove valuable to SCG's program design, as the next section of the report describes.

FUNNEL/FILTER EXERCISE

A funnel/filter exercise is an activity designed to facilitate the consideration and selection of various options through a narrowing process that characterizes each option using a defined criteria. The first step in this process is to collect all possible options for consideration. Since the previous tasks illustrated the limited potential for crop replacement, the Alliance decided to consider a broader range of programming options through this funnel/filter exercise.

Based on grower input from Tasks 2 and 3, as well as input from forum participants from previous years, the Alliance’s researchers developed an overall list of potential programming options (both individual measures and specific activities) to be considered in this project (see Table 1).

Table 1. Agriculture Program Options

| Measures | Activities |
|---|---|
| Rebates for green house lining cloth, curtain, and film | Retrocomissioning of greenhouse operations |
| Rebates for second greenhouse lining system | Promote innovation in daytime CO ₂ capture and nighttime hot water circulating systems |
| Incentives for greenhouse lining frames | Provide back office technical and form processing support for farm-to-table organic growers |
| Incentives for soil steam blankets | Update SCG agriculture website to attract and address the needs of small to midsized growers |
| Incentives for water treatment and recycling | Conduct additional agriculture forums with account executives and Alliance consultants |
| Incentives for condensing boilers for subsurface soil warming | Help small growers achieve organic certification through systems support |
| Rebates for direct-fired heaters | Provide intercrop growing system support |
| Incentives for new infrared heating technology | Audit PHP operations for process improvements |
| Rebates for high tunnels (specific to berry production) | Mechanize production phases with gas-powered loading systems |
| Incentives for computer-controlled operations | Partner with fossil fuel extractors to capture flared natural gas on growers’ land |
| Incentives for retractable greenhouse roofs | |
| Incentives for aquifer recharge | |

Source: Alliance analysis

These agricultural program options were first filtered using following criteria. Options requiring deep research or with unknown readiness were filtered out, and the ready-to-

go options or those requiring minor measure analysis were advanced to the funnel phase.

Table 2. Filter Phase Criteria

| Determination | Criteria |
|-------------------------|--|
| Ready-to-go | Off-the-shelf solutions exist and are practiced by other utilities and mainstream market actors. |
| Measure analysis needed | Research is necessary to determine the applicability of the measure or activity for SCG, but it is in use at other utilities and/or by sophisticated market actors. |
| Deep research needed | Substantial research (>8 hours) necessary to characterize the potential of the measure or activity, but it is in use at a few utilities or cutting-edge market actors. |
| Readiness unknown | Creating a program with recoverable expenses seems unlikely; regulatory reform may first be necessary. |

Source: Alliance analysis

The Alliance research team’s application of these criteria advanced a subset of 12 measures and activities to the funnel phase:

- PHP audits
- Water treatment and recycling
- Additional agricultural forums
- Updating the SCG agriculture website
- Direct-fired heater rebates
- Infrared heater rebates
- Greenhouse lining rebates
- Greenhouse lining frame rebates
- High tunnel rebates
- Greenhouse secondary lining rebates
- Greenhouse retrocommissioning
- Condensing boiler rebates

The funnel assessment for each of the measures and activities is listed in Appendix C: Funnel/Filter Exercise Overview.

The funnel phase narrowed these 12 options based on three additional criteria, depicted in Table 3.

Table 3. Funnel Phase Criteria

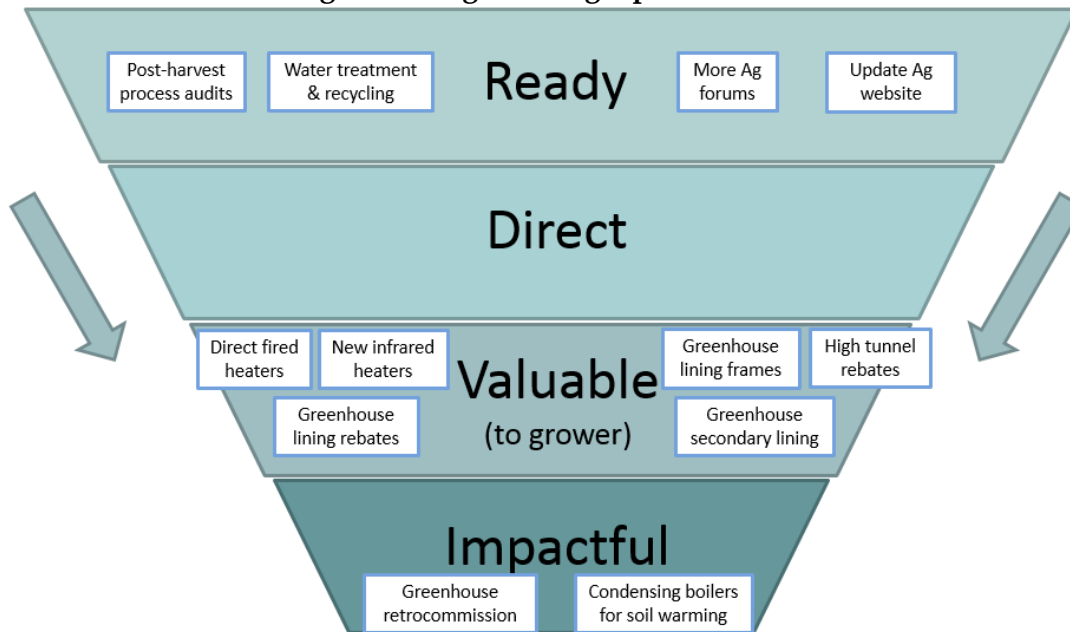
| Determination | Criteria |
|--------------------|---|
| Direct | Direct gas savings is recoverable energy efficiency spending. Indirect gas savings, such as reduced need for soil fertilizer, is not recoverable. |
| Valuable to grower | What is helpful to the gas company is not necessarily helpful to the grower. Only options valuable to growers would meet this criteria. |
| Impactful | Wide scale applicability to multiple agriculture subsectors—e.g., not just for a portion of greenhouse growers. |

Source: Alliance analysis

Four options (post-harvest process audits, water treatment & recycling, more agricultural forums and an updated website for utility programs) were “ready” for implementation but none could provide direct natural gas savings. Six other options (direct fired heaters, new generation infrared heaters, greenhouse lining, greenhouse secondary lining, greenhouse lining frames and high tunnels) would provide direct savings but were applicable only to growers in the greenhouse segment of the agricultural community.

