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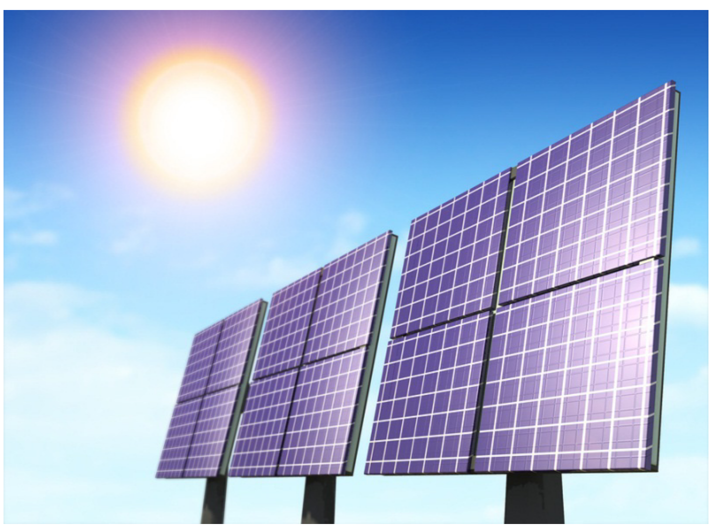
ENVIRONMENTAL SCAN

SOLAR INDUSTRY & OCCUPATIONS

Distributed and Utility-scale Generation

Southern California, Central Valley, South Central Coast, and the Bay Area

FEBRUARY 2012



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An Initiative of

ECONOMIC & WORKFORCE DEVELOPMENT through the CALIFORNIA COMMUNITY COLLEGES

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Mission: The Centers of Excellence, in partnership with business and industry, deliver regional workforce research customized for community college decision making and resource development.

Vision: We aspire to be the premier source of regional economic and workforce information and insight for community colleges.

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Contents

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And finally, this report would not have been possible without the research, writing, publishing expertise, and support of the following individuals on the Center of Excellence team:

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Statewide, the solar industry, currently accounting for close to 50,000 workers, is expected to increase by as many as 18,000 jobs by 2015.

— Center of Excellence Employer Survey

Executive Summary

Despite the recession, the solar industry is somewhat insulated from the economic recession and has experienced significant growth since 2006, when state legislation was passed to encourage its growth. Today, nearly 2,000 solar firms employing close to 50,000 workers are located in California. A recent workforce survey indicates the industry will continue to expand, adding between 18,000 and 24,000 jobs over the next three years, an increase of up to 49%. In the next year alone, the industry is expected to add between 6,800 and 8,500 jobs, with the San Francisco Bay Area increasing at a faster rate than any other California region.

Employment opportunities exist in both distributed generation and utility-scale subsectors of the solar industry. Within the field of distributed solar, there are more than 1,800 firms in California specializing in installation, manufacturing, and distribution. Among those, installation firms have the greatest number of employees and are projected to add between 8,000 and 10,000 jobs by 2015.

The objectives of this study were to identify workforce trends, job requirements and employment challenges, as well as document how community colleges across the state have responded to the demand for solar workers. To achieve these objectives, the Centers of Excellence (COE) surveyed solar industry employers and community colleges to determine if any potential mismatches exist between industry workforce needs and education and training. Key findings from this research effort include:

- Employment in utility-scale solar mainly involves short-term construction jobs. In general, about two jobs are created for every planned megawatt of a project.
- Within the distributed solar industry, jobs for installation occupations are projected to grow the fastest, increasing by 41% and adding over 5,800 jobs in the next year.
- The majority of employers report difficulty hiring for most of the occupations studied, with water or pool heating installers, sales and marketing occupations, and cost estimators being the most difficult to hire.
- Fifty-four community colleges in the state offer some type of solar training. The San Francisco Bay and the Los Angeles/Orange County regions lead the state in the number of solar courses and programs offered by community colleges.
- Of those surveyed, community college administrators and faculty identified a lack of employment opportunities for students as their greatest challenge.

Analysis of employer needs and college offerings indicate that community colleges have adequately addressed the demand for solar photovoltaic installers and do not need to start new programs to train for this occupation. However, potential skill mismatches on the labor market still exist and colleges are well positioned to address them. Our recommendations to colleges include:

1) expand the knowledge areas of their programs and courses to include other solar occupations, such as solar thermal installers and sales representatives/estimators,
2) strengthen partnerships with employers to develop internships, apprenticeships, and other programs in which students can gain work experience, and
3) develop and offer courses on the basics of energy production, power plant management, and solar technologies to address the needs of utility-scale solar projects.

Introduction

The adoption of solar technology across the world has gained momentum over the last decade. In large part this is due to an ever-increasing demand for energy. Annual global energy consumption is currently about 12 terawatts, and given the current rate of increase, world energy demand is expected to reach 30 terawatts within three decades.[1] At the same time, oil and gas prices are increasing while global demand for energy is outpacing the ability to locate and harvest new sources of fossil fuels. In addition, mounting concern over forecasts that global warming will be exacerbated by a continued reliance on fossil fuels and increasing carbon dioxide emissions have spurred a number of countries to provide incentives for large-scale renewable energy projects. Currently, the largest solar market in the world is Germany, followed by Japan. The United States is not far behind, as the third largest market.[2]

Despite the recession, demand for renewable energy has steadily increased. For the first time, renewable energy sources eclipsed fossil fuels in new power-plant investments, receiving $187 billion last year compared with $157 billion for natural gas, oil and coal, according to calculations by Bloomberg New Energy Finance.[3] Solar energy generation in particular is promising. This may be in large part due to the characteristics of solar energy compared to other types of renewable energy sources. Solar power relies on the sun, which is an abundant, reliable, and free energy source.

Given the historic importance of the solar industry in California and its incredible growth in recent years, it is critical that community colleges ensure that the state's workforce has the skills and knowledge to secure and maintain long-term employment in this field.

The California Community Colleges have charged the Economic & Workforce Development (EWD) Centers of Excellence Initiative to identify industries and occupations with unmet workforce development needs and introduce partnering potential for the college's programs. The Inland Empire/San Diego-Imperial and Central Valley/South Central Coast COE partnered on a comprehensive statewide study of the solar industry and occupations to provide colleges with industry-validated information on employment growth, skills preferences and deficiencies, educational requirements, and other pertinent labor market data.

In 2009, a white paper issued by the Bourns College of Engineering Center for Environmental Research and Technology (CE-CERT) at University of California, Riverside predicted a long-term need for training in operations, maintenance, and eventually decommissioning and recycling of solar installations.[4] The research conducted through the COE study confirms the type of training that is needed for solar industry employers and in which training areas community colleges need to focus more attention.

The Solar Industry & Occupations report focuses on three regions of California: the San Francisco Bay Area, Central California (including the Central Valley and Central Coast), and Southern California. The Greater Sacramento Region was studied in a separate environmental scan released in July 2011[5]. Some of those findings have been included in this report. Specifically, this environmental scan details the information on workforce demand within both distributed and utility-scale solar industries[6], analyzes current solar education and training offerings by community colleges, and provides recommendations for action in addressing industry workforce needs.

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[1] "Energy of the Future: Conservation + Renewable Energy." Renewable Power News, August 20, 2010. http://www.renewablepowernews.com/archives/1675.

[2] Environment California. http://www.environmentcalifornia.org/energy/million-solar-roofs/fact-sheet2/legislation.

[3] Morales, Alex. "Renewable Power Trumps Fossils for First Time as UN Talks Stall." Bloomberg News, November 25, 2011. http://www.bloomberg.com/news/2011-11-25/fossil-fuels-beaten-by-renewables-for-first-time-as-climate-talks-founder.html.

[4] University of California, Riverside, Bourns College of Engineering-Center for Environmental Research and Technology "So Cal Research Initiative for Solar Energy" White Paper, http://www.cert.ucr.edu/research/sc-rise/whitepaper.pdf.

[5] "Solar Industry Environmental Scan: Greater Sacramento Region." Northern California Region Center of Excellence, July 2011, http://www.coeccc.net/Environmental_Scans/solar_scan_gs_11.pdf.

[6] Distributed solar is small-scale, decentralized energy generation located at or near the point of end use, while utility-scale solar includes large-scale generation projects that provide greater than one megawatt of electricity feeding into the transmission grid and supplying energy to utility companies.

Methodology

The findings of this report result from of a variety of research methods, including primary and secondary data collection from both employers and community colleges. Appendix B contains further information about the methodology used in this report.

To form an accurate understanding of the solar industry and employer needs, an extensive literature review was conducted. The COE then conducted a survey of solar firms in May and June of 2011. With the assistance of The Solar Foundation, the COE was able to identify more than 1,850 solar industry employers across California. Depending on a firm's position in the solar value chain, it was given one of the three questionnaires, designed specifically to gather information on installation, manufacturing, or trade/distribution businesses. Each survey focused on a set of relevant occupations identified as important for the industry and relevant for community colleges. The survey included questions pertaining to current employment, 12-month and 3-year occupational growth, and difficulty hiring for these occupations; as well as training offered to employees; and interest in training/education programs. Of the 1,850 employers identified, 485 firms (26%) responded to the survey.

For input from community colleges, public data sources were mined by the research team to inventory programs that train for solar-related occupations. Community colleges offering programs were asked to participate in a survey. Of the 54 colleges with some type of solar program or coursework, 18 (33%) responded to the survey. Completion data were obtained using the California Community Colleges Data Mart System.

Solar Industry Drivers

In the United States, California is the photovoltaic market leader, with much of the nation's research and development as well as installation and large-scale construction activities centered in the state — particularly in the San Francisco Bay Area and Southern California.

As in Germany and Japan, the United States federal government has incentivized the adoption of solar power through legislation authorizing tax credits. For example, a 30% investment tax credit can be claimed when a solar project goes online, as long as the project begins operation by the end of 2016, has the correct ownership structure, and is not leased to a tax-exempt entity. This tax credit can be applied to a range of projects, from installing solar panels on an individual's residence to constructing a utility-scale solar thermal project. Under the American Recovery and Reinvestment Act, solar projects can opt out of the investment tax credit and claim a grant for the same amount as part of the Treasury Department's 1603 Program, but the project must have either been operational or have started construction by the end of 2011 and must be completed by the end of 2016. Unless the program is extended, it will end in Dec. 31, 2011.

Additionally, a "new markets tax credit" is available for renewable energy projects, including solar projects, in low-income or rural areas. Thirty-nine percent of the investment can be claimed as a tax credit over seven years. However, the projects are not financeable unless a utility company agrees to buy power from the project.

These support mechanisms have helped to foster recent growth in the solar industry. However, if the investment tax credit expires, it is possible that the construction and installation of both large- and small-scale solar projects could slow in the coming years.

California's Solar Incentives

In 2011, a report by the non-profit Environment California found the state's solar capacity doubled in the past five years.[7] According to the report, California is home to about 20% of all solar power companies in the United States. The report concludes that "even in a weak economy, California's solar market has been expanding exponentially by about 40% per year. If the market continues growing at a rate of 25% per year, the state will achieve the 3,000 MW goal by the end of 2016."

In addition to federal incentives, state programs and consumer demand are two other factors driving growth in California. Within California, the Million Solar Roofs Initiative, which was signed into law in 2006, has spurred the growth of solar projects. Since the legislation was enacted, projects generating more than one gigawatt of solar energy, or enough energy to power 750,000 homes, have been installed.[8] Recently, Governor Jerry Brown has called for building 12 gigawatts, the equivalent of 12 nuclear power plants, of local clean energy across the state by 2020.

This legislation has fostered the adoption of solar power, by allowing customers to get a credit on their electric bill for excess power generated by their home's solar system; mandating that solar panels become a standard option for buyers of new construction homes, allowing them to add solar panels to a home while it is being constructed; and requiring that the state's municipal utilities create solar rebate programs totaling $800 million in rebate funds.[9]

Another state program is the $2.8 billion California Solar Initiative that provides incentives and rebates to customers of Pacific Gas and Electric (PG&E), Southern California Edison (SCE), San Diego Gas & Electric (SDG&E) to generate electricity by installing solar panels or other renewable energy technologies. The goal is to generate three gigawatts by the end of 2016. Part of the California Solar Initiative is New Solar Homes Partnership, which provides financial incentives and other support to home builders to construct energy-efficient, solar-enabled homes.

However, in the event of the federal tax-credit sunset, the industry could experience some contraction and market growth could stagnate, even in California. Smaller businesses or start-ups specializing in solar could consolidate or be acquired by large corporations if financing is limited. California's high energy costs, nevertheless, still provide an incentive to save money through solar power.

Industry Overview

Nearly 2,000 solar industry employers were identified, of which more than 50% are construction firms that focus on installation of solar energy technologies. A number of firms surveyed engage in both distributed and utility-scale solar projects. Utility-scale solar development firms were not included among the employers identified by the study. Out of the 2,000 employers identified, the COE surveyed 485 employers, about one-quarter of the total. Employers were surveyed between May and June of 2011.

A conservative estimate of the current number of firms identified across California regions is illustrated in Table 1. The highest concentration of businesses is in Southern California, with 735 firms, followed by the Bay Area, with 548 solar companies. Central California has the third-highest concentration, with 278 firms.

[7] "Building a Brighter Future: California's Progress Toward a Million Solar Roofs." Environment California Research & Policy Center, November 2011. http://environmentcalifornia.org/reports/cae/building-brighter-future-california%E2%80%99s-progress-toward-million-solar-roofs

[8] Environment California. http://www.environmentcalifornia.org/energy/million-solar-roofs.

[9] Environment California. http://www.environmentcalifornia.org/newsroom/energy/energy-program-news/million-solar-roofs-bill-sb-1-signed-into-law.

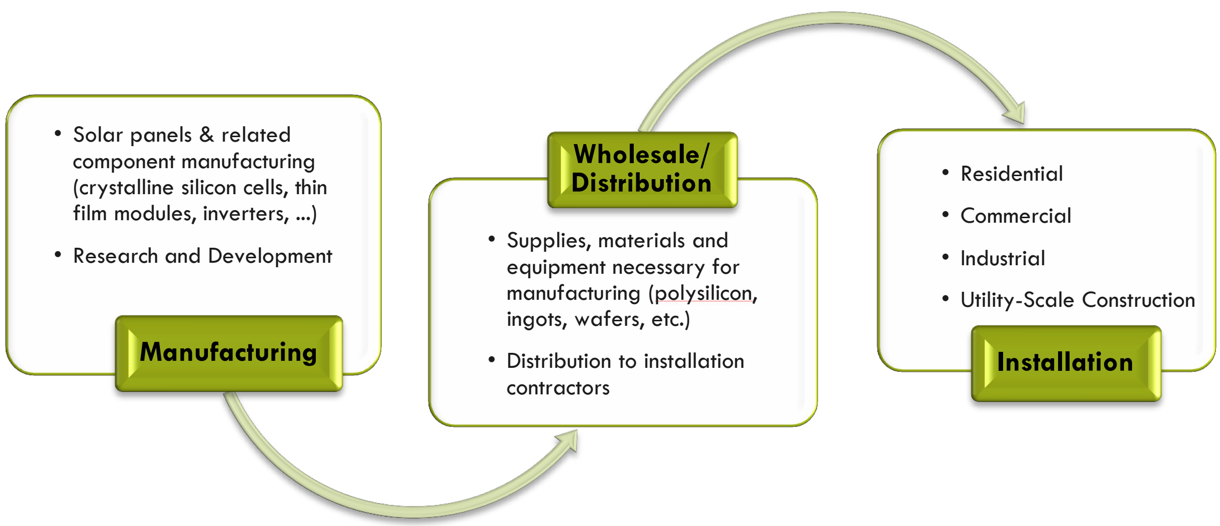
Table 1: Regional Distribution of Firms

	Bay Area	Central/South Central	Southern California	Other California[10]	Total
Estimated Number of Solar Installer, Manufacturing, or Trade Firms	548	278	735	292	1,853

Distributed Solar

Distributed solar generation is defined as small-scale, decentralized installations which are located at or near the point of end use.[11] In some cases, the installation may be connected to the grid of a utility company or it may solely provide power for its owner. For the purpose of this study, the distributed solar industry was divided into three subsectors: manufacturing, wholesale/distribution, and installation (Figure 1). The manufacturing subsector is characterized by research and development as well as the manufacturing of solar panels and related components. The wholesale/distribution subsector consists of supplying installation contractors with materials and equipment produced by the manufacturers of solar panels and associated products. Finally, the installation subsector is responsible for installing solar energy projects. This subsector is quite broad, providing services for residential, commercial and industrial customers as well as utility-scale construction.

Figure 1: Solar Energy Subsectors Driving Growth[12]



Of the three subsectors, solar installation is the largest subsector, comprising 56% of firms in the industry (Figure 2). Wholesale trade/distribution accounts for 26% of solar firms while manufacturing accounts for only 18%. The minor presence of the manufacturing industry in California is due in large part to the outsourcing of manufacturing activities overseas. There also many firms that are involved in a combination of value chain activities, such as manufacturing and distribution, distribution and installation, and all three.

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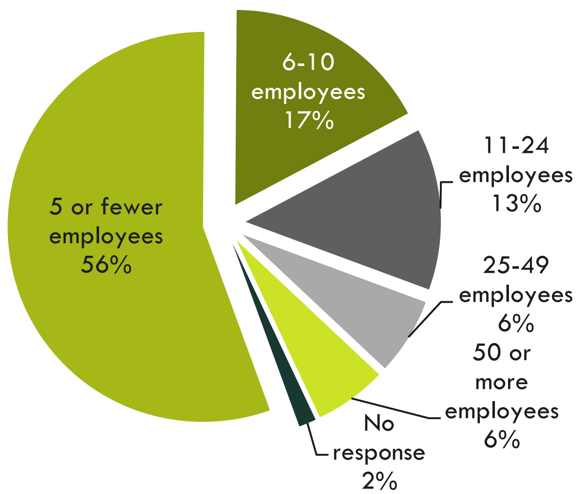
[10] Other California includes firms located in Greater Sacramento area and all the counties north of it as well as north of San Francisco Bay region up to the California/Oregon border.
[11] Energy-101, www.energy-101.org
[12] "Solar Industry Environmental Scan: Greater Sacramento Region." Northern California Region Center of Excellence, July 2011, http://www.coeccc.net/Environmental_Scans/solar_scan_gs_11.pdf.

