ECONOMIC & WORKFORCE DEVELOPMENT
through the CALIFORNIA COMMUNITY COLLEGES

BUSINESS AND WORKFORCE PERFORMANCE IMPROVEMENT INITIATIVE

Solar Technicians

Occupational Environmental Scan for California Community Colleges

Inland Empire Region

December 2007

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Executive Summary

Solar Technician (Installer) is a new occupation that appeared only a couple decades ago. However, with the accelerated growth of the solar energy industry, demand for qualified installers and repairers in this field is quickly growing. California, which has the most aggressive solar program in the country, presently accounting for 73% of all the U.S. solar installations, is projected to create 3,578 jobs for Photovoltaic (PV) System Installers and 780 for Solar Thermal System Installers by 2015.

In part due to incentives provided by the California Solar Initiative (CSI), legislated in 2006, the solar energy market is expected to explode. Major solar energy employers state that CSI has a "tremendous psychological impact on the industry, giving solar companies a much longer planning horizon to work with, greater confidence in making investments, more volume and market growth, and ultimately a faster pace of innovation."[1] At this pace, the optimistic employment projections by the state are that solar energy will open 40,000 new construction and maintenance jobs by 2016, with Solar Technician being at least one third of that total.

Analysis of the existing sources of information has revealed a potential future gap between the demand and supply of qualified solar energy technicians, unless the appropriate training programs are set up to meet the employers' needs. There are only three colleges in all of California that currently offer specific solar energy programs or courses, and only one provides the NABCEP[2] certified curriculum. Many employers therefore must hire entry-level technicians with some construction-related knowledge and provide on-the-job training or hire outside training organizations.

The best way for community colleges to meet the increasing industry need in solar professionals is to offer a certificate training program and possibly obtain NABCEP approval to utilize its curriculum. This is the model used by Diablo Valley College. The other more long-term approach is to partner with solar industry companies to provide apprenticeship programs in Solar Technology. There is also an opportunity for community colleges to present curriculum pertaining to a broader area than solar only – including sustainable and renewable energy – to meet the employment needs of a wider spectrum of companies.

[1] "Solar: California's Rising Star" by Claudia Graziano, November 10, 2006, RenewableEnergyAccess.com

[2] NABCEP = North American Board of Certified Energy Practitioners

Introduction

The Economic & Workforce Development (EWD) Network found that the Solar Technician occupation offers a strategic opportunity for California community colleges to provide trade-specific education and training. This report provides an overview of various aspects of the Solar Technician occupation, including a solar industry overview; key issues affecting employment; job growth potential; occupational skill sets; and existing programs and curricula.

In the Industry Overview, we present a variety of factors that will further influence the increasing demand for solar energy, expanding employment opportunities for qualified workers. **Enacted into law in 2006, the California Solar Initiative (CSI)[3] is expected to provide 3,995 operations and maintenance jobs through the year 2016, and 14,265 jobs through 2026**. Encouraged by the state incentives, investors are positively responding with new capital inflows into solar PV projects. As research and development efforts identify options to reduce the high cost of solar energy, industry growth will continue to accelerate.

Entry-level compensation rates for solar installers are not very attractive, but career opportunities are very good. Solar companies pay low entry-level wages, in part because they are concerned about the cost of each installation. However, promotion along the career ladder is much faster compared to traditional construction trades. Those with specific training and certifications will be in demand by the industry and will receive more frequent pay increases.

Although the number of jobs available for Solar Technicians in the next decade is relatively small for community colleges to launch training throughout California, there are regions that are particularly in need of solar workforce development. Predominantly, these are the regions with aggressive municipal incentive programs and high concentrations of solar companies, such as the Los Angeles - San Diego area, Bay area and Sacramento. If colleges pursue partnerships with employers in their service areas, certificate programs in solar system integration could be a potential way of meeting industry's needs.

Note that the major limitation for this occupational analysis is the lack of workforce data on the solar industry, given its status as an emerging sector. Since neither solar technicians nor the solar industry exists as a category within the common labor market databases, secondary sources such as publications, periodicals and interviews with industry representatives were utilized to prepare this summary of the current market.. The EWD is currently conducting primary research on California's solar industry, focusing on collecting workforce data. When this research is completed in the Spring of 2008, a more thorough analysis will be available to the community colleges.

[3] California Solar Initiative aims to install 3,000 megawatts of solar energy on 1 million homes, businesses and public buildings over 11 years.(www.millionsolarroofs.org)

Industry Overview

The solar energy industry is perceived to be one of the most rapidly growing emerging industries in the U.S. and in California. Although there are certain market pitfalls associated with the high cost of producing solar cells, governmental policies and venture capital keep pushing the industry forward.