Using these criteria, the research team determined that greenhouse retrocommissioning and rebates for condensing boilers for soil warming were the most viable options for new programming, as shown in Figure 2. These measures were the only options that were currently ready for deployment and broadly valuable to growers across the region in multiple segments of agriculture.

Figure 2. Programming Options Funnel



Source: Alliance analysis

Additional detail regarding the funneling step is available in Appendix C: Funnel/Filter Exercise Overview.

CONCLUSIONS

The California agricultural sector constitutes a vital regional and national resource that is undergoing dramatic stress due to changes in market demands, increasing water scarcity, changes in labor availability, the impact of environmental regulations, and other forces. This is especially true in the Southern California agricultural sector, which is experiencing the perfect storm, as the intersection of these forces is most pronounced.

The initial goal of this study was to qualify whether a supported program of crop switching would benefit Southern California's growers by decreasing costs and increasing the economic value of crops, which would also result in natural gas savings by SCG. This relatively short-term research project, that included extensive secondary research and focused on primary field data gathering, did not conclude that crop switching would result in dramatic or even significant natural gas savings. This project did generate other results and recommendations that are perhaps more significant for SCG to build upon as long as there is a genuine commitment to provide value-added programs for growers and processors in the Southern California service area.

The fundamental finding is that growers continue to change crop practices based on market drivers, environmental conditions, and economic capability and necessity. While the cost of natural gas as an operating requirement can be significant for specific agricultural segments (i.e., greenhouse/nursery), the more pressing needs for growers and processors focus on meeting changing consumer demands, dealing with the impact of the drought, and updating aging systems and practices to optimize production and reduce operating expenses. The SCG-supported agricultural forums in its service area demonstrated that growers and processors are willing to exchange best practices and provide input to the utility. This most recent field research project built on the momentum and contributions from the previous forums held in Santa Barbara and Tulare with the initial goal of focusing on the potential natural gas savings associated with crop rotation. This research project evolved quickly from identifying the current status of crops being cultivated and processed to identifying the program opportunities perceived to hold the most value for growers and processors.

The research completed during this project identified SCG as positioned to respond to the needs of growers through the following actions:

- Implementing the most readily adoptable measures and activities: Promoting and rebating greenhouse retrocommissioning as well as condensing boilers for soil warming.
- Exploring the potential for less readily available options for agricultural programming through additional research; these include measure analysis or detailed market segment characterization.

- Hosting a series of agricultural forums that are segment-specific and are promoted and co-delivered by agriculture SMEs, SCG account executives, grower professional associations, and the innovators operating in the fields.
- Focusing on the small to midsize growers that historically have not been serviced by the account executives and field services staff of SCG.
- Making a commitment to help sustain California agriculture in their service area by considering the full impact of both direct and indirect natural gas savings opportunities.

APPENDIX A: FIELD DATA GATHERING INSTRUMENT FOR GROWERS

Date: _____

Interviewer(s): _____

BASIC INFORMATION

Respondent name: _____

Name of Company/Farm: _____

Location: _____

Role within company: _____

Agriculture sector: _____

Previous Experience (if applicable): _____ **B. AG**

SEGMENT

4. How many years has the farm been in operation? _____ years

5. Is this a family business? Y N

6. Describe your farm's production

- a. Acreage
- b. Acres irrigated
- c. Form of irrigation
- d. Presence of greenhouses Y N
- e. PHP on site Y N
- f. Diversified production Y N
- Explain _____
- g. Other

7. Has the crop history changed over time? Y N

a. Describe how and when

8. If your current crops became unprofitable who or to what sources of information would you turn?



15. Are you considering switching crops in response to the current drought?

Y N

a. FROM _____ TO _____

16. Do you know of anyone in the area who has switched crops?

Y N

a. FROM _____ TO _____

17. <share our top 20 list> Can you identify potential crop replacements based on this list?

a. FROM _____ TO _____

b. FROM _____ TO _____

c. NO. List reasons

18. **What are the important considerations to make when thinking about what to replace a crop with? What criteria did you use for your suggestions?** <probe deeper if the response includes any of the following: similar growing conditions (soil type, pH, temperature, etc.), processing requirements, transport requirements, customer market, and the expertise or training of labor>

19. **What are the barriers to replacing a crop** (If needed, ask about these barriers: affording necessary equipment, guidance from agricultural experts, and government incentives)?