The survey of employers revealed that many of the firms involved in the solar industry can be categorized as small businesses (Figure 3). The majority of these firms have five or fewer employees. Over 90% of the firms that responded to the survey have fewer than 50 employees.

Figure 3: Size of Surveyed Firms



Installation

By far, the majority of firms surveyed (93%) about their solar installation activities responded that they install photovoltaic panels (Table 2). The installation of water heating systems, including pool heating, followed second, with 38% of firms conducting this activity.

More than three quarters of the firms specializing in installation provide services for residential customers (Table 3). Nearly 60% of firms provide services for small commercial systems generating anywhere from six to 50 kilowatts. About 25% of installers surveyed provide services for utility-scale projects, large commercial or industrial projects.

Of the installation firms surveyed, 71% reported employing dedicated solar installers or technicians (Figure 4). Interestingly, a greater number (88%) reported employing electricians with solar skills, suggesting that specializing in a traditional trade in addition to acquiring solar installation skills may be a valuable asset and could give installers a competitive advantage in the solar workforce. Similarly, 48% of firms reported employing roofers with solar installation skills.

Figure 2: Composition of the Distributed Solar Industry

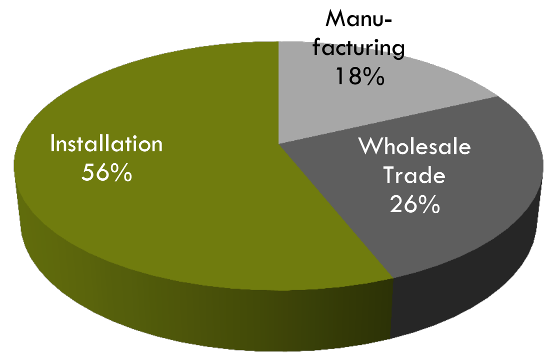


Table 2: Types of Installations Conducted by Distributed Solar Firms

Multiple responses were permitted.

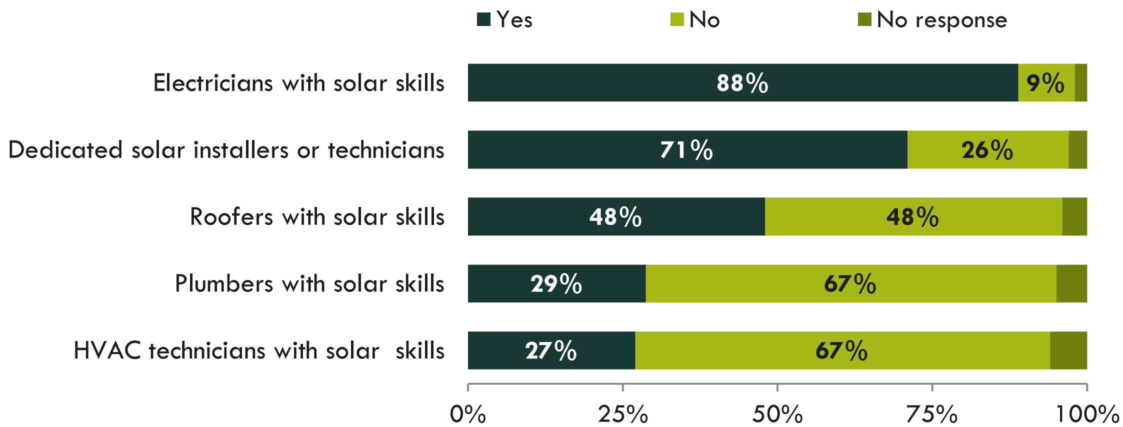
Type of Solar Installation	% of firms
Photovoltaic	**93%**
Water heating, including pool heating	**38%**
Space heating	**14%**
Cooling systems	**10%**
No response	**3%**

Table 3: Types of Installation Projects Served by Distributed Solar Firms

Multiple responses were permitted.

Types of solar installation projects	% of firms
Residential systems	**76%**
Small commercial systems, *6-50 kilowatts*	**57%**
Medium to large commercial and industrial systems, *51-200 kilowatts*	**34%**
Large commercial and industrial or utility-scale projects, *201 kilowatts or larger*	**24%**
No response	**1%**

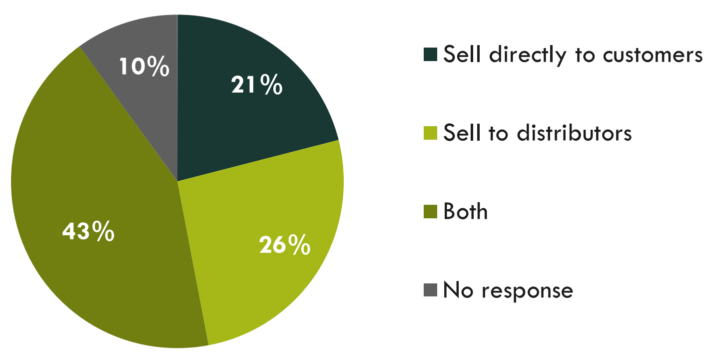
Figure 4: Trade Specialization with Solar Installation Skills



Manufacturing

Manufacturing firms are almost equally divided between selling their products directly to consumers and selling to distributors (Figure 5). A significant percentage of firms (43%) sell to both.

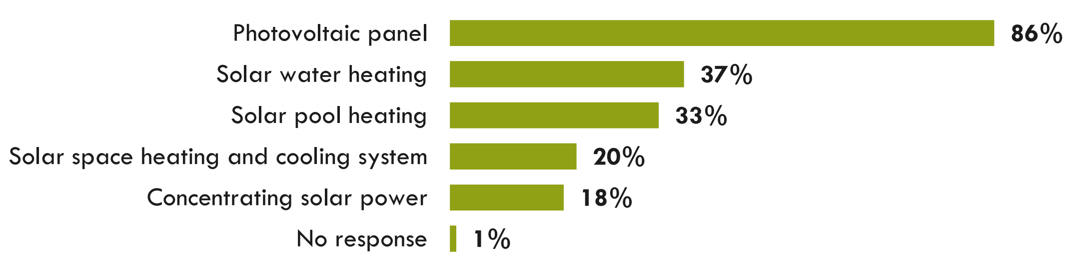
Figure 5: Manufacturing Firms' Customer Base.



Trade/Distribution

Of those surveyed, a majority of distribution firms surveyed (86%) provide products or services related to photovoltaic panels (Figure 6). Thirty-seven percent provide products or services related to solar water heating, and one-third provide products or services associated with solar pool heating. Twenty percent provide services or products related to solar space heating and cooling systems.

Figure 6: Types of Solar Products and Services Provided by Distribution Firms
Multiple responses were permitted.



Utility-scale solar

Utility-scale solar is defined by large-scale generation projects which provide greater than one megawatt of electricity that feeds into the transmission grid and supplies energy for utility companies. There are two main technological areas in which firms specialize: 1) photovoltaic generation and 2) solar thermal.

Photovoltaic (PV) power plants generate energy by using large solar panels containing photovoltaic cells that convert sunlight directly into electricity.

Solar thermal technology (also known as Concentrated Solar Power or CSP) uses direct heat from the sun and concentrates it to produce heat for electricity generation. There are several variations of solar thermal technologies, including:

- ***Power tower system***, which uses flat, sun-tracking mirrors to focus and concentrate sunlight onto a receiver on the top of a tower. The receiver contains a heat-transfer fluid that is used to generate steam which a conventional turbine generator then uses to produce electricity.
- ***Stirling engine***, which employs mirrored dishes similar to very large satellite dishes that direct and concentrate sunlight onto a thermal receiver. The heat is collected by the receiver and transferred to an engine generator.
- ***Parabolic trough***, which consists of a field of mirrored solar collectors shaped like parabolic troughs which track the sun. The troughs concentrate the sunlight, which heats a tube running behind the mirrors. The high temperature collected by the fluid in the tube then heats high-pressure steam in a turbine generator.

In California, there are currently 70 utility scale solar projects in development. Additional information on utility-scale projects across the state can be found in Appendix C. The COE conducted 13 executive interviews with representatives from firms developing, operating, or constructing utility-scale (defined as >1 megawatt) solar power plants. The majority of interviews were with operators and developers of three main technologies – photovoltaic (7 interviews), Power Tower (2), and Stirling Engine (2).

The survey of utility-scale firms revealed that construction jobs are created where the general contractors are based, not necessarily where the project is located. General contractors in the business of developing large projects, and, more specifically, large energy projects, tend to bring skilled workers with them, meaning that the majority of workers on construction projects are not hired locally.

Several employers noted that most of the local hiring was short term, as needed trade employment. In other words, the majority of construction workers come temporarily to the job site from other locations, and local workers are only hired when a specific need arises (and usually just a few workers at a time).

Furthermore, the operation of solar utility-scale plants is not highly labor intensive. After the construction phase, permanent employment drops dramatically, depending again on the technology and size of the plant. Utility-scale photovoltaic projects require almost no ongoing employment for operations and maintenance. Aside from periodic cleaning, photovoltaic plants require little ongoing maintenance; exceptions include basic monitoring of power, which is generally automated, and billing and administrative work. In several of the small plants studied, up to 3-megawatts worth of projects (three one-megawatt plants) could be managed by one person offsite. This low to no labor costs during operation was a significant factor influencing the decision of one developer to switch from thermal technology to photovoltaic, even at a cost of getting new approvals.

In contrast, Stirling engine plants require uniquely skilled technicians but in small numbers. The Stirling engine plants require workers with mechanical skills and understanding of mechanical engineering. The labor intensities were much higher for this technology with a need for one worker per six megawatts of power.

Firm Employment & Growth

Given its consistent expansion over the last few years, the solar industry appears to be well insulated from the economic downturn. However, it should be noted that this expansion has been bolstered by federal tax incentives. The following projections do not take into account the possible expiration of tax incentives and the effect that could have on employment opportunities in the solar industry. The projections are based on responses gathered from firms which provide services for either distributed solar or utility-scale projects, or both. Employment and growth projections are presented as ranges between low-end and high-end estimates for more accuracy. High-end estimates are based on the sample's averages/means, while low-end estimates rely on the averages/means of a smaller sample from which responses with extraordinarily high numbers (outliers) have been excluded.

Statewide, the solar industry, currently estimated to employ about 47,800 workers, is expected to add at least 6,800 jobs in the next year, and 18,000 over the next three years (Table 4). Overall employment growth in the solar industry is expected to increase at a rate between 14% and 17% over the next 12 months.

Table 4: Statewide Overall Employment, 2011-2015[13]

	Current Employment	12-month projected growth	% 12-month growth	3-year projected growth	% 3-year growth
High-end estimate	49,630	8,437	17%	24,070	49%
Low-end estimate	47,854	6,795	14%	17,993	38%

Table 5 shows regional firm employment and growth numbers. The Southern California region accounts for the most employment in the sector, with 30,800 solar industry jobs in 2011. However, the San Francisco Bay area is expected to experience the fastest employment growth of 30% in the next 12 months, resulting in almost 3,000 jobs.

Table 5: Projected Employment Growth by Region[14]

Region	Current Employment	12-month projected growth	% 12-month growth	3-year projected growth	% 3-year growth
Bay Area	10,114	2,994	30%	7,110	70%
Southern CA	30,883	2,440	8%	5,868	19%
Central California	2,738	422	15%	1,676	61%
Other CA	2,247	319	14%	845	38%
Statewide	**47,854**	**6,795**	**14%**	**17,993**	**38%**

In addition, employment projections for the three distributed solar subsectors (installation, manufacturing, and trade) were analyzed (Table 6). The installation sector employs the greatest number of individuals, but is expected to have the slowest rate of growth. Over the next year, employment in this sector is expected to grow by about 10%, adding 3,100 to 4,100 jobs. Over the next three years, the installation sector will add about 8,000 to 10,000 new jobs. In contrast, the manufacturing sector, while employing fewer people, is expected to grow at a faster rate. The sector will add 2,800 to 5,500 jobs in 2012. By 2015, the sector could increase by as many as 18,000 jobs.

The smallest sector as far as current employment numbers are concerned is distribution/trade. This sector is projected to grow between 17% and 22%, adding close to 7,200 jobs over the next three years.

[13] To arrive at estimated employment, survey data for a sample of employers were extrapolated to approximate the numbers for the universe of firms.

[14] Conservative (low-end) estimates were used to provide regional employment data.

Table 6: Statewide Solar Employment by Subsector

Subsector	Type of Estimate	Current Employment	12-month projected growth	% 12-month growth	3-year projected growth	% 3-year growth
Installation	High-end estimate (n=241)	38,362	4,143	11%	10,204	27%
	Low-end estimate (n=237)	37,259	3,167	9%	7,936	21%
Manufacturing	High-end estimate (n=77)	16,941	5,489	32%	17,975	106%
	Low-end estimate (n=71)	14,359	2,800	20%	9,046	63%
Trade	High-end estimate (n=113)	6,500	1,450	22%	7,254	112%
	Low-end estimate (n=105)	4,473	765	17%	3,462	77%

Occupational Overview

The Centers of Excellence conducted a preliminary review of solar-related occupations to determine which were most appropriate for further study. Based on a review of secondary data, existing literature, current community college offerings, and expert advice and opinion, 10 occupations/occupational groups were selected (Table 7).

Table 7: Solar Occupations

Installation Occupations	Manufacturing/Distribution
Water or Pool Heating Installation Technicians	Production & Operating Workers
Photovoltaic Installers/Technicians	Production Supervisors/Managers
Sales Representatives/Estimators	Accounting and Finance Staff
Designers/Engineers	Engineers
Installation Managers/Project Foremen	Sales & Marketing

The occupational overview includes two sections: distributed solar and utility-scale solar. The distributed solar section discusses the occupational findings from the manufacturing, wholesale/distribution, and installation employer surveys. Occupational and employer data for manufacturing and wholesale/distribution subsectors have been combined to increase data validity for analysis purposes. The employment estimates and projections did not take into account the possible changes in federal legislation which could affect solar tax incentives and ultimately, future expansion in the industry.

Distributed Solar

While the job outlook for utility-scale projects is somewhat nebulous given the possibility of the expiration of federal tax incentives, the prospects for employment growth in the field of distributed solar look promising. Employment opportunities within the installation and manufacturing/distribution subsectors are expected to grow. In California, the total number of distributed solar jobs for the 10 selected occupations in 2011 exceeded 24,500. There is an expected 40% growth over the next 12 months, resulting in additional 9,900 jobs in 2012 (Table 8).

The total number of jobs for five solar installation occupations in 2011 was roughly 14,400. These installation jobs are expected to increase by 41% or about 5,800 positions in 2012. Similarly, employment for manufacturing and distribution occupations is expected to increase. While there are fewer existing jobs for the five manufacturing and distribution occupations, a combined estimate of 10,100 positions, these two sectors are expected to grow at a similar high rate, by nearly 40%, adding approximately 4,000 jobs in the next year.

Table 8: Extrapolated Occupational Employment Growth, 2011-2012

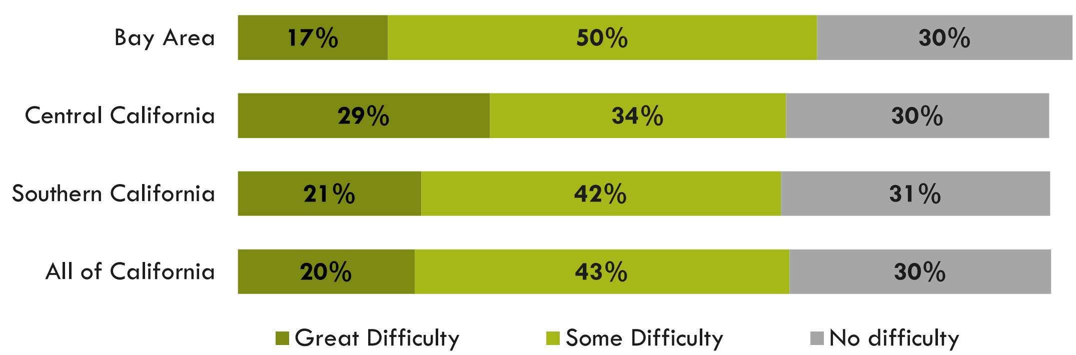
Occupational Groups	2011 Jobs	2012 Jobs	12-Month Growth	Growth Rate
Installation Occupations	14,417	20,295	5,878	41%
Manufacturing/Distribution Occupations	10,167	14,201	4,034	40%
Total	**24,584**	**34,496**	**9,912**	**40%**

Difficulty Hiring

Respondents were asked to rate the difficulty filling positions for the 10 solar installation and manufacturing/distribution occupations identified for this study. Figure 7 depicts these responses for each of the regions.

- Across California, almost two-thirds of employers surveyed reported challenges in hiring.
- Firms in the Bay Area reported the most difficulty hiring, with nearly 50% saying they experienced "some difficulty" and more than 17% experiencing "great difficulty."
- Of employers in Central California and Southern California, 63% report difficulty in hiring.