20. **Which of these barriers is the most important to speed the replacement process?**

21. **Assuming those investments are possible, what kind of timeframe is realistic for replacing most of a crop? 3 years? 6 years? 9 years? 15 years?** <If respondent responds that it obviously it depends on the specific crop, invite the respondent to provide specific examples and timeframes for those examples>

CLOSING

- 22. Are there any programs in California that you feel are particularly successful at educating growers or influencing the selection of crops that they field <probe for the program name, not just the name of the agency or office that administers it>?**
- 23. Gas savings will be a future component of our research. Are you aware of any studies or experts who have studied the gas footprint, especially in post-harvest processing, of the crops we talked about today?**
- 24. Are there any other growers you can suggest we speak with for this study?**
- a. If so, could you please provide their name and contact information?**

APPENDIX B: CROP REPLACEMENT PRODUCTIONS IN SOUTHERN CALIFORNIA

As noted previously in this report, the Alliance team used county crop reports from the 12 counties in SCG territory to obtain the production figures for most of the crops in each county. Data entry focused first on the top 10 crops as defined by the county crop reports (either county production value or county production tonnage) and put a lesser focus on crops with lower dollar values. The data entry from the county crop report did not include every crop in each crop report. The production totals below are accurate in most cases but may exclude marginal crop production in some counties. The Alliance team focused on crops with the most economic activity because candidate replacements would have supply chains, market features, and knowledgeable experts to support the transition successfully. An ideal replacement crop would be new to the grower but not new to the market.

The team then aggregated the crop production figures into three generally recognized regions, each with production focused on different crop families and characterized by different climate zones: Coastal, Lower San Joaquin, and Southern Inland. Table 4 details the counties that compose each region. The analysis excluded Orange and Los Angeles counties because their crop production is frequently reported in large miscellaneous categories that could not be further analyzed.¹

Table 4. Counties Composing Each Agricultural Region

| Coastal Region | Lower San Joaquin Valley | Southern Inland Region |
|-----------------|--------------------------|------------------------|
| San Luis Obispo | Fresno | Imperial |
| Santa Barbara | Kings | San Bernardino |
| Ventura | Kern | Riverside |
| | Tulare | |

Source: Alliance analysis

After calculating regional production tonnage for the majority of crops grown in each region, the Alliance team completed secondary research to obtain per ton water use estimates for each crop. The team multiplied this per ton water use estimate by the production tonnage for each crop to estimate the total water footprint of each crop in each region. SGC should target the crops responsible for the greatest water use in each region for replacement. The following pages identify the 15 crops with the largest water

¹ Per the U.S. Department of Agriculture (USDA) National Agricultural Statistics Service disclosure rules: "Where there are less than three producers of one product or where one producer is responsible for 60 percent or more of the product entering the marketplace, the product total must be combined with other products to avoid disclosure of the business affairs of the firms involved."

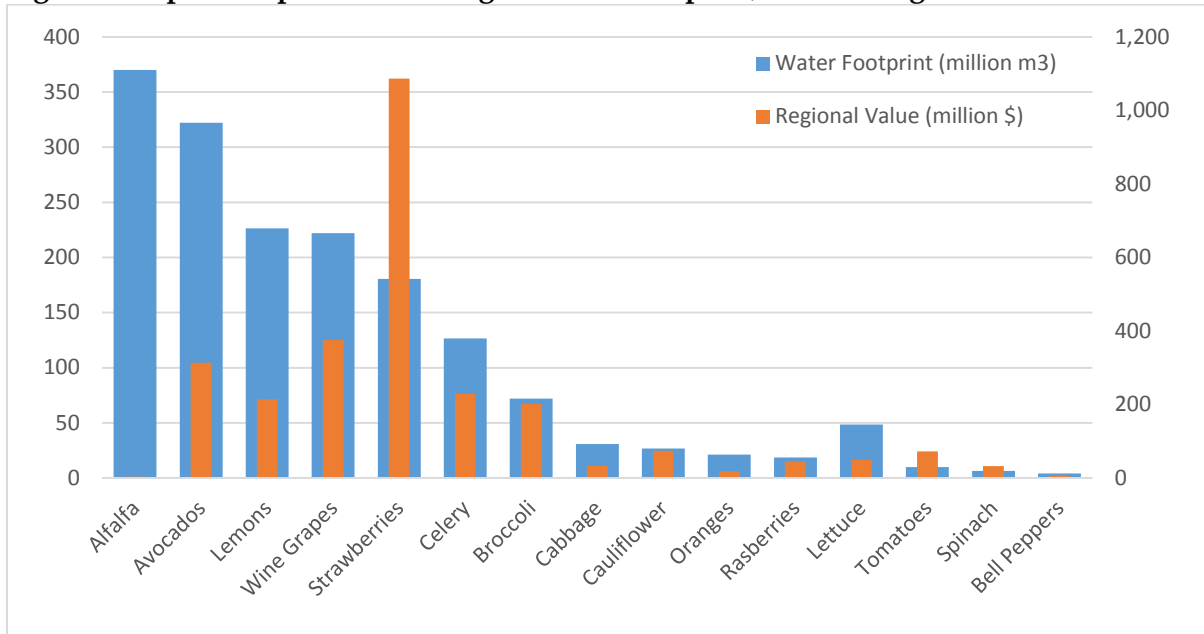
footprint. Please note that the y-axis scale changes between regions, thus the relative value and water use of crops are not comparable between regions.²

The Alliance team believes the most viable replacements for growers are crops of equal or greater value than what the growers are being asked to replace. Thus, to identify replacements for the candidate crops, the Alliance team used the production value of each crop to compute its per ton value and then normalized those values for the per ton water use. This analysis created a value/water use ratio, which delineates between low value/high water use crops like alfalfa and high value/low water use crops like tomatoes. For each region, a figure shows the 15 crops with the highest value/water use ratio.

The crops seen on the left of Figure 3 have a low value relative to their water intensity. The crops on the right have a high value relative to their water intensity. All things being equal, to reduce water use, replace crops on the left with crops on the right. However, as shown in Figure 3, there is no strict point at which the relationship between value and water change.