Figure 7: Difficulty in Hiring by Solar Installation & Manufacturing/Distribution Trade Occupations



Installation Occupations: Employment & Difficulty Hiring

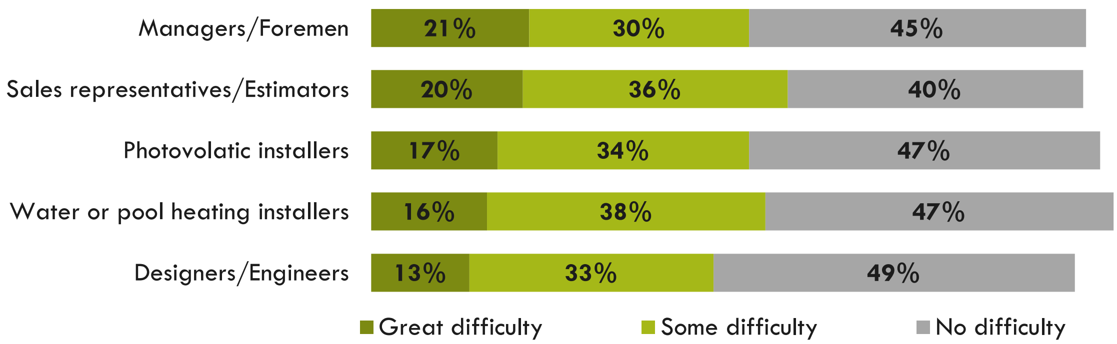
Occupations in solar installation were divided into five areas, comprising solar pool heating installers and technicians, photovoltaic installers and technicians, designers and engineers, installation managers and foremen, and representatives and estimators. Within the solar installation sector, sales representatives/estimators could experience the highest growth rate (53%), with almost 1,300 jobs (Table 9). Solar photovoltaic installers/technicians have the second highest growth rate (52%), with an additional 2,376 jobs projected. The occupations for solar designers/engineers and solar installation managers/project foremen are expected to have the least, but still robust, growth of 16 and 22% respectively.

Table 9: Solar Installation Occupational Employment Growth, 2011-2012

Solar Installation Occupations	2011 Jobs	2012 Jobs	12-Month Growth	Growth Rate
Solar pool heating installers/technicians	2,369	3,577	1,208	51%
Solar photovoltaic installers/technicians	4,570	6,946	2,376	52%
Solar designers/engineers	1,814	2,105	290	16%
Solar installation managers/project foremen	3,220	3,928	708	22%
Sales representatives/estimators	2,443	3,739	1,295	53%
Total	**14,417**	**20,295**	**5,878**	**41%**

Employers were surveyed about their difficulty finding qualified applicants for the following positions: solar pool heating installers and technicians, photovoltaic installers and technicians, designers and engineers, installation managers and foremen, and representatives and estimators (Figure 8). Appendix D contains further information.

Figure 8: Difficulty in Hiring by Solar Installation Occupations



Regional employers report varying degrees of difficulty in finding qualified applicants for the installation occupations. The findings are as follows:

- ***Solar pool heating:*** Of the three regions, employers in Central California reported experiencing the most difficulty hiring for these positions. Forty percent said they had "great difficulty" hiring. In the Bay Area and Southern California, more than 40% of employers reported no difficulty in hiring.
- ***Photovoltaic:*** Employers in California seem to split almost equally between experiencing difficulty hiring photovoltaic installers and technicians and experiencing no difficulty filling those positions. For example, in the Bay Area, 48% of employers reported having "no difficulty," while 32% reported "some difficulty" and 20% reported "great difficulty." Again, the Central region of the state reported the most difficulty hiring, with 24% of employers experiencing "some difficulty" and 29% experiencing "great difficulty."
- ***Designers and Engineers:*** Compared to the Bay Area and Central California, Southern California had the least difficulty hiring designers and engineers for solar projects, with 53% of employers reporting "no difficulty" in hiring while 41% in the Bay Area and 50% in the Central region reported "no difficulty." The Bay Area led the three regions with 46% of employers reporting "some difficulty" in filling these positions.
- ***Managers and Foremen:*** A majority of employers in the Bay Area and Southern California reported experiencing difficulty hiring for installation managers or project foremen. In the Bay Area, 57% reported experiencing either "some difficulty" or "no difficulty" while in Southern California, 54% reported encountering the same challenges.
- ***Sales Representatives/Estimators:*** Of the three regions, employers in Southern California reported the least difficulty filling these positions, with 51% reporting "no difficulty." In contrast firms in the Bay Area, Central Valley, and Central Coast experienced more challenges in finding qualified employees. In the Bay Area, 72% of employers reported experiencing either "some difficulty" or "great difficulty." In the Central region, 67% reported experiencing either "some difficulty" or "great difficulty."

Manufacturing/Distribution: Employment & Difficulty Hiring

The manufacturing/distribution subsector was divided into five occupations, comprising production and operations workers, supervisors and managers, accounting and finance staff, engineering, and sales and marketing jobs. In 2011, the total number of manufacturing/wholesale trade occupational jobs was approximately 10,100. Over the next year, that number is expected to increase by 40%. The two occupations expected to experience the most growth are those in finance as well as sales and marketing

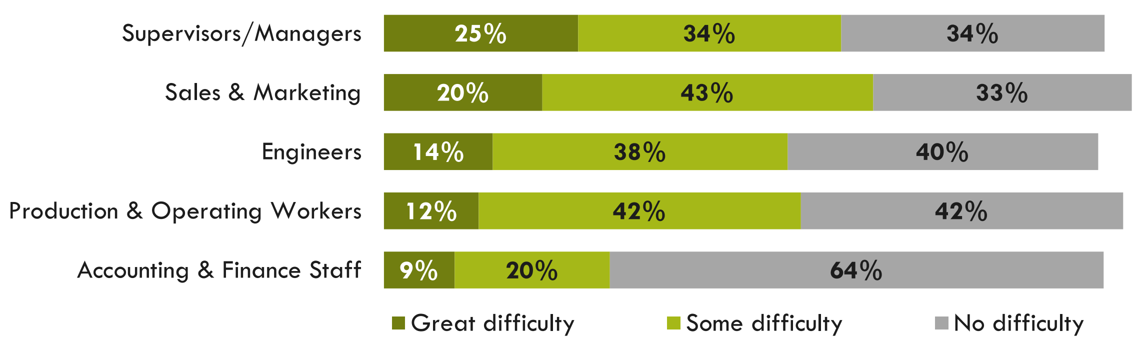
(Table 10). Employment for accountants, accounting clerks, and finance staff is projected to increase by 46%, adding nearly 400 jobs. Sales and marketing occupations are estimated to grow by 55% or more than750 jobs. Healthy growth within production and operating occupations is also projected, with growth of 43% or 880 jobs. Engineers by far account for the largest percentage of workers compared to other occupations, that field is expected to grow at a slower rate (33%).

Table 10: Manufacturing/Distribution Occupational Employment Growth, 2011-2012

Manufacturing/Distribution Occupations	2011 Jobs	2012 Jobs	12-Month Growth	Growth Rate
Production & operating workers	2,048	2,928	880	43%
First-line supervisors & managers	1,049	1,458	410	39%
Accountants, accounting clerks or finance staff	811	1,184	373	46%
Engineers	4,868	6,474	1,606	33%
Sales & marketing occupations	1,391	2,156	765	55%
Total	**10,167**	**14,201**	**4,034**	**40%**

Employers were surveyed about their difficulty finding qualified applicants for each of the five occupations studied (Figure 9). Please refer to Appendix D for more details.

Figure 9: Difficulty in Hiring by Solar Manufacturing/Distribution Occupations



Significant findings from regional employers include:

- **Production and Operating:** Employers in Southern California reported having the least difficulty hiring production and operating workers. In the Bay Area, however, half of employers reported experiencing "some difficulty" while 42% reported "no difficulty." All employers surveyed in Central California reported having "no difficulty" hiring.
- **Production Supervisors/Managers:** Sixty-seven percent of employers in Central California reported "no difficulty" hiring production supervisors or managers. In contrast, 75% of firms in the Bay Area said they experienced either "some difficulty" or "great difficulty" hiring for these positions while 57% of employers in Southern California reported experiencing some form of difficulty.
- **Accounting and Finance Staff:** In Central California, 80% of employers reported "no difficulty" hiring accounting and finance staff. Similarly, 88% of employers in Southern California reported "no difficulty." In the Bay Area, 48% reported "no difficulty," 30% reported "some difficulty," and 13% reported "great difficulty."
- **Engineers:** Employers in the Bay Area have the most difficulty filling engineering positions compared to Southern California and Central California. In the Bay Area, 67% of firms reported

either "some difficulty" or "great difficulty," compared to 55% in Southern California and 50% in Central California.

- **Sales and Marketing:** One in four Central region firms said they had "great difficulty" filling sales and marketing positions. Those reporting "great difficulty" in the Bay Area and Southern California totaled 19% and 18%, respectively.

Appendix E provides occupational employment, growth and difficulty hiring information for each of the three regions studied: San Francisco Bay Area, Central Valley & South Central Coast, and the combined Southern California region. Appendix F contains occupational profiles for each of the 10 occupations studied.

Utility-scale Solar

Thirteen executive interviews were conducted with representatives from firms developing, operating, or constructing utility-scale solar power plants generating greater than one megawatt of power. These firms were drawn from a pool of 70 projects throughout California. Firms that specialize in either the operation or the development of solar projects were surveyed. These interviews yielded several important findings.

Employment during the construction phase of utility-scale projects is significant, considerably more so than employment for operations and maintenance. However, many of these employment opportunities are short term, rather than long term. The overwhelming majority of employment opportunities connected to utility scale solar operations are during the construction phase. Firms that plan on beginning construction within the next six to 18 months said they expected large general contractors to bring their own workforce and to only hire temporary day labor from the local trades. Thus, these projects may not benefit localities that are in need of permanent job generation where projects are being planned.

Our research also analyzed which of the three technology areas – photovoltaic, solar thermal or Sterling engine – create the most jobs. Solar photovoltaic technology proved to have the greatest labor intensity, producing 20-50 jobs per megawatt during construction. However, these jobs were short term, spanning six to 12 months in duration. Power tower plants are the source of two to four jobs per megawatt, and tend to be longer term, covering a two- to three-year period. Large-scale projects generate considerably more construction-related jobs.

One of the general contractors interviewed noted the creation of 600 construction jobs for a 150 megawatt plant. Another developer of a 10 megawatt power tower plant noted 500 peak jobs in construction, with 20-25 jobs in operations and maintenance thereafter. Stirling engine technology had the lowest construction-related employment per megawatt at roughly 0.5 construction workers per megawatt — though the small sample size cannot effectively be considered representative.

The size of a solar project and the amount of energy generated seem to directly influence the number of jobs created. By and large, photovoltaic plants were significantly smaller than the thermal plants under development. The average photovoltaic plant varied from one megawatt to five megawatts while the thermal plants were more than 150 megawatts. For example, the Tenaska plant in Imperial County is expected to generate 150 megawatts of photovoltaic power, creating approximately 300 construction jobs. This drops the labor intensity to two construction jobs per megawatt, a ratio that is lower than the smaller plants but still four times higher than the average thermal plant.

Employer Needs and Challenges

Distributed Solar

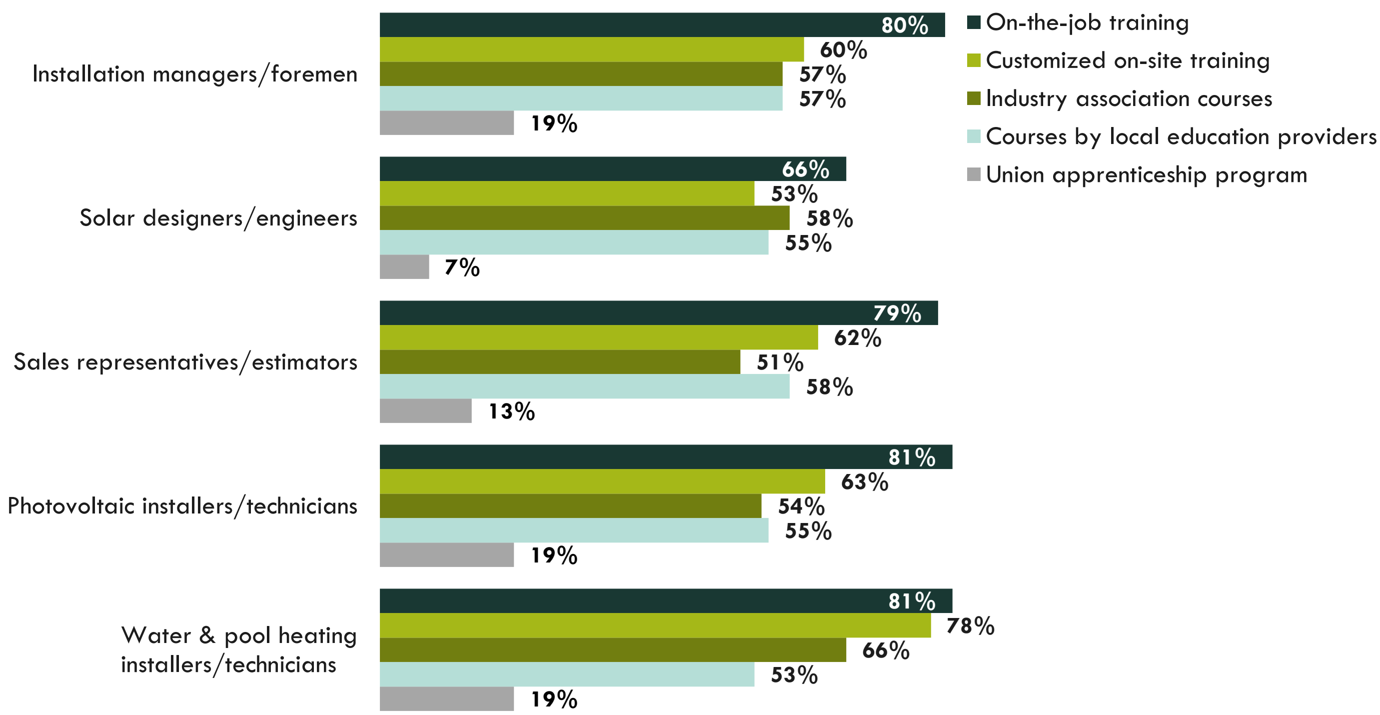
Distributed solar firms were surveyed about their education and training requirements. As in previous sections of this report, the distributed solar industry is divided into two subsectors: installation and manufacturing/distribution. Additionally, firms specializing in manufacturing/distribution were asked about their staffing needs. The survey revealed that a majority of firms in California both require and provide safety training. Only 10% of firms reported that safety training was not required.

Installation Training and Education

Figure 10 illustrates education and training requirements for installation occupations. Firms reported a mix of training activities. The majority (66%-81%) of employers report that they prefer on-the-job training across all installation occupations. The second most popular training practice among employers is customized on-site training (53%-78% of firms). Courses provided by local education institutions account for about 53%-57% of employer votes for various installation occupations. Only a small proportion of employers (7%-19%) prefer union apprenticeship programs as a way to train their employees.

Figure 10: Education and Training Requirements for Installation Occupations

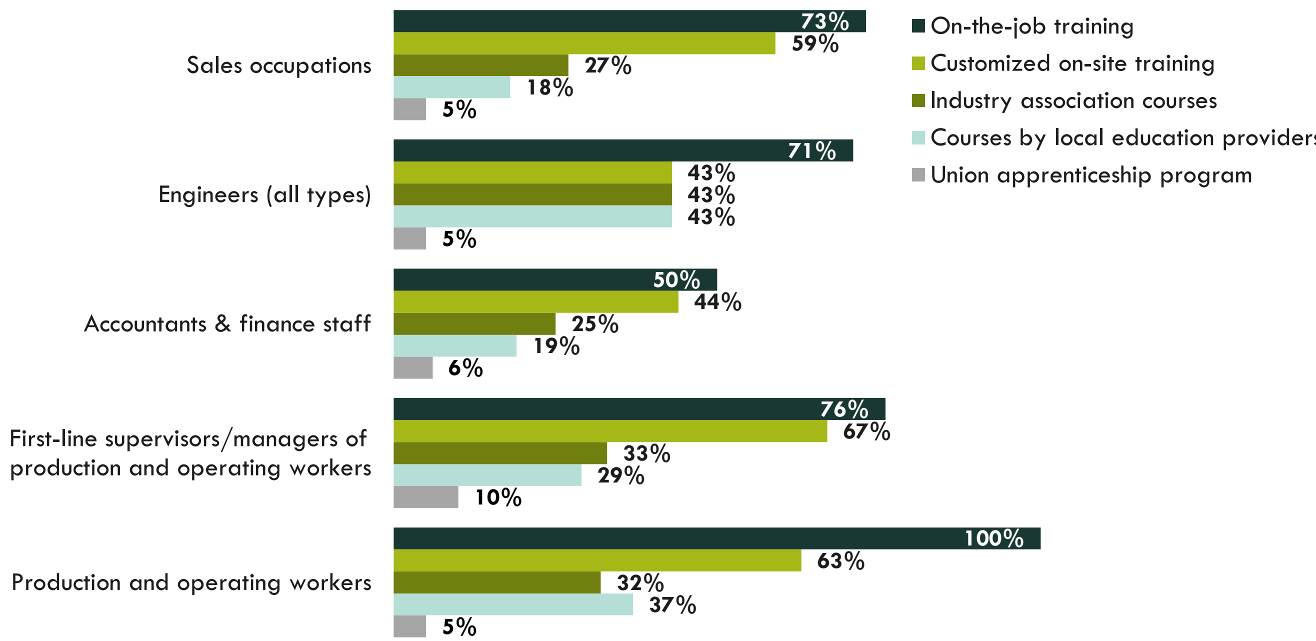
Multiple responses allowed.



Manufacturing/Distribution Training & Education

On average, on-the-job training is a preferred method of training for all occupations among 75% of manufacturing and distribution solar firms. About two-thirds of employers also provide customized on-site training for production and operating workers and first-line supervisors. Thirty-seven percent of firms require training through local educational providers for production and operation workers. Figure 11 shows the results broken down by specific occupation.

Figure 11: Education and Training Requirements for Manufacturing/Distribution Occupations
Multiple responses allowed.



Utility-scale Solar

Utility-scale employers identified several education and training needs. Employers noted significant frustration with the current labor pool of solar workers, particularly power plant operators, managers, and safety technicians. Employers noted a need for, and the perceived lack of, the following skills:

- Communication (oral and written)
- General understanding of energy and power systems
- Basics of power plant management
- Basic understanding of solar technologies
- Technical ability in finance and regulatory affairs

Employers expressed a general concern that recent hires do not seem interested in careers in power generation, evidenced by their lack of commitment to continuous improvement or desire to learn their boss' job. Employers see community colleges as critical player in the training of workers.

College Response and Issues

As the solar industry continues to grow, so does the number of degrees, certificates, and courses providing preparation for solar-related occupations. To assess how community colleges are addressing employer demand for training for both utility-scale and distributed solar projects, the COE identified and surveyed administrators and faculty of community colleges throughout California.