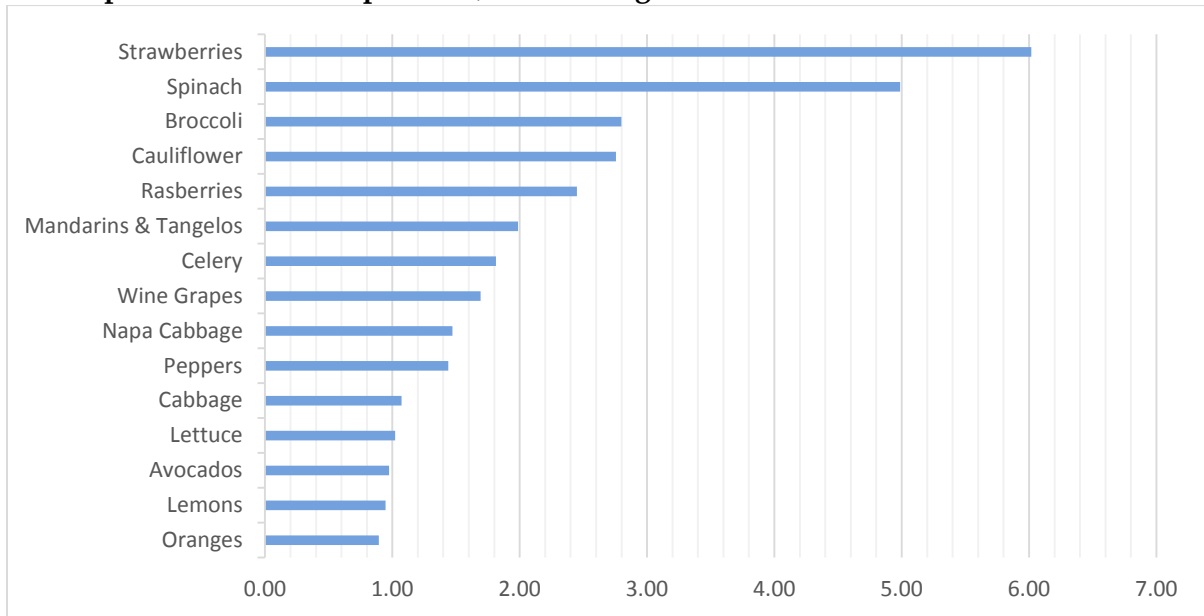
² For example, compare alfalfa in each figure. In all three figures it has a constant water-use intensity and its per ton value fluctuates less than 25% between regions. However, it appears to have a different relationship between value and water use in each region, demonstrating that the relative value and water-use of crops are not comparable between regions.

Figure 3. Top 15 Crops with the Largest Water Footprint, Coastal Region



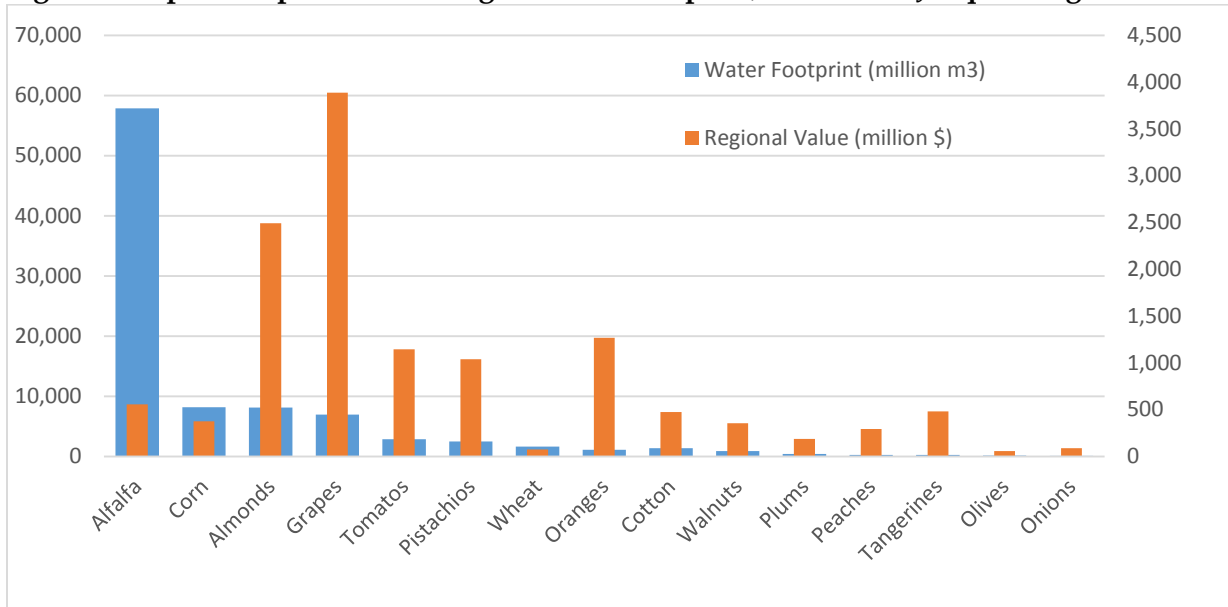
Source: Alliance analysis

Figure 4. Crops Ranked by Value to Water Ratio (Value per Ton/Water Use per Ton), Coastal Region