In total, 54 community colleges, offering 81 solar educational and training programs and courses, were identified. Table 11 shows the colleges identified and the number of different solar education and training offerings by region. Please note that the "unknown" category represents programs that were not easily classified. A more detailed table displaying each college's offerings can be found in Appendix G.

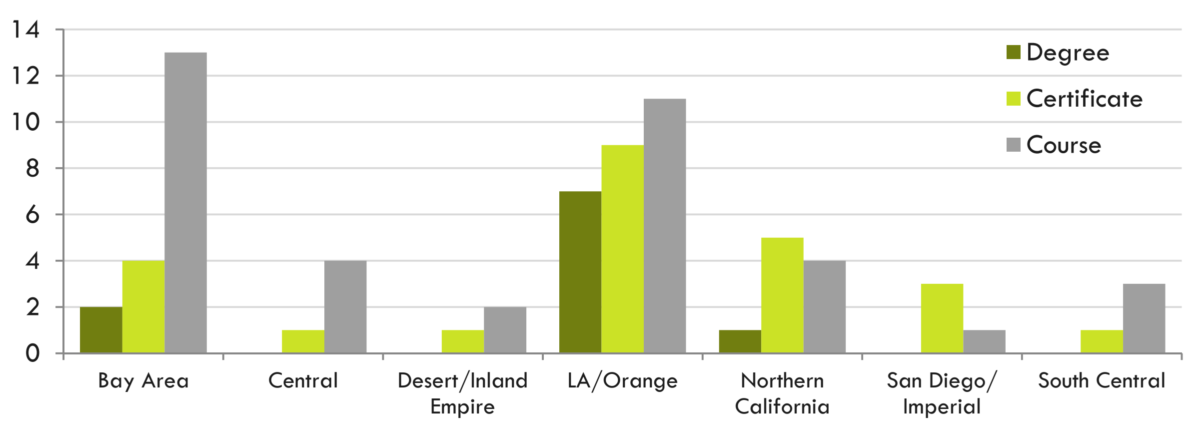
Table 11: Solar Programs by Region

Region	Colleges	Associate Degrees	Certificates	Courses Only	Unknown*	Total
Bay Area	Cabrillo, Contra Costa, Diablo Valley, Evergreen Valley, Laney, Marin, Napa Valley, Ohlone, San Francisco, San Jose, San Mateo, Santa Rosa, Skyline, West Valley	2	4	13	3	**22**
Central	Bakersfield, Cerro Coso, Fresno, Gavilan, Hartnell, Modesto, San Joaquin,	0	1	4	2	**7**
Desert/Inland Empire	Desert, Riverside, San Bernardino CCD, Victor Valley	0	1	2	1	**4**
LA/Orange	Cypress, El Camino, Golden West, L.A Trade-Tech, Long Beach, Los Angeles Harbor, LA Pierce, LA City, LA Valley, Orange Coast, Pasadena, Rio Hondo, Santa Ana, Sana Monica, Santiago	7	9	11	1	**29**
Northern California	American River, Butte, Redwoods, Sacramento City, Shasta, Sierra, Siskiyou	1	5	4	1	**11**
San Diego/ Imperial	Imperial Valley, Mira Costa, Miramar, San Diego City	0	3	1	1	**5**
South Central	Canyons, Cuesta, Santa Barbara City	0	1	3	0	**10**
TOTAL		**10**	**24**	**38**	**9**	**81**

*Unknown is a category assigned when the type of offering could not be verified or otherwise determined.

As Table 11 shows, colleges are typically providing one or more of the following: a program resulting in an associate degree or certificate, or one to two courses specific to solar. In total, community colleges are currently offering 10 associate degree programs and 24 certificate programs. Figure 12 displays the distribution of programs across the five regions.

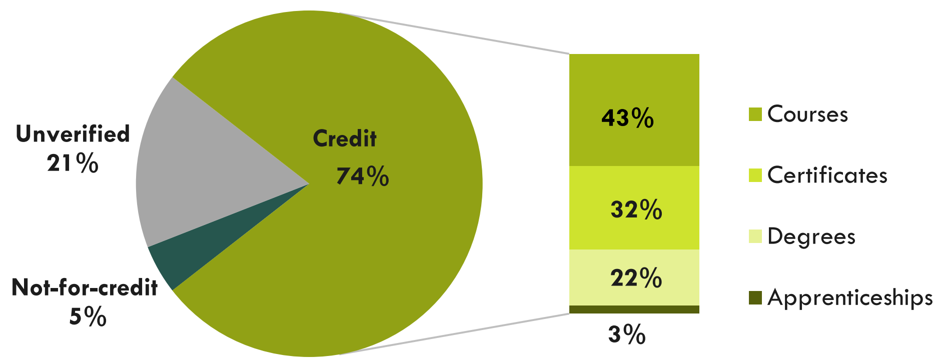
Figure 12: Number of Program and Course Offerings by Region



The graph in Figure 12 demonstrates that the majority of identified solar programs reside in the LA/Orange (37%) and the Bay Area (29%) regions, making up more than two-thirds of the total offerings. However, there are differences in the types of offerings available in colleges within these two regions. The overwhelming majority of Bay Area colleges have addressed a need for solar trained workforce by incorporating solar courses into existing traditional programs. The LA/Orange regional colleges both added courses and also created a significant number of new degree and certificate programs.

The identified solar training programs were categorized into for-credit and not-for-credit, where information was available to make such determination. Figure 13 displays the breakdown of solar programs that are for-credit, not-for-credit, and those that are unknown.

Figure 13: Breakdown of Credit and Not-for-Credit Programs



Nearly three-fourths of the training offerings are for-credit programs, whether it is a stand-alone associate degree, certificate program, or a solar course integrated into an established program, such as Heating, Ventilation, and Air Conditioning (HVAC), or Engineering Technology. A handful of degree programs (roughly 22%) focus on alternative or renewable energy, with an emphasis on solar or photovoltaic. Certificate programs that include both departmental (fewer than 12 units) and state-approved (12 units or more) are more common, comprising 32% of all for-credit offerings in California. Finally, two colleges provide apprenticeships as a form of training for solar occupations. The course offerings that are integrated into traditional programs make up just over 43% of the inventory. Most of these courses focus on providing introductory training in photovoltaic systems.

Of the 81 solar training and education offerings, five were identified as not-for-credit, two of which were stand-alone courses and the other three were not-for-credit certificate programs. Four of the five colleges place a focus on photovoltaic systems. The not-for-credit offerings included in this inventory differ significantly in the number of hours required for completion: from three to 110 training hours.

Student Completion

Out of 54 colleges with solar programs, 18 completed the COE college survey. Colleges responding to the survey provided the number of students they have had complete their solar training program(s). Table 12 below displays, by region, the number of students who completed an associate degree, received a certificate, or completed a not-for-credit program. Please note that only 12 college respondents provided response to this question, amounting to information for 17 program offerings.

Table 12: Number of Students Completing Associate Degrees and Certificates Reported by Respondents (n=12)

Region	Associate Degrees	Certificates	Not-for-credit Offerings	All Offerings
Bay Area	62	95	251	408
Central & South Central	0	0	30	30
Desert & San Diego/Imp	0	0	42	42
LA/Orange	14	70	25	109
Program Mean (Average # of Awards)	**15**	**24**	**70**	**35**
Program Median	***7***	***7***	**42**	**25**
Total	**76**	**165**	**348**	**589**

*Please note that completion rates for stand-alone, for-credit solar courses were not available for analysis. Programs in the Northern California region did not respond to the survey.

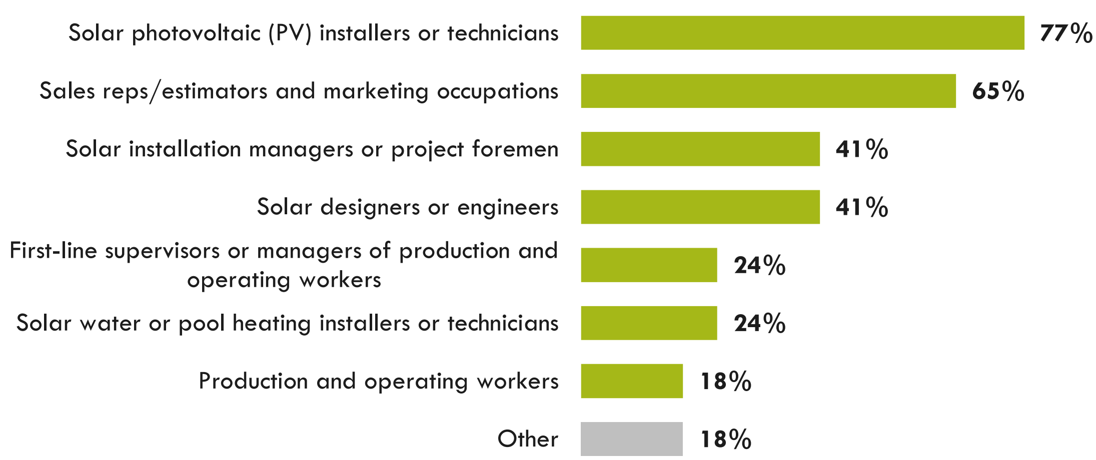
As displayed in the table, the not-for-credit programs have the highest number of students completing training. These same programs, representing less than six percent of the solar training programs surveyed, are producing almost 60% of all completers. This demonstrates the role of not-for-credit programs in responding to the needs of the community and the demand of local industry. It also mirrors the funding that was available for such programs last year, for example, through the American Recovery and Reinvestment Act (ARRA). Furthermore, of the surveyed programs, those in the Bay Area are responsible for about 70% of completers. This high percentage is probably a result of the workforce demand of individuals skilled for solar occupations in this region. Since the data represent only 12 colleges, the actual number of community college solar program graduates is presumed to be much higher for the whole state and for individual regions.

Using the average number of program completers and the total number of programs identified in each category, the estimated number of student completers across various programs statewide falls within a range of 1,700 to 3,300 completers in program year 2010-2011. Considering that most of these programs train for solar photovoltaic installation, this completion can be compared to the estimated 2,360 annual job openings for solar photovoltaic installers in the next year. Thus, colleges' output of solar photovoltaic installers generally meets estimated demand, with a potential of slight oversupply (if the higher-end estimate of student completion is utilized for calculation). This also does not take into account the supply of trained workforce by other educational institutions, so the actual output of trained workforce in the state is likely to be even higher, contributing to a greater oversupply.

Occupational Training

Solar programs throughout the state are training and preparing students to enter a variety of occupations. Based on the survey data, the most common are solar photovoltaic installers or technicians (77%), and solar sales reps/estimators and marketing occupations (65%). These findings are displayed in Figure 13.

Figure 13: Occupational Focus of Community Colleges Offerings (n=17)
Multiple responses were allowed.

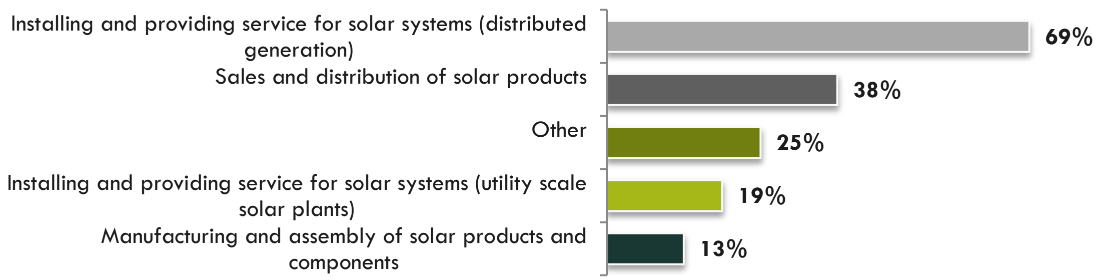


Following the top two occupations, seven programs reported training their students for occupations such as solar installation managers or project foremen, and solar designers or engineers. All but two colleges in the sample align solar curriculum with industry certification requirements, such as the North American Board of Certified Energy Practitioners (NABCEP). The "other" occupational training category includes engineering and survey/geomatics, architectural and civil drafting, and basic knowledge of solar energy theory.

Specializations

Colleges were surveyed about system specializations that they provide training in. Figure 14 summarizes these responses. Of the 16 colleges responding, more than two-thirds offer training in installation and servicing distributed generation solar systems. The second most common specialization is sales and distribution of solar products (37%).

Figure 14: Specialized Training Programs Offered by Community Colleges (n=16)
Multiple responses were allowed.



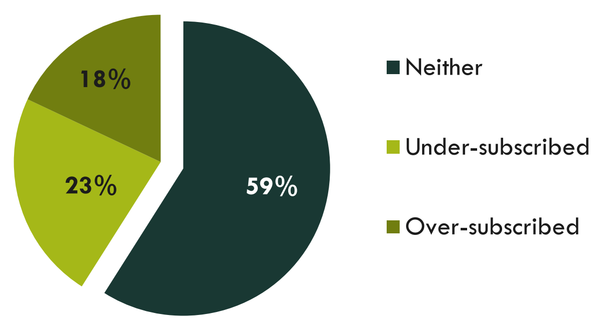
Funding

For those programs surveyed, the majority receives funding from one or both of the following resources: general funds including student tuition (50%) and grants (~35%). Additionally, a few programs receive funding from employer fees (~8%), non-tuition student fees and contracts (~4% each).

Student Enrollment

The majority of programs (59%) reported being neither under- nor over-subscribed (Figure 15). This means that the number of available slots for these programs is meeting the demand of students who are interested in enrolling. As presented in Figure 15, 23% of community colleges reported that students are not filling all the available seats in their classes. The smallest percentage of programs (18%), reported being impacted and having to turn down interested students. This finding confirms that existing college programs are likely meeting or exceeding the market demand for the solar installation workforce.

Figure 15: Number of seats available vs. student interest in programs.



Employer Involvement & Partnerships

Programs reported relatively high involvement of, and interaction with, local employers. Three out of four program administrators/faculty surveyed indicated that employers serve primarily as advisory board members. Other common ways of employer engagement included donating supplies and equipment and providing instruction as part-time instructors.

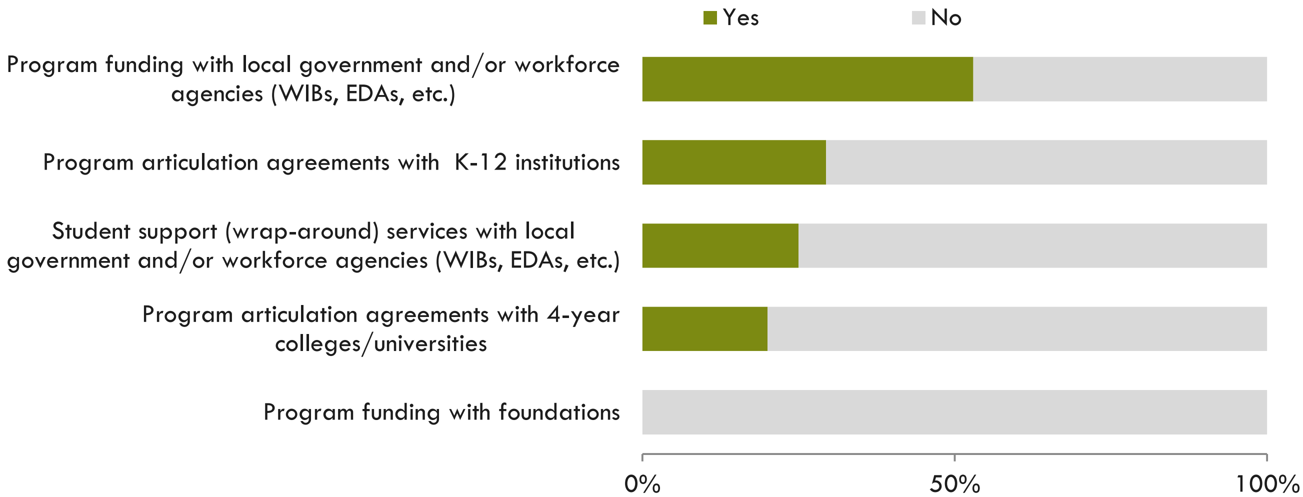
Overall, community colleges reported partnering with employers for the following:

- Served as advisory board members (76% of colleges responding to the survey)
- Donated supplies or equipment (65%)
- Served as adjunct instructors (59%)
- Offered internships for students (47%)
- Offered externships for faculty (12%)

The COE employer survey also revealed that nearly one-quarter of firms in California have formed partnerships with a community college. These partnerships may have included providing training or assisting with recruitment. Among the most noteworthy findings is that almost one-third of firms in the San Francisco Bay Area reported forming such partnerships.

Some community colleges also enter into partnerships with other educational establishments, foundations, and local governments. The most commonly identified collaboration (53%) was with local government and/or workforce agencies for program funding (Figure 16).