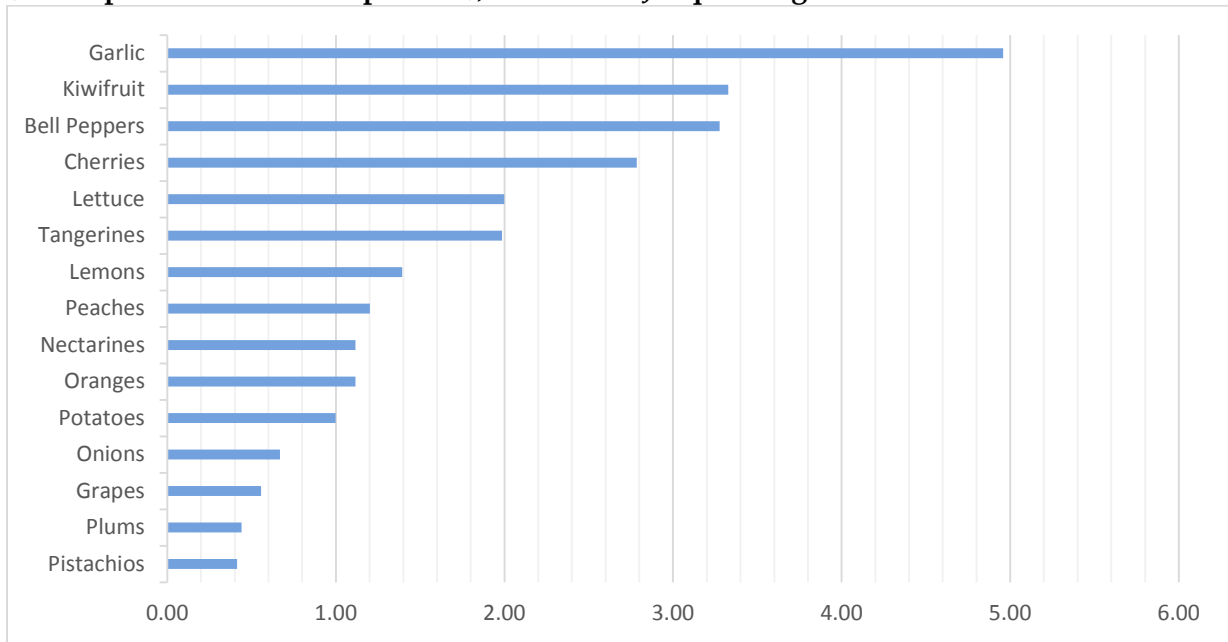
Source: Alliance analysis

Figure 5. Top 15 Crops with the Largest Water Footprint, Lower San Joaquin Region



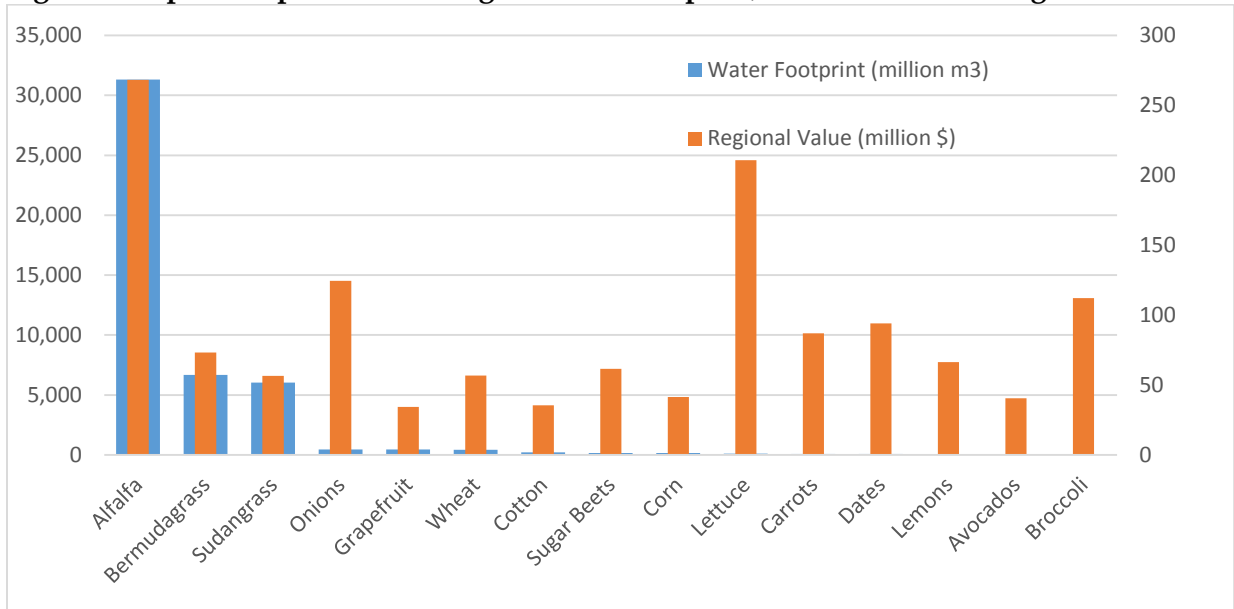
Source: Alliance analysis

Figure 6. Crops Ranked by Value to Water Ratio (Value per Ton/Water Use per Ton), Lower San Joaquin Region