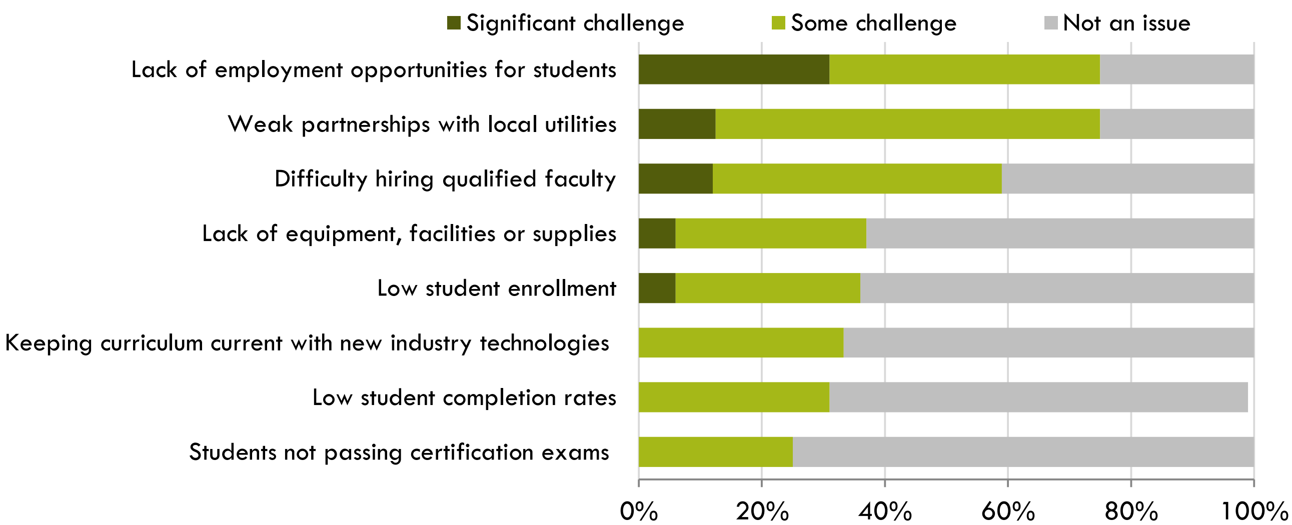
Figure 16: Partnerships established and their purposes



Program Challenges

Community college respondents were asked to rate potential program challenges as a “significant challenge”, “somewhat of a challenge”, or “not an issue” (Figure 17). Thirty-one percent of programs identified finding employment opportunities for students as the most significant challenge they face. Establishing partnerships with local utility agencies and hiring qualified faculty were rated as significant challenges by about 12% of respondents. Low student completion rates, students passing certification exams, and keeping curriculum current with industry technologies were not rated as a significant challenge by any program. At least 66% of respondents said these were not issues for them.

Figure 17: Program Challenges



Conclusion and Recommendations

In a 2009 white paper, researchers at the University of California, Riverside, Bourns College of Engineering-Center for Environmental Research and Technology pointed out that, "[solar] technician training is already offered by several community colleges, unions, and job training programs in California. Indeed, the pipeline of trained installers already is growing so large that some industry insiders are fearful of a glut." Our findings confirm that this is indeed the case. The need for photovoltaic installers, in particular, has been met.

In 2007, the Centers of Excellence issued a statewide report which projected that the solar industry would create about 40,000 new construction and maintenance jobs by 2016, with the occupation of solar technicians accounting for one third of that total.[15] At the time, the report found that only three colleges in California were offering specific solar energy programs or courses, and only one provided certified curriculum recommended by the North American Board of Certified Energy Practitioners (NABCEP). This raised concern that there was a significant need for community colleges to offer solar programs and courses.

Nearly five years later, updated research has demonstrated a key finding—community colleges statewide rapidly increased their offerings since 2007, with at least 54 colleges providing some type of training. Most programs are focusing on training solar photovoltaic installers or technicians (77%) and sales representatives/estimators and marketing occupations (65%). The analysis of current college output and labor market needs suggests that community colleges are meeting and potentially exceeding the market demand for solar installers in California. The college output of program graduates in 2011 is estimated to be between 1,700 and 3,300, while employment projections show a need for about 2,300 solar installers. Based on these figures, California community colleges would seem to be producing enough, or perhaps more, solar installers than the industry is projected to need.

This finding is also supported by our college survey results which determined that the majority of colleges responding (59%) experience neither lack of student enrollment nor over-enrollment in their classrooms, while 24% of colleges report low enrollment issues. At the same time, lack of employment opportunities for graduates was reported the top challenge for colleges as many students struggle to secure jobs in a solar profession upon graduation. This does not necessarily suggest that opportunities for employment in solar industry are scarce since our research finds that solar industry has been growing and adding jobs. The situation could be partially explained by increased competition in the labor market from construction workers who lost their employment in large numbers during the recent recession. Since many solar employers prefer some construction experience when selecting new hires, displaced construction workers may have been more likely to find employment than recent solar graduates.

According to the employer survey, a large number of firms (88%), reported employing electricians with solar skills, suggesting that specializing in a traditional trade in addition to acquiring solar installation skills is a valuable asset and may give installers a competitive advantage in the solar workforce. Similarly, 48% of firms reported employing roofers with solar installation skills. Thus, colleges need to consider expanding their electrical and construction programs with solar courses to give their graduates a competitive edge.

These data show how well-positioned community colleges are to meet the solar industry's workforce demands. Additionally, this study's findings formulate a snapshot of industry needs for each region in the state and how community colleges are responding to those needs. For example, the majority of solar industry and college program activity takes place in the San Francisco Bay Area and LA/Orange regions. On the industry side, the Southern California region accounts for the most employment in the sector, with 30,800 solar industry jobs in 2011, while the San Francisco Bay is expected to experience the fastest regional growth (30%) in the next 12 months, resulting in almost 3,000 jobs. On the college side, these regions account for more than 66% of total programs, and roughly 88% of student completers from the

[15] "Solar Technicians: Occupational Environmental Scan for California Community Colleges." Southern California Centers of Excellence Hub, December 2007, http://www.coeccc.net/Environmental_Scans/SolarTechs_Scan_SW_08.pdf.

surveyed programs. The comparison of these numbers underlines the fact that program offerings are generally located where there is the most need for the workforce.

Given the rapid expansion of utility scale solar projects in the recent years, a separate research effort was conducted to better understand workforce needs of this industry. Utility-scale projects, especially those that use photovoltaic technology, require little to no ongoing employment for operations and maintenance. While the construction phase is normally more labor intensive, local employment impacts should not be over-estimated as utility-scale solar development firms often do not hire locally. Nevertheless, utility-scale employers identified several education and training needs. Employers noted significant frustration with the current labor pool for solar workers, particularly power plant operators, managers, and safety technicians. Employers noted a need for and the lack of such skills and knowledge areas as communication; general understanding of energy and power systems, power plant management, and solar technologies; and technical ability in finance and regulatory affairs.

The role that community colleges play in preparing solar workforce in California is vital. In addition to graduating students, colleges have created numerous opportunities for incumbent worker training and re-training in the solar industry through contract education and not-for-credit offerings. While union apprenticeship programs in solar are widely advertised, the survey of employers found that only three to seven percent of firms responding utilized this method of workforce preparation for solar installation occupations, relying more heavily on a combination of courses provided by local colleges (17%), on-the-job training (~33%) and customized on-site training (25%).

Finally, community colleges across the state are to be commended for developing courses and programs that meet industry demand in a relatively short period (2007-2011) and for aligning programs with industry certification requirements.

Recommendations to Community Colleges

Robust growth of the solar industry, a significant number of solar training and education programs at community colleges, and skill mismatches in the labor market require strategic consideration and a targeted response by community colleges. Specific recommendations for action are:

- ***Expanding (Diversifying) existing solar program offerings to include a broader spectrum of occupations.*** The solar industry contains a large number of unique occupations. Our research of the distributed solar industry indicates that while colleges are addressing the need for photovoltaic installers, they should expand the knowledge areas of their programs and courses to include other occupations associated with the solar industry. For example, there is a significant workforce gap for solar water heater installers. In particular, program development by community colleges should focus on offering solar sales representatives/estimators programs, as this occupation is projected to be the fastest growing (53%; 1,300 jobs in 12 months) and employers are still experiencing difficulty hiring for this occupation in many regions. Colleges are advised to work with regional employers and explore the best ways to adjust or create courses to address this need.
- ***Strengthening partnerships with employers to increase job placement of students.*** Since college respondents report job placement as a major challenge, colleges with solar programs need to strengthen partnerships with employers to develop internships, apprenticeships, and other programs in which students can gain work experience.
- ***Developing customized courses for utility-scale solar projects.*** Although there does not appear to be a significant community college role for utility-scale training programs since the projects generate few long-term jobs and the majority of jobs are in construction, some educational offerings focused on utility-scale operations could be created to fill an educational gap identified by developers. It is recommended that community colleges develop and offer course(s) on the basics of energy production, power plant management, and solar technologies, together with modules focused on communication and problem-solving skills. This is particularly relevant for colleges in the inland areas of Southern California and the Central Valley.

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Appendix A: How to Utilize this Report

This report is designed to provide current industry data to:

- Define potential strategic opportunities relative to an industry's emerging trends and workforce needs;
- Influence and inform local college program planning and resource development;
- Promote a future-oriented and market responsive way of thinking among stakeholders; and,
- Assist faculty, Economic Development and CTE administrators, and Community and Contract Education programs in connecting with industry partners.

The information in this report has been validated by employers and also includes a listing of what programs are already being offered by colleges to address those workforce needs. In some instances, the labor market information and industry validation will suggest that colleges might not want to begin or add programs, thereby avoiding needless replication and low enrollments.

About the Centers of Excellence

The Centers of Excellence (COE), in partnership with business and industry, deliver regional workforce research customized for community college decision making and resource development. This information has proven valuable to colleges in beginning, revising, or updating economic development and Career Technical Education (CTE) programs, strengthening grant applications, assisting in the accreditation process, and in supporting strategic planning efforts.

The Centers of Excellence Initiative is funded in part by the Chancellor's Office, California Community Colleges, Economic and Workforce Development Program. The total grant amount (grants #10-305-027 at San Bernardino Community College District and #10-305-026 at Modesto Junior College for $205,000 each) represents funding for multiple projects and written reports through the Center of Excellence. The Centers aspire to be the premier source of regional economic and workforce information and insight for California's community colleges.

More information about the Centers of Excellence is available at www.coeccc.net.

Important Disclaimer

All representations included in this report have been produced from primary research and/or secondary review of publicly and/or privately available data and/or research reports. Efforts have been made to qualify and validate the accuracy of the data and the reported findings; however, neither the Centers of Excellence, COE host District, nor California Community Colleges Chancellor's Office are responsible for applications or decisions made by recipient community colleges or their representatives based upon components or recommendations contained in this study.

Appendix B: Survey Methodology and Sample Data

About the Employer Survey

The Centers of Excellence, with assistance from BW Research Partnership and The Solar Foundation, collected workforce information regarding solar industry and occupations via an in-depth employer survey. The survey used both telephone and online surveys to gather feedback from employers. Employers with email addresses were initially invited to participate in the survey via an email invitation beginning on May 8, 2011 and final follow-up telephone calls were completed on June 22, 2011. In total 485 surveys were completed with solar employers in California, 425 via the telephone and 60 through the online survey.

Technique	Online and telephone survey
Population	About 1,850 solar employers in California
Sample	485 employer respondents
Field dates	May-June 2011

The Universe of Firms

The methodology for this study was based on a stratified sampling plan taken from a universe of 3,502 solar employers. Solar employers were identified in a database that was initially built from previous studies that BW Research had completed and was rigorously updated and reviewed as part of this study. The database categorized employers into regions and provided industry designations: Installer and Non-installer (Table B-1). It should be noted that not all employers in the database had a physical address (70 employers in the database were not given a regional designation) or a solar industry designation (358).

Table B-1: Description of Solar CA Employer Database before Filtering Survey Feedback

	Installer	Non-Installer	Not Identified	**Total**
Number of Firms in Database	1,944	1,200	358	**3,502**

After data collection was completed, we not only gathered information from the 485 completed surveys but also compiled and reviewed feedback on the accuracy of the employer database. Phone numbers that were not working (wrong number of disconnect), were a residence, or were screened out because they did not have a location in California or were not in the solar industry were identified. A new database was developed that removed those phone numbers that were either not working, a residence or screened out. Table B-2 provides the description of the database after the non-working, resident and screened out numbers have been removed.

Table B-2: Description of Solar CA Employer Database after Filtering Survey Feedback

	Installer	Non-Installer	Not Identified	**Total**
Number of Firms in Database	1,578	812	217	**2,607**

Using the occurrence rate of non-working, resident and screened-out and applying it to the database of companies that were not contacted for the survey, we have arrived at the following estimate of the solar industry universe in California:

Extrapolated Known Universe Count (Solar Installer, Manufacturing, or Trade)	**1,853**

Industry Employment

An estimate of overall solar employment for the universe was based upon conservative employment numbers obtained by eliminating statistical outliers. For the firm employment calculation, eight firms were removed that reported adding 300 or more employees or having a growth of 1900%. The average employment data for the sample and the number of firms in the universe were used to extrapolate the number of employees in each of the subsectors of solar industry. A similar method was used to extrapolate 1- and 3-year growth. Since fewer firms provided responses for the 3-year growth question, we utilized the responses for only those who responded to this question to estimate current and projected employment. Percentage growth within the sample was applied to the extrapolated employment numbers, yielding the 1- and 3-year projected growth in the solar industries. Table B-3 provides sample statistics used to calculate industry employment.

Table B-3: Sample Data for Solar Industry Employment & Projected Growth

Subsector	Type of Estimate	Current Employment	1-year projected growth	% 1-year growth	3-year projected growth	% 3-year growth
Installation	High-end estimate (n=241)	8,076	888	11%	2,180	27%
	Low-end estimate (n=237)	7,942	715	9%	1,668	21%
Manufacturing	High-end estimate (n=77)	1,874	600	32%	1,987	106%
	Low-end estimate (n=71)	1,728	346	20%	1,089	63%
Trade	High-end estimate (n=113)	857	188	22%	959	112%
	Low-end estimate (n=105)	796	135	17%	613	77%
Overall	High-end estimate	10,807	1,837	17%	5,295	49%
	Low-end estimate	10,466	1,465	14%	3,977	38%

Occupational Employment

Ten occupations related to solar industries (five in installation and five in manufacturing and distribution subsectors) were identified as high growth and aligned with community college education programs.

To arrive at the estimates of occupational employment currently and in 12 months, survey data for the sample was extrapolated to approximate the employment for the universe of firms.

- First, respondents were asked to report the number of workers they employed in each of the ten occupations. Specifically, employers were asked to report full-time, permanent positions. Based upon these responses, the COE calculated the distribution of employment, mean employment, and total employment.
- Respondents then reported the number of workers that would be employed in the ten solar installation and manufacturing & distribution occupations in the next 12 months. These responses resulted in occupational growth rates for the 1-year period.
- The average employment data for the sample and the number of firms in the universe were used to extrapolate the number of employees in each of the ten solar occupations. The actual solar employment is likely to differ from the estimated numbers presented in the report due to sample limitations, and lack of complete knowledge about the universe of firms.

The following table details the current employment and growth expectation from the survey sample of employers.

Table B-1 - Sample Data for Occupational Employment and Projected Growth

Solar Installation Occupations	2011 Employment	2012 Employment	1-year employment (new jobs)	1-year growth rate
Water or Pool Heating Installers/Technicians	111	167	56	51.0%
Photovoltaic Installers/Technicians	214	324	110	51.6%
Sales Representatives/Estimators	114	175	61	53.3%
Designers/Engineers	85	99	14	16.1%
Installation Managers/Project Foremen	151	184	33	22.1%
Total	**674**	**949**	**275**	**40.8%**
Solar Manufacturing & Trade Occupations	2011 Employment	2012 Employment	1-year employment (new jobs)	1-year growth rate
Production and Operating Workers	80	114	34	43.2%
First-line Supervisors/Managers of Production/Operating Workers	41	57	16	38.8%
Accountants and Accounting Clerks/Finance Staff	32	46	14	45.5%
Engineers	190	251	62	32.5%
Sales and Marketing	54	84	30	55.0%
Total	**396**	**552**	**156**	**39.4%**

Additional Data Considerations:

- Certain regions like Central Valley & Central Coast were oversampled, meaning we called employers in those regions up to ten times, so the regional breakdown of completes is not representative of the solar employers in California.
- While we completed surveys online that we could not connect to the employer database due to the fact that industry partners emailed out a survey link for us, we were able to identify five employers that had already taken the survey online when we called them on the phone.

For additional information on data methodology or to request a copy of the survey questions, please contact the Center of Excellence at www.coeccc.net.

Appendix C: Regional Utility-scale Projects

The Southwest United States and California, in particular, have tremendous solar energy potential. In California the area most conducive for these projects roughly stretches from Mono County south to Mexicali, and from Lancaster east to the Nevada and Arizona state borders.[16] Compared to the Mojave Desert, only the Sahara Desert and Chilean Andes have better solar fuel.[17]

The increased development of large-scale solar projects can be attributed to the requirement that California's electric utility companies use renewable energy to produce 20% of their power by 2010 and increase that percentage to 33% by 2020, under a goal set by state's Energy Action Plan.[18]

The Bureau of Land Management has received requests encompassing more than 300,000 acres for the development of approximately 34 large solar thermal power plants, which are estimated to produce around 24,000 megawatts. Although solar ventures are located throughout California, the majority are located in the state's desert region where the concentration of solar radiation energy is greatest.[19]

The Obama administration is planning to designate 17 solar zones covering 285,417 acres in six Western states. The largest zone is located along the Interstate 10 corridor in eastern Riverside County, totaling 148,000 acres. The zones were chosen for their proximity to urban areas, availability of existing power lines and abundant sunshine and because they are less environmentally sensitive, among other criteria[20]. Solar developers can expect an expedited approval process when choosing a site within a solar zone, versus an increased scrutiny and longer evaluation process when building on land not included in these areas.[21]

Secretary of the Interior Ken Salazar approved one of the largest photovoltaic solar projects thus far in August 2011, a 550-megawatt project to be constructed in the desert east of Palm Springs in Riverside County. The Desert Sunlight Solar Farm will be a photovoltaic system using solar panels to attract solar radiation, which is then converted into direct current electricity by semiconductors.