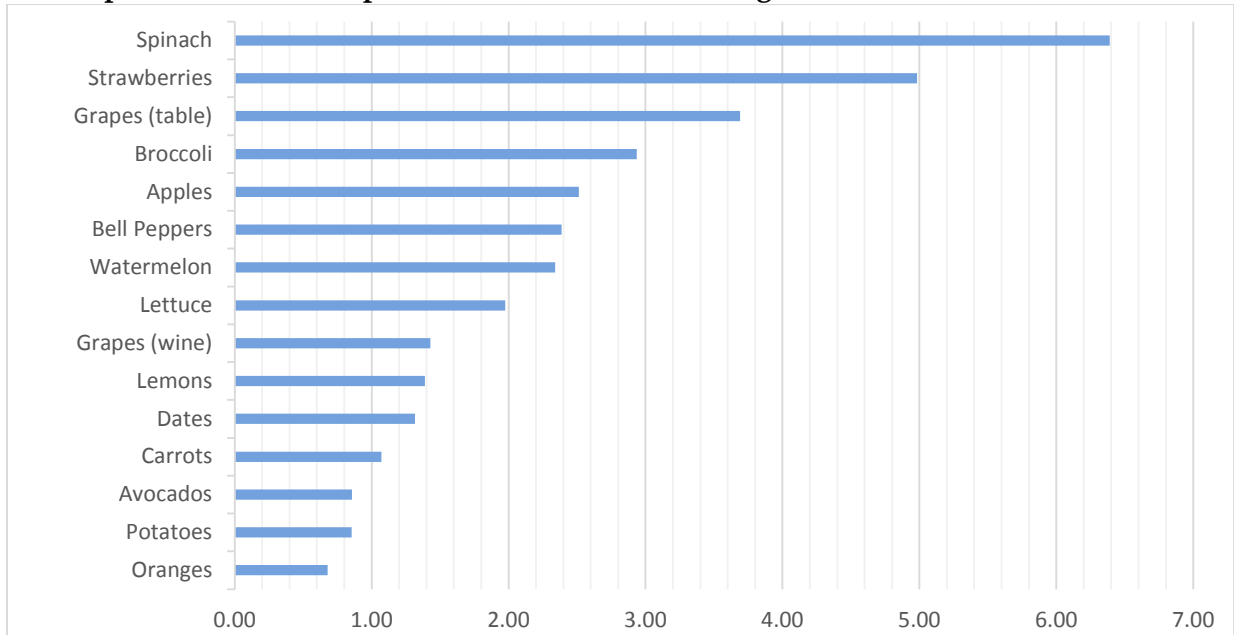
Source: Alliance analysis

Figure 7. Top 15 Crops with the Largest Water Footprint, Southern Inland Region



Source: Alliance analysis

Figure 8. Crops Ranked by Value to Water Ratio (Value per Ton/Water Use per Ton), Southern Inland Region



Source: Alliance analysis

Sources

The Alliance team used the following sources to complete the program scan and the estimate of therm savings potential for incenting a switch to organic row crops or early tree replacement.

Agriculture Energy Research:

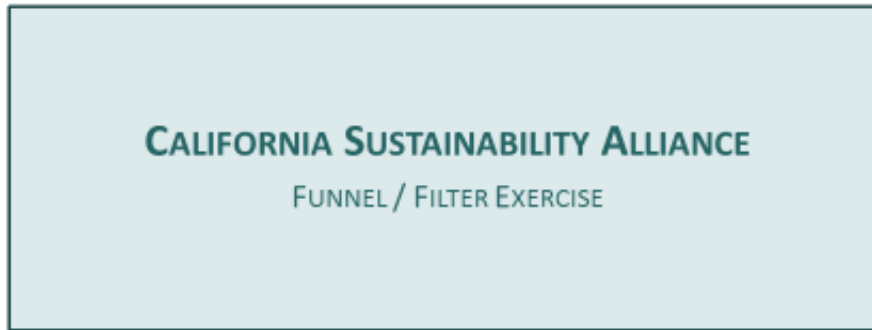
1. California Public Utilities Commission: Agricultural Programs (2013-2014) <<http://www.cpuc.ca.gov/PUC/energy/Energy+Efficiency/Agricultural+Energy+Efficiency+Programs.htm>>
2. California Energy Commission // Irrigation Training and Research Center: Consultant Report (2011) <<http://www.itrc.org/reports/awee.htm>>
3. Cal Alumni Association // UC Berkeley (2014) <<http://alumni.berkeley.edu/california-magazine/summer-2014-apocalypse/greener-plants-researchers-aim-curb-energy-glutton-food>>
4. California Energy Commission // CALIFORNIA ENERGY DEMAND 2014–2024 REVISED FORECAST (2013) <http://www.energy.ca.gov/2013publications/CEC-200-2013-004/CEC_200-2013-004-SD-V1-REV.pdf>
5. Energy Use and Greenhouse Gas Emissions from Crop Production Using the Farm Energy Analysis Tool (2013). *BioScience* 63: 263–273. ISSN 0006-3568, electronic ISSN 1525-3244. American Institute of Biological Sciences. <<http://bioscience.oxfordjournals.org/content/63/4/263.abstract>>
6. Gleick, Peter. (2015). Impacts of California’s Ongoing Drought: Hydroelectricity Generation. The Pacific Institute <<http://pacinst.org/publication/impacts-of-californias-ongoing-drought-hydroelectricity-generation/>>
7. PG&E Agriculture and Food Processing Rebate Catalog (2015) <http://www.pge.com/includes/docs/pdfs/mybusiness/energysavingsrebates/rebatesincentives/agricultureandfoodprocessing_catalog.pdf>
8. PG&E Energy Solutions for Post-Harvest (2015) <http://www.pge.com/includes/docs/pdfs/mybusiness/energysavingsrebates/moneybacksolutions/af_fp/post_harvest/post-harvest_fs.pdf>
9. PG&E Currents (2014) <<http://www.pgecurrents.com/2014/02/13/farmers-get-help-during-drought-as-pge-gets-cpuc-approval-to-delay-rate-changes/>>
10. Duncan, Roger. (2014). UC Cooperative Extension. “Where and Why Will Tree Crops Replace Rangeland.” <<http://www.carangeland.org/images/1020Duncan.pdf>>
11. NASA. (2015). NASA: California Drought Causing Valley Land to Sink. <<http://www.jpl.nasa.gov/news/news.php?release=2015-273>>

Organic Agriculture:

1. Statistical Review of California's Organic Agriculture 2009 – 2012. (2013). Agricultural Issues Center: University of California. <http://aic.ucdavis.edu/publications/StatRevCAOrgAg_2009-2012.pdf>
2. California Department of Food and Agriculture (CDFA): Organic Programs. (2015) <http://www.cdfa.ca.gov/is/i_&_c/organic.html>
3. CCOF Magazine (Spring and Fall 2015). California Certified Organic Farmers- USDA. <<http://www.ccof.org/>>
4. National Organic Program Strategic Plan 2015-2018. USDA Agricultural Marketing Service. <<http://www.ams.usda.gov/sites/default/files/media/NOP-2015StrategicPlan.pdf>>
5. Financial competitiveness of organic agriculture on a global scale. Proceedings of the National Academy of Sciences (PNAS). (2015). <<http://www.pnas.org/content/112/24/7611>>
6. Dr. Karen Klonsky, UC Davis. The Profitability of Organic Agriculture: Lessons from the Sustainable Agriculture Farming Systems Project (SAFS). <<http://aic.ucdavis.edu/publications/ProfitabilityOrganicAgriculture.pdf>>

APPENDIX C: FUNNEL/FILTER EXERCISE OVERVIEW

On December 3, 2015, the Alliance team conducted a funnel exercise to determine which potential ideas had the best applicability to both SCG and growers. Over a WebEx presentation, the Alliance team discussed the merits and limitations of each idea, arriving at two measures that satisfy all four criteria. The team determined greenhouse software retrocommissioning and condensing boilers for soil warming were ready technologies/approaches with direct gas savings that would be valuable to growers as well as generate meaningful savings for the utility. The slide deck used during this WebEx presentation is provided below.



December 3, 2015



Funnel Input Parameters and Partners

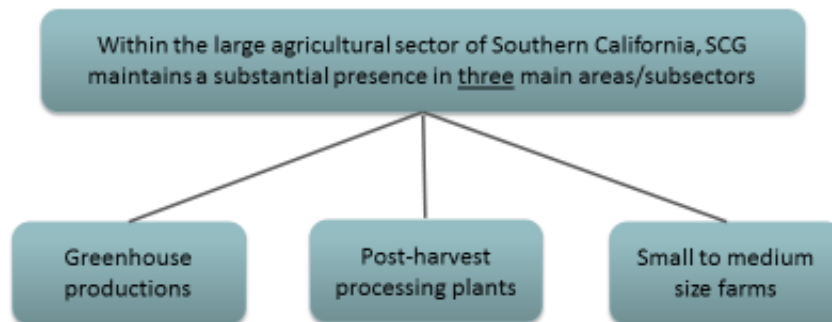
- Four primary input contribution sources
 - Extensive secondary data research of Ag focused water-energy and crop switching policies, programs, and new initiatives (available via DropBox)
 - New interviews with several Subject Matter Experts (SMEs), including UC AG and County Extension Professionals (available via DropBox)
 - Grower input from two previous Alliance forums held in 2013 and 2014 (available via DropBox)
 - New input from growers for this project gathered summer 2015 (to be added to DropBox)
- Consideration of SCG service area geographical regions
 - Geographical regions: Southern San Joaquin, Coastal, Inland Empire/Desert
- Primary focus on crop replacement, inter-cropping, and organic opportunities



2

Funnel / Filter Exercise – Areas of Interest

Areas of greatest implementation potential for SCG



SCG also can expand its presence by exploring opportunities and measures that pertain to the expansion of the organic market and the development of new intercropping systems with substantial post-harvest processing needs.



3



Readiness Categories

1. Ready-to-go. Off the shelf solutions exist and are practiced by other utilities and mainstream market actors.
2. Measure analysis needed. Research is necessary to determine the applicability of the measure or activity for SCG, but it is in use at other utilities and/or sophisticated market actors.
3. Deep research needed. Substantial research (>8 hours) necessary to characterize the potential of the measure or activity but it is in use at few utilities or cutting-edge market actors
4. Readiness unknown. Creating a program with recoverable expenses seems unlikely; regulatory reform may first be necessary.



Measures (direct savings, equipment, financial incentives)

| Ref. # | Program Offering | Ready-to-go | Measure analysis needed | Deep research needed | Readiness unknown |
|--------|---|-------------|-------------------------|----------------------|-------------------|
| M1 | Rebates for greenhouse lining cloth, curtains & films | x | | | |
| M2 | Rebates for second greenhouse lining system | x | | | |
| M3 | Incentives for greenhouse lining frames | x | | | |
| M4 | Incentives for soil steam blankets | | | x | |
| M5 | Incentives for water treatment and recycling measures | | x | | |
| M6 | Incentives for condensing boilers for subsurface soil warming | | x | | |
| M7 | Rebates for direct fired heaters | | x | | |
| M8 | Incentives for new infrared technology | | x | | |
| M9 | Rebates for high tunnels (specific to berry production) | x | | | |
| M10 | Incentives for computer-controlled operations | | | x | |
| M11 | Incentives for retractable roofs for greenhouses | | | x | |
| M12 | Incentives for aquifer recharge | | | | x |



Activities (indirect savings, services, technical consulting)

| Ref. # | Program Offering | Ready-to-go | Measure analysis needed | Deep research needed | Readiness unknown |
|--------|---|-------------|-------------------------|----------------------|-------------------|
| A1 | Retrocommission greenhouse operations | | x | | |
| A2 | Promote innovation in daytime CO2 capture and nighttime hot water circulating systems | | | x | |
| A3 | Provide back-office technical and farm processing support for Farm to Table organic growers | | | | x |
| A4 | Update SCG Ag website to attract and address the needs of small-to-mid-sized growers | x | | | |
| A5 | Convene AE's with Alliance consultants to conduct more AG segment focused forums | x | | | |
| A6 | Help small growers achieve organic certification through systems support | | | x | |
| A7 | Provide intercrop growing system support | | | x | |
| A8 | Audit post-harvest operations for process improvements | | x | | |
| A9 | Mechanize production phases with gas-powered loading systems | | | x | |
| A10 | Partner with fossil fuel extractors to capture flared natural gas on growers land | | | | x |



6

Funnel Criteria – prioritizes offerings which are:

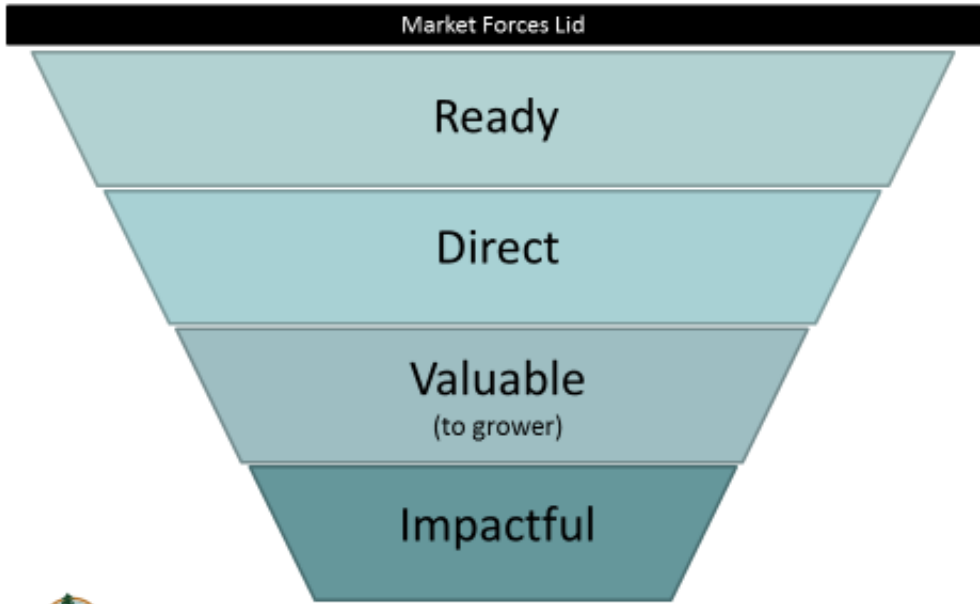
1. Ready. Possible measures and activities already placed in funnel according to readiness.
2. Direct. Direct gas savings is recoverable EE spending. Indirect gas savings, such as reduced need for soil fertilizer, is not recoverable.
3. Valuable to grower. What is helpful to the gas company is not necessarily helpful to the grower.
4. Impactful. Wide-scale applicability to multiple ag sub-sectors, e.g., not just for a portion of greenhouse growers.



7

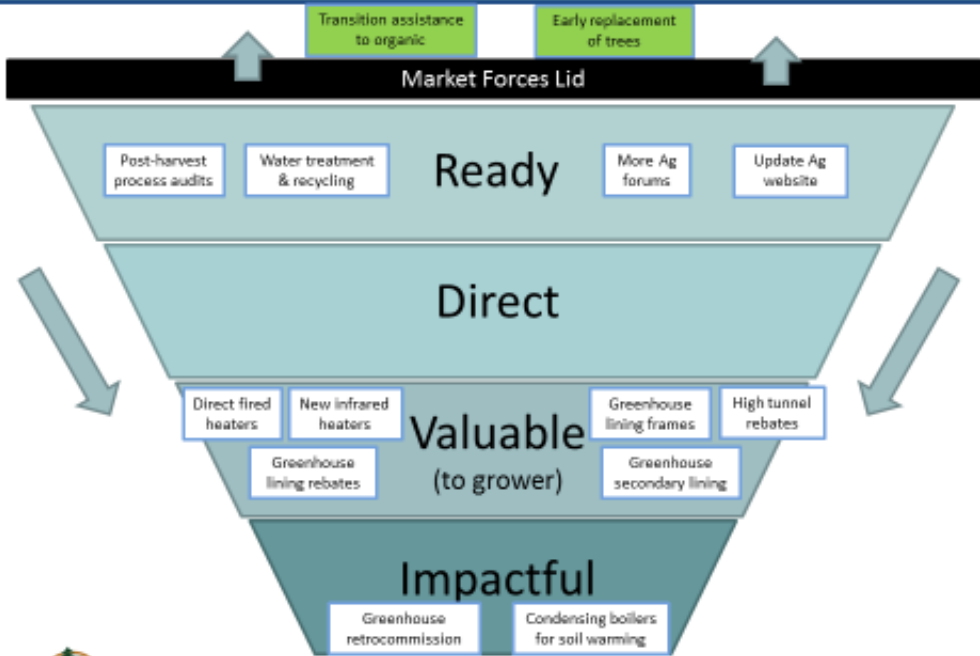


Funnel / Filter Exercise – Funnel



8

Funnel / Filter Exercise – Funnel



9



Ready-to-go

1. Rebates for replacing greenhouse lining cloth, curtains, and films at shorter intervals (lifecycle 5-6 years)
2. Rebates for installing secondary layers of greenhouse lining cloths and film
3. Provide hardware incentives for lining frames (80% of total cost of lining and curtains and longer lifetime)
4. Rebates for high tunnels for berry growers

Analysis needed

1. Incentives for growers to implement water treatment (including addition of organic nutrients) and recycling systems
2. Incentives for condensing boilers for subsurface soil warming
3. Incentives for directed fired heaters to address adverse climate and other conditions
4. Incentives for new infrared technologies for heating and pest control, especially in organic production



10

Ready-to-go

1. Partner SCG AG AE's with Alliance consultants to conduct more AG segment focused forums
2. Update SCG Ag website to attract and address needs of small-mid size growers

Analysis needed

1. Support software updates for existing computer control to retrocommission greenhouse operations and minimize energy and water use.
2. Audit post-harvest drying, canning, and other operations for traditionally industrial energy efficiency opportunities.



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 - Cinzia Fissore, Energized Solutions
 - Craig McDonald, Navigant
 - Chris Chambers, Navigant



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