The project will be located on approximately 4,100 acres of public lands and operated by Desert Sunlight Holdings, LLC, a subsidiary of First Solar, Inc. The project promises to generate enough energy to power over 165,000 homes on Southern California Edison's regional grid.[22]

In addition, the BLM has compiled a list of nine priority solar projects for 2012 with in cooperation with the National Park Service, Bureau of Indian Affairs and the U.S. Fish and Wildlife Service. These projects were selected based on the progress of the necessary public participation and environmental analysis under the National Environmental Protection Act and applicable state environmental laws, among other criteria. Five of the nine 2012 priority projects are in California.[23] Other utility-scale projects of note include the following:

- Imperial County, near the state's southern border, is home to another large-scale photovoltaic project under development near El Centro called Imperial Valley Solar. Operated by Imperial Valley Solar LLC, the project will generate 709 megawatts on 6,360 acres. The designated land is an abandoned agricultural area.[24]

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- Calico Solar is a large Stirling engine solar project, also under development, located 37 miles east of Barstow in San Bernardino County. The primary equipment at this location is a 25-kilowatt solar dish Stirling system, referred to as a SunCatcher. The solar dish collects sunlight that is used as the heat source to power a Stirling engine, an external combustion engine. The dish is expected to output 663.5 megawatts on 8,230 acres. The operation will be run by Calico Solar LLC, a subsidiary of Tessera Solar. [25]
- BrightSource Energy, Inc. has two of the larger solar projects in development in the desert region, including the Ivanpah Solar Electric Generating System and the Broadwell SEGS. The Ivanpah photovoltaic development, which is under construction about 50 miles northwest of Needles in San Bernardino County, will produce 392 megawatts on approximately 2,154 acres and will supply electricity to 140,000 homes.[26]
- The Rio Mesa Solar project in Riverside County is awaiting approval. The proposed power tower solar development is expected to output 750 megawatts on 5,750 privately-owned acres, about 13 miles southwest of Blythe. The Rio Mesa project will supply an estimated 300,000 homes with power.[27]
- The Blythe Solar project under construction in Riverside County, operated by Solar Milennium, is a photovoltaic development. The site was originally slated as a parabolic trough system — a series of long parabolic mirrors that reflect sunlight on to a vacuum flask — but Solar Milennium announced the change to photovoltaic in August 2011. This development will generate 968 megawatts on 7,025 acres.[28]

The majority of utility-scale solar projects, which are either planned or under development, are concentrated in San Bernardino, Riverside and Imperial Counties, but the state's Central Valley also hosts several locations. The Great Valley Solar Farm in Alpaugh, Tulare County will output 150 megawatts on a 1,503-acre photovoltaic system.[29] The existing power tower solar project Sierra SunTower in Lancaster, Los Angeles County, debuted in 2009. Solar power tower systems consist of a centralized solar furnace using a tower to collect sunlight from a series of encircling mirrors. The Sierra SunTower occupies 20 acres and generates 5 megawatts.[30] A number of projects which planned to use older technology, such as the parabolic trough or power tower, have since switched to photovoltaic because it is both cheaper and faster to construct.

[25] Calico Solar Project, The California Energy Commission, http://www.energy.ca.gov/sitingcases/calicosolar/index.html.
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[28] Hull, Dana. "Solar thermal power plants switching technology to take advantage of falling PV prices." The San Jose Mercury News, December 8, 2011. http://www.mercurynews.com/business/ci_19498442.
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[30] eSolar, http://www.esolar.com/our_projects/.

Appendix D: Additional Data on Difficulty Hiring

Solar Water or Pool Heating Installers/Technicians			
	No difficulty	Some difficulty	Great difficulty
Bay Area	44%	44%	11%
Central Valley & Central Coast	60%	0	40%
Southern CA	40%	47%	13%
Other CA	47%	38%	16%
California Total	47%	38%	16%

Solar Photovoltaic Installers/Technicians				
	No difficulty	Some difficulty	Great difficulty	DK/NA
Bay Area	48%	32%	20%	0
Central Valley & Central Coast	43%	24%	29%	5%
Southern CA	52%	34%	14%	0
Other CA	48%	34%	17%	2%
California Total	47%	34%	17%	2%

Sales Representatives/Estimators				
	No difficulty	Some difficulty	Great difficulty	DK/NA
Bay Area	28%	52%	16%	4%
Central Valley & Central Coast	33%	33%	28%	6%
Southern CA	51%	26%	19%	5%
Other CA	40%	36%	20%	4%
California Total	40%	36%	20%	4%

Solar Designers/Engineers				
	No difficulty	Some difficulty	Great difficulty	DK/NA
Bay Area	41%	46%	9%	5%
Central Valley & Central Coast	50%	40%	10%	0
Southern CA	53%	27%	17%	3%
Other CA	49%	33%	13%	5%
California Total	49%	33%	13%	5%

Solar Installation Managers/Project Foremen				
	No difficulty	Some difficulty	Great difficulty	DK/NA
Bay Area	43%	33%	23%	0
Central Valley & Central Coast	53%	32%	11%	5%
Southern CA	46%	32%	22%	0
Other CA	45%	30%	21%	4%
California Total	45%	30%	21%	4%

Production & Operating Workers				
	No difficulty	Some difficulty	Great difficulty	DK/NA
Bay Area	41.7%	50%	0	8.3%
Central Valley & Coast	100%	0	0	0
Southern CA	52.6%	26.3%	21.1%	0
Other CA	41.5%	41.5%	12.2%	4.9%
California Total	41.5%	41.5%	12.2%	4.9%

Supervisors/Managers of Production & Operating Workers				
	No difficulty	Some difficulty	Great difficulty	DK/NA
Bay Area	16.7%	50%	25%	8.3%
Central Valley & Coast	66.6%	0	0	33.3%
Southern CA	40%	33.3%	23.3%	3.3%
Other CA	33.9%	33.9%	25%	7.1%
California Total	33.9%	33.9%	25%	7.1%

Accountants/Accountant Clerks or Finance Staff				
	No difficulty	Some difficulty	Great difficulty	DK/NA
Bay Area	47.8%	30.4%	13%	8.7%
Central Valley & Coast	80%	0	0	20%
Southern CA	88.2%	5.9%	5.9%	0
Other CA	63.6%	20%	9.1%	7.3%
California Total	63.6%	20%	9.1%	7.3%

Engineers				
	No difficulty	Some difficulty	Great difficulty	DK/NA
Bay Area	22.2%	44.4%	22.2%	11.1%
Central Valley & Coast	33.3%	33.3%	16.7%	16.7%
Southern CA	45%	45%	10%	0
Other CA	40%	38%	14%	8%
California Total	40%	38%	14%	8%

Sales & Marketing Occupations				
	No difficulty	Some difficulty	Great difficulty	DK/NA
Bay Area	29%	48.4%	19.4%	3.2%
Central Valley & Coast	33.3%	16.7%	25%	25%
Southern CA	34.7%	46.9%	18.4%	0
Other CA	33.3%	42.6%	20.4%	3.7%
California Total	33.3%	42.6%	20.4%	3.7%

Appendix E: Regional Occupational Data

Bay Area Region

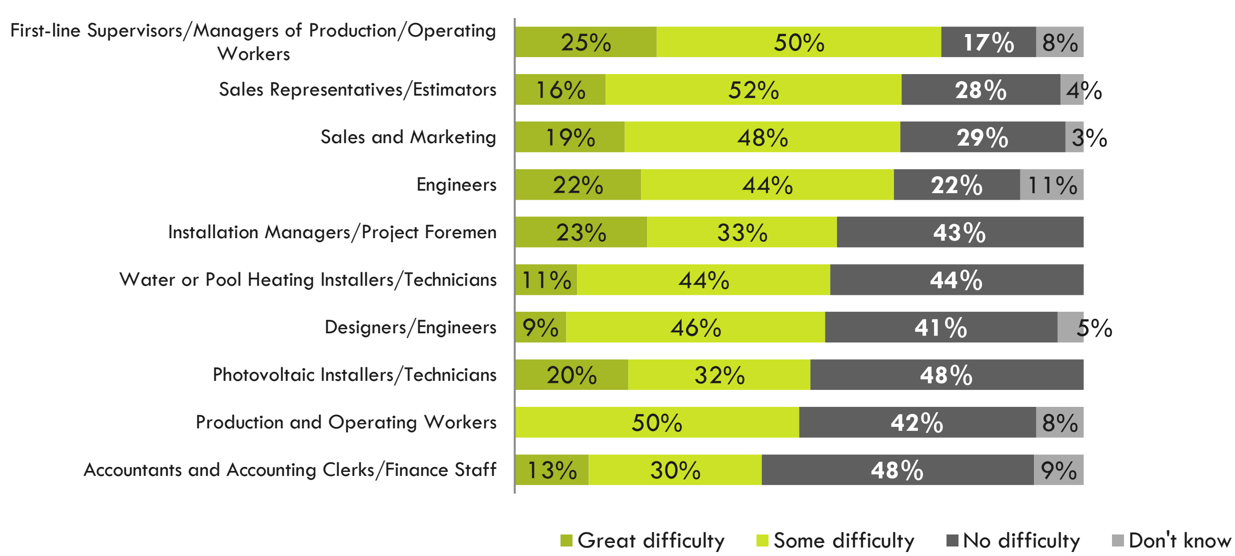
- According to our survey results, Bay Area firms employ 9,508 solar manufacturing, trade and installation workers in the ten occupations studied. In the next year there may be as many as 3,749 new and replacement jobs within these ten occupations.
- Engineers are the largest occupations with an estimated 4,075 workers. This occupation is also projected to create 913 new and replacement jobs in the next year.
- Solar photovoltaic installers or technicians are the second largest occupation in the Bay Area, with an estimated 1,630 workers. It is projected to have a replacement rate of 6.5% over the next 12 months, and could create as many as 538 new jobs (33% growth).

Table C-1: Extrapolated employment and growth for solar occupations in the Bay Area

Solar Occupation	2011 Employment	12-month employment (new jobs)	12-month growth rate	12-month replacement jobs	Replacement job rate	New and replacement jobs
Water or Pool Heating Installers/Technicians	346	192	55.6%	38	11.1%	231
Photovoltaic Installers/Technicians	1,630	538	33.0%	106	6.5%	644
Sales Representatives/Estimators	555	219	39.4%	116	20.9%	335
Designers/Engineers	484	36	7.4%	54	11.1%	90
Installation Managers/Project Foremen	384	128	33.3%	32	8.3%	160
Production and Operating Workers	603	341	56.5%	107	17.8%	448
First-line Supervisors/Managers of Production/Operating Workers	443	89	20.0%	26	5.9%	115
Accountants and Accounting Clerks/Finance Staff	315	189	60.0%	109	34.6%	298
Engineers	4,075	660	16.2%	253	6.2%	913
Sales and Marketing	674	393	58.3%	125	18.5%	518
Total	**9,508**	**2,784**	**29.3%**	**966**	**10.2%**	**3,749**

- Over 50% of the respondents reported having at least some difficulty hiring for nine out of the ten occupations.
- Employers within the Bay Area are having the least difficulty hiring Accountants and Accounting Clerks or Finance staff.

Figure C-1 Employers' difficulty in hiring for solar occupations



Central & South Central Region

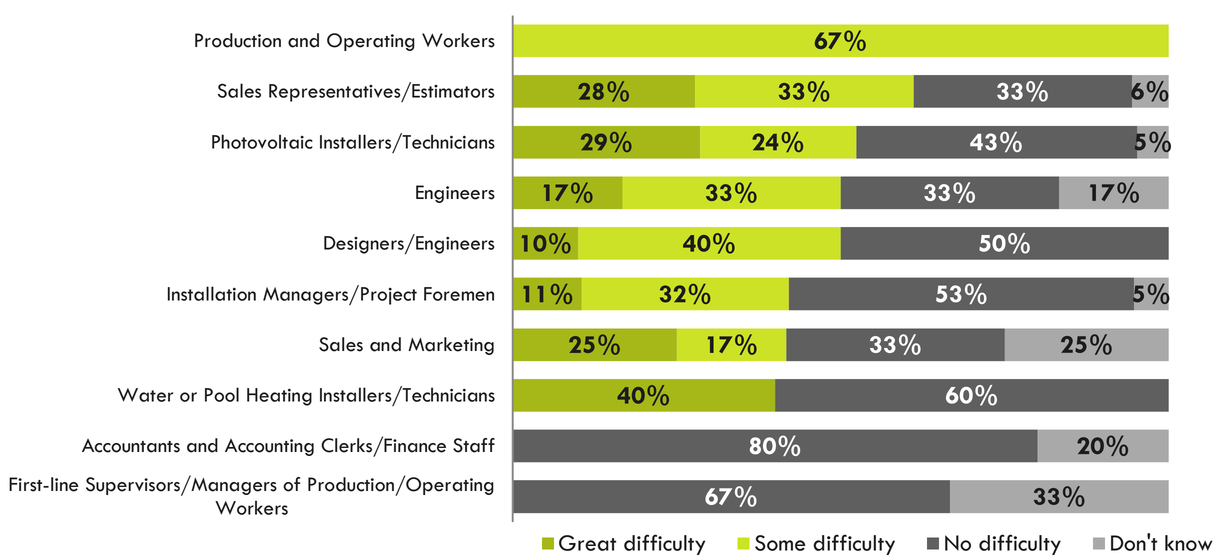
- According to the survey, Central Valley & South Central California firms employ 3,237 solar manufacturing, trade and installation workers in the ten occupations studied. In the next year there may be as many as 2,810 new and replacement jobs for these ten occupations.
- Engineers are the largest occupations with an estimated 896 jobs in 2011. This occupation is also projected to create 728 jobs due to growth as well as 420 replacement jobs in the next year.
- Solar water or pool heating installers or technicians are the second largest occupation in the Central Valley & South Central region, accounting for about 525 jobs. Solar sales representatives or estimators are the third largest with an estimated 400 workers. It is projected to have a replacement rate of 18.8% over the next 12 months, and could create as many as 238 new jobs.

Table C-2: Extrapolated employment and growth for solar occupations in the Central & South Central California

Solar Occupation	2011 Employment	12-month employment (new jobs)	12-month growth rate	12-month replacement jobs	Replacement job rate	New and replacement jobs
Water or Pool Heating Installers/Technicians	525	350	66.7%	0	0.0%	350
Photovoltaic Installers/Technicians	383	273	71.4%	20	5.2%	293
Sales Representatives/Estimators	400	238	59.4%	75	18.8%	313
Designers/Engineers	253	78	30.8%	39	15.4%	117
Installation Managers/Project Foremen	252	120	47.8%	21	8.3%	141
Production and Operating Workers	70	0	0.0%	0	0.0%	0
First-line Supervisors/Managers of Production/Operating Workers	70	140	200.0%	0	0.0%	140
Accountants and Accounting Clerks/Finance Staff	70	35	50.0%	0	0.0%	35
Engineers	896	728	81.3%	420	46.9%	1,149
Sales and Marketing	319	249	78.0%	23	7.3%	272
Total	**3,237**	**2,211**	**68.3%**	**598**	**18.5%**	**2,810**

- Over 50% of the respondents reported having at least some difficulty hiring for seven out of the ten occupations.
- Employers within Central California are having the least difficulty hiring Accountants and Accounting Clerks or Finance staff, and Solar Water or Pool Heating Installers or Technicians.

Figure C-2 Employers' difficulty in hiring for solar occupations



Southern California (Imperial, Los Angeles, Orange, Riverside, San Bernardino, and San Diego Counties)

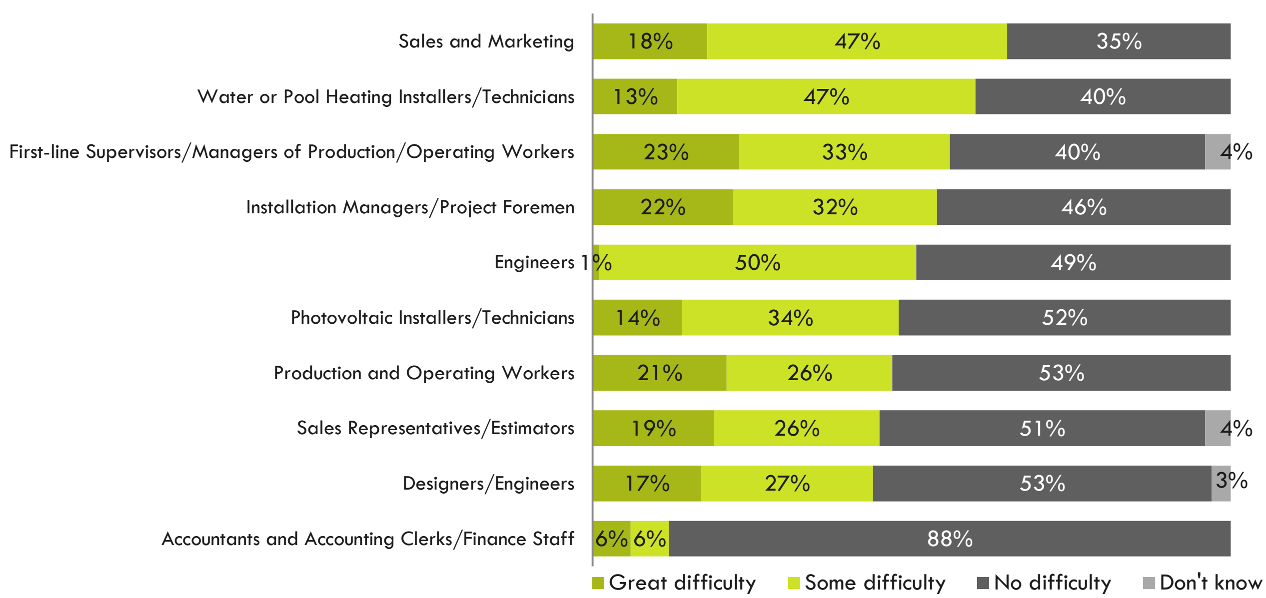
- According to respondents, Southern California firms employ 10,051 solar manufacturing, trade and installation workers in the ten occupations studied. In the next year there may be as many as 4,977 new and replacement jobs within these ten occupations.
- Solar installation managers and project foremen are the largest occupations with an estimated 2,495 workers. This occupation is also projected to create 1,588 new and replacement jobs in the next year.
- Solar photovoltaic installers or technicians are the second largest occupation in Southern California with an estimated 2,196 workers. It is projected to have a replacement rate of 15.2% over the next 12 months, and could create as many as 1,254 new jobs.

Table C-3: Extrapolated employment and growth for solar occupations in Southern California

Solar Occupation	2011 Employment	12-month employment (new jobs)	12-month growth rate	12-month replacement jobs	Replacement job rate	New and replacement jobs
Water or Pool Heating Installers/Technicians	1,135	299	26.3%	170	15.0%	469
Photovoltaic Installers/Technicians	2,196	1,254	57.1%	334	15.2%	1,588
Sales Representatives/Estimators	1,052	641	61.0%	200	19.0%	841
Designers/Engineers	842	114	13.5%	57	6.8%	171
Installation Managers/Project Foremen	2,495	314	12.6%	217	8.7%	531
Production and Operating Workers	860	339	39.4%	95	11.0%	434
First-line Supervisors/Managers of Production/Operating Workers	357	167	46.7%	47	13.3%	214
Accountants and Accounting Clerks/Finance Staff	280	103	36.8%	15	5.3%	118
Engineers	371	206	55.6%	56	15.2%	263
Sales and Marketing	464	293	63.3%	56	12.0%	349
Total	**10,051**	**3,730**	**37.1%**	**1,247**	**12.4%**	**4,977**

- Over 50% of the respondents reported having at least some difficulty hiring for five out of the ten occupations.
- Employers within Southern California are having the least difficulty hiring Accountants and Accounting Clerks or Finance staff.

Figure C-3 Employers' difficulty in hiring for solar occupations



Appendix F: Occupational Profiles

Occupation: Solar Energy Systems Engineers

Perform site-specific engineering analysis or evaluation of energy efficiency and solar projects involving residential, commercial, or industrial customers. Design solar domestic hot water and space heating systems for new and existing structures, applying knowledge of structural energy requirements, local climates, solar technology, and thermodynamics. The following describes in detail some of the tasks that may be required of Solar Energy System Engineers:

- Conduct engineering site audits to collect structural, electrical, and related information for use in the design of solar power systems.
- Design or coordinate design of photovoltaic or solar thermal systems, including system components.
- Create checklists for review or inspection of completed solar installation projects.
- Create electrical single-line diagrams, panel schedules, or connection diagrams for solar electric systems using computer-aided design (CAD) software.
- Create plans for solar energy system development, monitoring, and evaluation activities.
- Develop design specifications and functional requirements for solar energy systems or components.
- Perform computer simulation of solar photovoltaic generation system performance or energy production to optimize efficiency.
- Provide technical direction or support to installation teams during installation, start-up, testing, system commissioning, or performance monitoring.
- Design or develop vacuum tube collector systems for solar applications.
- Develop standard operation procedures and quality or safety standards for solar installation work.

Occupation: Energy Engineers

Design, develop, or evaluate energy-related projects or programs to reduce energy costs or improve energy efficiency during the designing, building, or remodeling stages of construction; may specialize in electrical systems, heating, ventilation, and air-conditioning (HVAC) systems, green buildings; lighting; air quality, or energy procurement. The following describes in detail some of the tasks that may be required of Energy Engineers:

- Identify energy savings opportunities and make recommendations to achieve more energy efficient operation.
- Manage the development, design, or construction of energy conservation projects to ensure acceptability of budgets and time lines, conformance to federal and state laws, or adherence to approved specifications.
- Conduct energy audits to evaluate energy use, costs, or conservation measures.
- Monitor and analyze energy consumption.
- Perform energy modeling, measurement, verification, commissioning, or retro-commissioning.
- Oversee design or construction aspects related to energy such as energy engineering and sustainable design.
- Conduct jobsite observations, field inspections, or sub-metering to collect data for energy conservation analyses.
- Review architectural, mechanical, or electrical plans and specifications to evaluate energy efficiency or determine economic, service, or engineering feasibility.
- Inspect or monitor energy systems, including heating, ventilating, and air conditioning (HVAC) or day-lighting systems to determine energy use or potential energy savings.
- Evaluate construction design information such as detail and assembly drawings and design calculations.

Required Knowledge, Skills, and Abilities:

Knowledge	Skills	Abilities
Engineering & Technology	Oral, Reading & Writing Competency	Deductive & Inductive Reasoning
Mathematics	Critical Thinking	Effective Oral & Written Communication
English Language	Complex Problem Solving	Problem Sensitivity
Building & Construction	Monitoring	Information Ordering
Physics	Active Learning	Near Vision
Design	Judgment & Decision Making	
Mechanical		
Administration & Management		
Computers & Electronics		
Economics & Accounting		

Engineers, All Other encapsulates the sector, wage, and educational data for Solar Energy Systems and Energy Engineers. The "All Other" title represent occupations with a wide range of characteristics which do not fit into one of the detailed O*NET-SOC occupations.

Occupational Wage and Employment Trends: Engineers, All Other are primarily found in two sectors; manufacturing (32% are employed in this sector), and professional, scientific, and technical services (25% are employed in this sector). In 2011, the national average wage for Engineers, All Other was $38.90 hourly. The average wage in 2011 for California was $43.92 hourly. In 2011 there were 188,875 Engineers, All Other nationally. The national projected growth of these occupations over the next five years is 3%, which is a gain of 5,398 jobs.

Education and Training: The most common educational or training level for Engineers, All Other is a Bachelor's degree.

Other Job Titles Associated with Solar Energy System & Energy Engineers:

- Energy Efficiency Engineers
- Energy/Distributed Generation Project Manager
- Environmental Solutions Engineer
- Industrial Engineer
- Measurement & Verification Engineer
- Test & Balance Engineer

Occupation: Mechanical Engineers

Planning and designing tools, engines, machines, and other mechanically functioning equipment; oversee installation, operation, maintenance, and repair of equipment such as centralized gas or steam systems. The following describes in detail some of the tasks that may be required of Mechanical Engineers.

- Read and interpret blueprints, technical drawings, schematics, or computer-generated reports.
- Assist drafters in developing the structural design of products using drafting tools or computer-assisted design (CAD) or drafting equipment and software.
- Research, design, evaluate, install, operate, and maintain mechanical products, equipment, systems and processes to meet requirements, applying knowledge of engineering principles.
- Confer with personnel to implement operating procedures or resolve system malfunctions.
- Recommend design modifications to eliminate machine or system malfunctions.
- Conduct research that analyzes feasibility, design, operation, of equipment or systems.
- Investigate failures to diagnose faulty operation, and to make maintenance recommendations.

- Develop and test models of alternate designs and processing methods to assess feasibility, operating condition effects, possible new applications and necessity of modification.
- Develop, coordinate, or monitor all aspects of production, including selection of manufacturing methods, fabrication, or operation of product designs.
- Direct modification of products to ensure conformance with engineering design and specifications.

Occupational Wage and Employment Trends: Mechanical Engineers are primarily found in two sectors; manufacturing (51% are employed in this sector), and professional, scientific, and technical services (29% are employed in this sector). In 2011 the national average wage for Mechanical Engineers was $36.19 hourly. The average wage in 2011 for California was $39.79 hourly. In 2011 there were 243,280 Mechanical Engineers nationally. The national projected growth of these occupations over the next five years is 0.8%, which is a gain of 2,056 jobs.

Education and Training: The most common educational or training level for Mechanical Engineers is a Bachelor's degree.

Required Knowledge, Skills, and Abilities:

Knowledge	Skills	Abilities
Engineering & Technology	Oral, Reading & Writing Competency	Deductive & Inductive Reasoning
Mathematics & Physics	Critical Thinking	Effective Oral & Written Communication
English Language	Complex Problem Solving	Problem Sensitivity
Building & Construction	Monitoring	Information Ordering
Mechanics	Active Learning	Near Vision
Design	Judgment & Decision Making	
Administration & Management		
Computer & Electronics		
Economics & Accounting		

Other Job Titles Associated with Mechanical Engineers:

- Design/Product/Equipment/Systems/Commissioning Engineers

Occupation: Electrical Engineer

Research, design, develop, test, or supervise the manufacturing and installation of electrical equipment, components, or systems for commercial, industrial, military, or scientific use. The following describes in detail some of the tasks that may be required of Electrical Engineers:

- Prepare technical drawings, specifications of electrical systems, or topographical maps to ensure that installation and operations conform to standards and customer requirements.
- Operate computer-assisted engineering or design software or equipment to perform tasks.
- Confer others to discuss existing or potential engineering projects or products.
- Direct or coordinate manufacturing, construction, installation, maintenance, support, documentation, or testing activities to ensure compliance with specifications, codes, or customer requirements.
- Design, implement, maintain, or improve electrical instruments, equipment, facilities or systems.
- Prepare specifications for purchases of materials or equipment.
- Perform detailed calculations to compute and establish manufacturing, construction, or installation specifications.
- Investigate complaints, determine nature and extent of problem, and recommend remedial measures.
- Oversee project production efforts to assure projects are completed on time and within budget.
- Plan or implement research methodology to apply principles of electrical theory to projects.

Occupational Wage and Employment Trends: Electrical Engineers are primarily found in two sectors; manufacturing (37% are employed in this sector), and professional, scientific, and technical services (32% are employed in this sector). In 2011 the national average wage for Electrical Engineers was $38.89 hourly. The average wage in 2011 for California was $43.81 hourly. In 2011 there were 154,663 Electrical Engineers nationally. The national projected growth of these occupations over the next five years is 0.2%, which is a gain of 357 jobs.

Education and Training: The most common educational or training level for Electrical Engineers is a Bachelor's degree.

Required Knowledge, Skills, and Abilities:

Knowledge	Skills	Abilities
Engineering & Technology	Oral, Reading & Writing Competency	Deductive & Inductive Reasoning
Mathematics & Physics	Critical Thinking	Effective Oral & Written Communication
English Language	Complex Problem Solving	Problem Sensitivity
Customer & Personal Service	Monitoring	Information Ordering
Mechanical	Active Learning	Near Vision
Design	Judgment & Decision Making	Use different sets of rules for grouping things
Administration & Management	Time Management	
Computers & Electronics		
Public Safety & Security		

Other Job Titles Associated with Electrical Engineers:

- Product/Test/Hardware Design/Circuits Engineers

Occupation: Solar Thermal Installers and Technicians (Solar Water or Pool Heating Installers or Technicians)

Install or repair solar energy systems designed to collect, store, and circulate solar-heated water for residential, commercial or industrial use. The following describes in detail some of the tasks that may be required of Solar Thermal Installers and Technicians:

- Design active direct or indirect, passive direct or indirect, or pool solar systems.
- Perform maintenance or repairs to solar thermal systems.
- Apply operation or identification tags to system components, as required.
- Assess collector sites to ensure structural integrity of potential mounting surfaces or the best orientation and tilt for solar collectors.
- Connect water heaters and storage tanks to power and water sources.
- Determine locations for installing solar subsystem components, including piping, water heaters, valves, and ancillary equipment.
- Fill water tanks and check tanks, pipes, and fittings for leaks.
- Identify plumbing, electrical, environmental, or safety hazards associated with solar thermal installations.
- Install circulating pumps using pipe, fittings, soldering equipment, electrical supplies, and tools.
- Install plumbing using pipes, fittings, pipe cutters, acetylene torches, solder, wire brushes, sand cloths, flux, plastic pipe cleaners, or plastic glue.

Occupational Wage and Employment Trends: Solar Thermal Installers and Technicians fall under the occupational category of Construction and Related Workers, All Other. These occupations are primarily found in two sectors; construction (38% are employed in this sector), and administrative and support services (17% are employed in this sector). In 2011 the national average wage for Construction and

Related Workers, All Other was $16.31 hourly. The average wage in 2011 for California was $17.45 hourly. In 2011 there were 54,499 Construction and Related Workers, All Other nationally. The national projected growth of these occupations over the next five years is 4.6%, which is a gain of 2,533 jobs.

Education and Training: The most common educational or training level for Construction and Related Workers, all other is a high school diploma or equivalent. According to the COE survey, the minimum hiring requirements for Solar Water or Pool Heating Installers or Technicians are on-the-job training or a certificate/degree from a community college or vocational school.

The "All Other" titles represent occupations with a wide range of characteristics which do not fit into one of the detailed O*NET-SOC occupations.

Required Knowledge, Skills, and Abilities: NOT YET AVAILABLE

Occupation: Solar Photovoltaic Installers (or Technicians)

Assemble, install, or maintain solar photovoltaic (PV) systems on roofs or other structures in compliance with site assessment and schematics; may include measuring, cutting, assembling, and bolting structural framing and solar modules, and may perform minor electrical work such as current checks. The following describes in detail some of the tasks that may be required of Solar Photovoltaic Installers or Technicians:

- Assemble solar modules, panels, or support structures, as specified.
- Install active solar systems, including solar collectors, concentrators, pumps, or fans.
- Install photovoltaic systems in accordance with codes and standards using drawings, schematics, and instructions.
- Perform photovoltaic system maintenance on modules, arrays, batteries, power conditioning equipment, safety systems, structural systems, weather sealing, or balance of systems equipment.
- Activate photovoltaic systems to verify functionality and conformity to performance expectations.
- Apply weather sealing to array, building, or support mechanisms.
- Check electrical installation for proper wiring, polarity, grounding, or integrity of terminations.
- Determine appropriate sizes, ratings, and locations for all devices and equipment.
- Determine connection interfaces for additional subpanels or for connecting photovoltaic (PV) systems with utility services or other power generation sources.
- Determine photovoltaic (PV) system designs or configurations based on factors such as customer needs, expectations, and site conditions.

Occupational Wage and Employment Trends: Solar Photovoltaic Installers fall under the occupational category of Heating and Air Conditioning Mechanics and Installers. These occupations are primarily found in two sectors; construction (38% are employed in this sector), and administrative and support services (17% are employed in this sector). In 2011 the national average wage for Heating and Air Conditioning Mechanics and Installers was $19.24 hourly. The average wage in 2011 for California was $22.93 hourly. In 2011 there were 319,329 Heating and Air Conditioning Mechanics and Installers nationally. The national projected growth of these occupations over the next five years is 8.9%, which is a gain of 28,483 jobs.

Education and Training: The most common educational or training level for Heating and Air Conditioning Mechanics and Installers is a high school diploma or equivalent. According to the COE employer survey, the minimum hiring requirements for Solar Photovoltaic Installers or Technicians are on-the-job training or a certificate/degree from a community college or vocational school.

Required Knowledge, Skills, and Abilities for Heating and Air Conditioning Mechanics & Installers:

Knowledge	Skills	Abilities
Mechanical	Installation	Near Vision
Customer & Personal Service	Troubleshooting & Repairing	Problem Sensitivity
Mathematics	Equipment Maintenance	Finger Dexterity
Building & Construction	Operation Monitoring	Perceptual Speed
Public Safety & Security	Quality Control Analysis	Visualization
Education & Training	Active Listening	Extent Flexibility
Engineering & Technology	Critical thinking	Manual Dexterity
Design	Operation & Control	Multi-limb Strength
English Language	Judgment & Decision Making	Trunk Strength
		Arm-Hand Steadiness

Occupation: Solar Sales Representatives or Assessors (or Estimators)

Contact new or existing customers to determine their solar equipment needs, suggest systems or equipment, or estimate costs. Solar sales representatives are expected to have some knowledge or experience in construction, accounting, and electrical systems. Additionally, the following background is desired: (1) General business and customer service skills (2) Energy system cost estimation and site analysis, and (3) Knowledge of government requirements and incentives as well as tax implications and municipal codes. The following describes in detail some of the tasks that may be required of Solar Sales Representatives or Estimators:

- Generate solar energy customer leads to develop new accounts.
- Prepare proposals, quotes, contracts, or presentations for potential solar customers.
- Select solar energy products, systems, or services for customers based on energy requirements, site conditions, price, or other factors.
- Assess sites to determine suitability for solar equipment, using equipment such as computer software.
- Calculate potential solar resources or solar array production for a particular site considering issues such as climate, shading, and roof orientation.
- Create customized energy management packages to satisfy customer needs.
- Develop marketing or strategic plans for sales territories.
- Gather information from prospective customers to identify their solar energy needs.
- Prepare or review detailed design drawings, specifications, or lists related to solar installations.
- Provide customers with information such as quotes, orders, sales, shipping, warranties, credit, funding options, incentives, or tax rebates.

Occupational Wage and Employment Trends: Solar Sales Representatives or Assessors fall under the occupational category of Sales Representatives, Wholesale and Manufacturing, Technical and Scientific Products. These occupations are primarily found in two sectors; wholesale trade (58% are employed in this sector), and manufacturing (11% are employed in this sector). In 2011 the national average wage for Sales Representatives, Wholesale and Manufacturing, Technical and Scientific Products was $33.56 hourly. The average wage in 2011 for California was $36.05 hourly. In 2011 there were 428,679 Sales Representatives, Wholesale and Manufacturing, Technical and Scientific Products nationally. The national projected growth of these occupations over the next five years is 5.5%, which is a gain of 23,696 jobs.

Education and Training: The most common educational or training level for Sales Representatives, Wholesale and Manufacturing, Technical and Scientific Products is a Bachelor's degree. Solar Sales Representatives or Estimators occupations generally require a business related Associates or Bachelor's degree depending on employer requirements.

Required Knowledge, Skills, and Abilities for Sales Representatives, Wholesale and Manufacturing, Technical and Scientific Products:

Knowledge	Skills	Abilities
Sales & Marketing	Oral & Reading Competency	Oral & Written Communication
Customer & Personal Service	Persuasion & Negotiation	Deductive & Inductive Reasoning
English Language	Social Perceptiveness	Near Vision
Computer & Electronics	Service Orientation	Problem Sensitivity
Production & Processing	Active Learning	
	Complex Problem Solving	
	Coordination	

Other Job Titles Associated with Sales Representatives, Wholesale and Manufacturing, Technical and Scientific Products:

- Account/Account Development Sales/Distribution Sales/Inside Sales Manager
- Account Executive
- Channel Sales/Sales Director
- Marketing Representative

Occupation: Solar Energy Installation Managers (or Project Foremen)

Direct work crews installing residential or commercial solar photovoltaic or thermal systems. The following describes in detail some of the tasks that may be required of Solar Energy Installation Managers:

- Plan and coordinate installations of photovoltaic (PV) solar and solar thermal systems to ensure conformance to codes.
- Supervise solar installers, technicians, and subcontractors for solar installation projects to ensure compliance with safety standards.
- Assess potential solar installation sites to determine feasibility and design requirements.
- Assess system performance or functionality at the system, subsystem, and component levels.
- Coordinate or schedule building inspections for solar installation projects.
- Monitor work of contractors and subcontractors to ensure projects conform to plans, specifications, schedules, or budgets.
- Perform start-up of systems for testing or customer implementation.
- Provide technical assistance to installers, technicians, or other solar professionals in areas such as solar electric systems, solar thermal systems, electrical systems, and mechanical systems.
- Visit customer sites to determine solar system needs, requirements, or specifications.
- Develop and maintain system architecture, including all piping, instrumentation, or process flow diagrams.

Occupational Wage and Employment Trends: Solar Energy Installation Managers fall under the occupational category of First-Line Supervisors/Managers of Construction Trades and Extraction Workers. These occupations are primarily found in two sectors; construction (63% are employed in this sector), and self-employed (19% are employed in this sector). In 2011 the national average wage for First-Line Supervisors/Managers of Construction Trades and Extraction Workers was $24.04 hourly. The average wage in 2011 for California was $30.00 hourly. In 2011 there were 772,639 First-Line Supervisors/Managers of Construction Trades and Extraction Workers nationally. The national projected growth of these occupations over the next five years is 7.2%, which is a gain of 55,833 jobs.

Education and Training: The most common educational or training level for First-Line Supervisors/Managers of Construction Trades and Extraction Workers is a high school diploma or equivalent. Most Solar Installation Managers or Project Foremen are required to have related on-the-job experience and/or Associate's degree; however, some positions require a bachelor's degree.

Required Knowledge, Skills, and Abilities:

Knowledge	Skills	Abilities
Building & Construction	Oral & Reading Competency	Oral & Written Communication
Administration & Management	Coordination	Problem Sensitivity
Mathematics	Critical Thinking	Deductive & Inductive Reasoning
Customer & Personal Service	Time Management	Near Vision
Mechanical	Management of Personnel Resources	Information Ordering
Public Safety & Security	Social Perceptiveness	Selective Attention
Design	Judgment & Decision Making	
Production & Processing	Monitoring	
Engineering & Technology		
Personnel & Human Resources		

Other Job Titles Associated with First-Line Supervisors/Managers of Construction Trades and Extraction Workers:

- Construction/Field Supervisor
- Construction/Job/Field Operations/General Foremen
- Construction/Project Superintendent

Occupation: Manufacturing Production Technicians (Production and Operating Workers)

The following describes in detail some of the tasks that may be required of Manufacturing Production Technicians:

- Adhere to all applicable regulations, policies, and procedures for health, safety, and environmental compliance.
- Inspect finished products for quality and adherence to customer specifications.
- Set up and operate production equipment in accordance with current good manufacturing practices and standard operating procedures.
- Calibrate or adjust equipment to ensure quality production, using tools such as calipers, micrometers, height gauges, protractors, or ring gauges.
- Set up and verify the functionality of safety equipment.
- Monitor and adjust production processes or equipment for quality and productivity.
- Troubleshoot problems with equipment, devices, or products.
- Test products or subassemblies for functionality or quality.
- Plan and lay out work to meet production and schedule requirements.
- Start up and shut down processing equipment.

Occupational Wage and Employment Trends: Production and Operating Workers fall under the occupational category of Manufacturing Production/Industrial Engineering Technicians. These occupations are primarily found in two sectors; manufacturing (28% are employed in this sector), and government (24% are employed in this sector). In 2011 the national average wage of Manufacturing Production/Industrial Engineering Technicians was $22.36 hourly. The average wage in 2011 for California was $21.86 hourly. In 2011 there were 66,930 Manufacturing Production/Industrial Engineering Technicians nationally. The national projected growth of these occupations over the next five years is 1.5%, which is a gain of 972 jobs.

Education and Training: The most common educational or training level for Manufacturing Production Technicians is some college, no degree.

Required Knowledge, Skills, and Abilities:

Knowledge	Skills	Abilities
Mechanical	Operation Monitoring	Problem Sensitivity
Production & Processing	Critical Thinking	Oral & Written Communication
Engineering & Technology	Oral Competency	Deductive & Inductive Reasoning
Mathematics	Equipment maintenance	Visualization
Design	Monitoring	Near Vision
Computers & Electronics	Complex Problem Solving	Arm-Hand Steadiness
English Language	Operation & Control	
	Quality Control Analysis	

Other Job Titles Associated with Manufacturing Production Technicians:

- Research and Development Machinist

Occupation: First-line Supervisors of Production and Operating Workers (or Managers)

Directly supervise and coordinate the activities of production and operating workers, such as inspectors, precision workers, machine setters and operators, assemblers, fabricators, and plant and system operators. The following describes in detail some of the tasks that may be required of First-line Supervisors of Production and Operating Workers:

- Enforce safety and sanitation regulations.
- Direct and coordinate the activities of employees engaged in the production or processing of goods, such as inspectors, machine setters, and fabricators.
- Confer with other supervisors to coordinate operations and activities within or between departments.
- Plan and establish work schedules, assignments, and production sequences to meet production goals.
- Inspect materials, products, or equipment to detect defects or malfunctions.
- Observe work and monitor gauges, dials, and other indicators to ensure that operators conform to production or processing standards.
- Conduct employee training in equipment operations or work and safety procedures, or assign employee training to experienced workers.
- Interpret specifications, blueprints, job orders, and company policies and procedures for workers.
- Keep records of employees' attendance and hours worked.
- Read and analyze charts, work orders, production schedules, and other records and reports to determine production requirements and to evaluate current production estimates and outputs.

Occupational Wage and Employment Trends: First-line Supervisors of Production and Operating Workers are primarily found in the manufacturing industry (70% are employed in this sector). In 2011 the national average wage for First-line Supervisors of Production and Operating Workers was $24.49 hourly. The average wage in 2011 for California was $25.44 hourly. In 2011 there were 634,756 First-line Supervisors of Production and Operating Workers nationally. The national employment for this occupation is projected to decline over the next five years by -2.4%, which is a loss of 15,365 jobs.

Education and Training: The most common educational or training level for First-line Supervisors of Production and Operating Workers is a high school diploma or equivalent. However, according to the COE employer survey, most First-line Supervisors of Production and Operating Workers are required to have related on-the-job experience and/or an Associate's degree.

Required Knowledge, Skills, and Abilities:

Knowledge	Skills	Abilities
Production & Processing	Oral, Reading & Writing Competency	Oral & Written Communication
Mechanical	Coordination	Problem Sensitivity
Administration & Management	Critical Thinking	Deductive & Inductive Reasoning
Personnel & Human Resources	Time Management	Use different sets of rules for grouping things
Engineering & Technology	Management of Personnel Resources	
Computers & Electronics	Social Perceptiveness	
Education & Training	Judgment & Decision Making	
	Monitoring	

Other Job Titles Associated with First-line Supervisors of Production and Operating Worker:

- Production/Manufacturing/Shift/Molding/Assembly Supervisor
- Production/Plant/Department Manager
- Team Leader

Occupation: Accountants (and accounting clerks or finance staff)

Analyze financial information and prepare financial reports to determine or maintain record of assets, liabilities, profit and loss, tax liability, or other financial activities within an organization. The following describes in detail some of the tasks that may be required of Accountants:

- Prepare, examine, or analyze accounting records, financial statements, or other financial reports to assess accuracy, completeness, and conformance to reporting and procedural standards.
- Report to management regarding the finances of establishment.
- Establish tables of accounts and assign entries to proper accounts.
- Develop, implement, modify, and document recordkeeping and accounting systems, making use of current computer technology.
- Compute taxes owed and prepare tax returns, ensuring compliance with payment, reporting or other tax requirements.
- Maintain or examine the records of government agencies.
- Advise clients in areas such as compensation, employee health care benefits, the design of accounting or data processing systems, or long-range tax or estate plans.
- Develop, maintain, and analyze budgets, preparing periodic reports that compare budgeted costs to actual costs.
- Provide internal and external auditing services for businesses or individuals.
- Analyze business operations, trends, costs, revenues, financial commitments, and obligations, to project future revenues and expenses or to provide advice.

Occupational Wage and Employment Trends: Accountants are primarily found in the professional, scientific, and technical services industry (30% are employed in this sector). In 2011 the national average wage for Accountants was $24.02 hourly. The average wage in 2011 for California was $25.34 hourly. In 2011 there were 1,537,886 Accountants and Auditors nationally. The national projected growth of these occupations over the next five years is 9.8%, which is a gain of 150,511 jobs.

Education and Training: The most common educational or training level for Accountants is a Bachelor's degree.

Required Knowledge, Skills, and Abilities:

Knowledge	Skills	Abilities
Economics & Accounting	Oral, Reading & Writing Competency	Mathematical Reasoning
Mathematics	Judgment & Decision Making	Oral & Written Communication
English Language	Complex Problem Solving	Number Facility
Clerical	Time Management	Deductive & Inductive Reasoning
Computers & Electronics	Active Learning	Problem Sensitivity
Administration & Management		Near Vision
Customer & Personal Service		
Law & Government		

Other Job Titles Associated with Accountants:

- Certified Public Accountant (CPA)
- Staff/General/Cost/Financial Reporting Accountant
- Accounting Manager/Officer/Supervisor
- Business Analyst

Occupation: Green Marketers (Sales and Marketing Representatives)

The following describes in detail some of the tasks that may be required of Green Marketers:

- Analyze green product marketing or sales trends to forecast future conditions.
- Analyze the effectiveness of marketing tactics or channels.
- Attend or participate in conferences, community events, and promotional events related to green products or technologies.
- Conduct research on consumer opinions and buying habits, and identify target audiences for green products, services, or technologies.
- Develop branding or sales initiatives for green products, such as solar energy systems, green cleaning products, or products using renewable or recycled materials.
- Develop communications materials, advertisements, presentations, or public relations initiatives to promote awareness of green products and technologies.
- Develop comprehensive marketing strategies, using knowledge of green products and technologies, markets, and regulations.
- Identify marketing channels for green products or services.
- Revise existing marketing plans or campaigns for green products, technologies, or services.
- Write marketing content for green product web sites, brochures, or other communication media.

Occupational Wage and Employment Trends: Green Marketers are housed under the Advertising and Promotions Managers occupational category. These occupations are primarily found in two sectors; professional, scientific, and technical services (21% are employed in this sector), and self-employed (17% are employed in this sector). In 2011 the national average wage for Advertising and Promotions Managers was $31.44 hourly. The average wage in 2011 for California was $32.43 hourly. In 2011 there were 56,418 Accountants and Auditors nationally. The national projected growth of these occupations over the next five years is 2.4%, which is a gain of 1,370 jobs.

Education and Training: The most common educational or training level for Green Marketers is a Bachelor's degree.

Required Knowledge, Skills, and Abilities:

Knowledge	Skills	Abilities
English Language	Oral, Reading & Writing Competency	Oral & Written Communication
Communication & Media	Time Management	Deductive Reasoning
Administration & Management	Critical Thinking	Problem Sensitivity
Sales & Marketing	Judgment & Decision Making	Fluency of Ideas
Customer & Personal Service	Complex Problem Solving	Originality
Computers & Electronics	Coordination	
Clerical		
Production & Processing		
Telecommunications		

Other Job Titles Associated with Green Marketers:

- Advertising/Sales/Marketing/Marketing and Promotions Manager
- Promotions/Advertising/Marketing Director
- Account Executive

Appendix G: College Data and Survey Method

College Program Inventory

To identify solar programs active in the California Community College (CCC) system, a number of methods were employed. First, a preliminary internet search to identify community college solar programs was conducted. This process included a search of the CCC Chancellor's office website and a review of previously published reports. After the initial list of programs was compiled, it was sent to several representatives within community colleges for review and to provide insight on additional programs not yet identified.

Table D-1 lists community colleges in California that provide associate degree, certificate, or course only offerings in solar by region.

College Survey

Once the list of programs was compiled, the main contact for each program was emailed and asked to complete a short survey about their solar program(s).

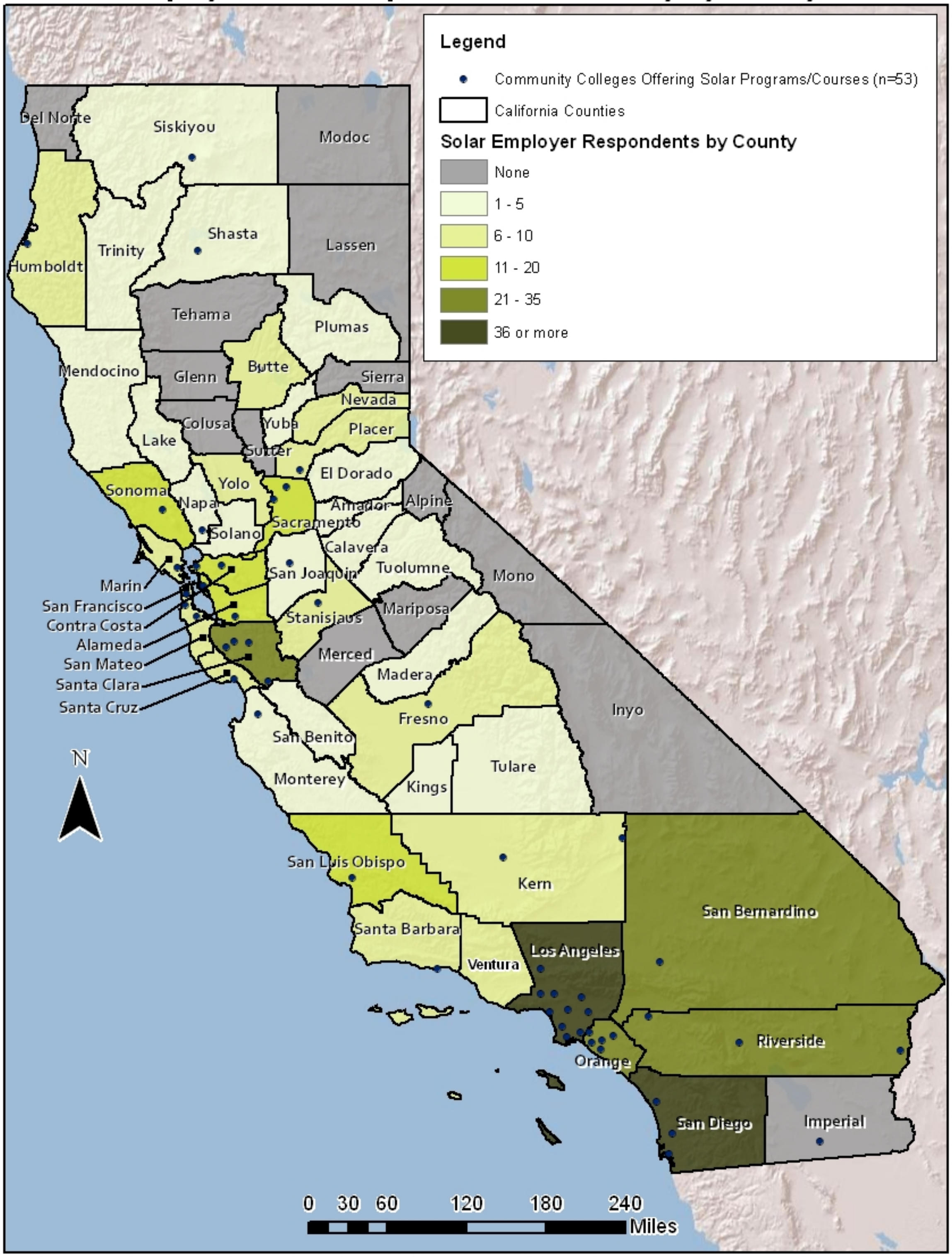
Technique	Online survey
Population	54 community colleges with solar programs/offerings
Sample	18 college respondents
Field dates	September-October 2011

Of the 54 individuals emailed, 19 responded and 18 fully completed the survey, yielding a 33% response rate. Some of the colleges that responded, however, represent more than one solar training program. In total, the 19 responding colleges represented 31 active programs, roughly 36% of all identified training programs.

It is important to note that respondents typically completed one survey regardless of the number of programs active at their college. As a result, the data reflects information regarding the 31 college solar programs and not the disaggregated data from each of the individual training programs.

For additional information on data methodology or to request a copy of the survey questions, please contact the Center of Excellence at www.coeccc.net.

Solar Employers* that Responded to COE Survey by County, 2011



Developed by Centers of Excellence, California Community Colleges. *Total of 427 Solar Employers responded to survey in CA.
Software is provided by ESRI.

Table D-1: Solar Programs by Region and College

Region	College Title	Associate Degree	Certificate	Course Only	Unknown
Bay Area	Cabrillo College				1
	Contra Costa College			2	
	Diablo Valley	2	2		
	Evergreen Valley College				1
	Laney College			2	
	Marin, College of			1	
	Napa Valley College				1
	Ohlone College		1		
	San Francisco, City College of			2	
	San Jose City College			2	
	San Mateo, College of			1	
	Santa Rosa Junior College		1		
	Skyline			2	
	West Valley College			1	
Central Valley	Fresno City College			1	
	Gavilan				1
	Hartnell College			1	
	Modesto Junior College			1	
	San Joaquin Delta College				1
	Bakersfield College			1	
	Cerro Coso		1		
Desert/Inland Empire	Riverside City College				1
	San Bernardino CCD/Prof. Development Center			1	
	Victor Valley		1		
	Desert, College of the			1	
LA & Orange	Cypress			1	
	El Camino College			1	
	Golden West College	1	2		
	L.A. Trade-Tech	4	2		
	Long Beach City College		1		
	Los Angeles Harbor College				1
	Los Angeles Pierce College			2	
	Los Angeles Southwest College			1	
	Los Angeles Valley College			2	
	Orange Coast College			3	
	Pasadena City College		1		
	Rio Hondo College	1	1		
	Santa Ana College			1	
	Santa Monica City College	1	1		
	Santiago Canyon College		1		
Northern	American River		2		
	Butte College			1	
	Redwoods, College of the		1		
	Sacramento City College			1	
	Shasta College			2	
	Sierra College	1	2		
	Siskiyou, College of the				1
San Diego & Imperial	Imperial Valley		1		
	Mira Costa College			1	
	Miramar College				1
	San Diego City College		2		
South Central	College of the Canyons		1		
	Cuesta College			2	
	Santa Barbara City College			1	
	TOTAL Offerings	**10**	**24**	**38**	**9**