On average, U.S. solar companies are expecting 30-40% annual growth in the next decade.[4] According to the U.S. Solar Industry Review, the National Solar Energy Industry saw record growth in 2006 due to increased customer and utility demand – a result of rising energy prices as well as the expansion of federal and state support for solar deployment. The 2005 Energy Policy Act (EPAct) took effect in January of 2006 providing significant tax credits for solar installations. In addition, the California Solar Initiative was passed with $3.35 billion in funding for new systems and the president's Solar America Initiative was created to double the funding for research, development, and deployment of solar energy technologies to provide energy alternatives.[5] All these factors support predictions of a boom in the solar industry and related occupations.

Understanding the Industry Structure

There are two major system technologies associated with solar energy: Photovoltaic systems, and Solar Water Heating/Thermal systems.

Photovoltaic (PV) systems are high-tech solid state solar modules that convert radiant sunlight directly into electricity. This converted electricity is collected and stored in batteries of various sizes and can be used as needed.[6] PV systems present a unique energy alternative and draw the most attention from the government, venture capitalists and media. The challenge associated with PV is the high cost and limited supply of silicon, which is used to construct the solar panels. Growth of solar PV will greatly depend on how and when this challenge is resolved.

Solar Thermal systems use direct heat from the sun, concentrating it in some manner to produce heat at useful temperatures.[7] Solar water heating system (non-swimming pool) installations have recently been supported by governmental incentives, and their number is expected to grow 50% annually.[8]

Solar Thermal and PV systems are also utilized on a large commercial scale in *concentrating solar power (CSP) plants*. These CSP plants are utility-scale generators that produce electricity by using mirrors or lenses to efficiently concentrate the sun's energy. Most of the existing CSP plants are based on solar thermal systems; the largest

[4] These numbers are based on our interviews of solar companies and their presentations at the Solar Power Conference 2007 in Long Beach, at which 12,500 participated.
[5] U.S. Solar Industry Year in Review, 2006, Solar Energy Industry Association (SEIA)
[6] California Employment Development Department, Labor Market Information, Occupational Guides http://www.calmis.ca.gov/file/occguide/SOLAR.HTM
[7] Energy Information Administration, at www.eia.doe.gov
[8] U.S. Solar Industry Year in Review, 2006, Solar Energy Industry Association (SEIA)

one in the world is a 310 MW (megawatt) parabolic trough facility, located in the Mojave Desert (Kramer Junction, California) and owned by FPL Energy, a member of Florida Power and Light Group. According to a number of recently signed contracts nationwide, CSP plants will be located in the U.S. Southwest, with potential production of 473,000 GWh (gigawatts) per year and thousands of new jobs (see Appendix B for announced CSP projects). California is expected to account for over half of that employment growth.[9]

Solar Electric Generating System, Kramer Junction, CA

Governmental Policies and Incentives

There is significant governmental support for the solar energy industry both on national and state levels. In 2004, the Solar Energy Industry Association (SEIA) published a PV roadmap for taking the country from 340 megawatts (MW) of installed solar capacity to 9,600MW by 2015.[10] This increase would require annual growth rates of 35%, which is aggressive but in line with growth rates achieved since the late 1990s. In February 2006, the Department of Energy announced its Solar America Initiative[11], the goal of which is to deploy 5,000-10,000MW of photovoltaic capacity by 2015. It also projects that direct employment will increase up to 62,000 nationally by 2015.

California set the bar for state solar programs in 1996, when it created a $540 million public benefits fund for renewable energy with generous rebates for installed solar power systems.[12] In 2006, California enacted the largest solar program outside of Germany through the passage of two initiatives: the California Solar Initiative, established on January 12th by the California Public Utilities Commission (CPUC), and the Million Solar Roofs Bill signed into law on August 21st.[13] The Million Solar Roofs Plan aims to install solar power systems on one million homes by 2017. The state estimates that the million homes would have a total solar power capacity of 3,000

[9] U.S. Solar Industry Year in Review, 2006, Solar Energy Industry Association (SEIA)
[10] Our Solar Power Future: The U.S. Photovoltaics Industry Roadmap through 2030 and Beyond. 2004. Washington DC: Solar Energy Industry Association, www.seia.org/roadmap.pdf
[11] More information about Solar America Initiative is available at www.eere.gov/solar/solar_america
[12] *Our Solar Power Future: The U.S. Photovoltaics Industry Roadmap through 2030 and Beyond. 2004*. Washington DC: Solar Energy Industry Association. www.seia.org/roadmap.pdf
[13] "U.S. Solar Industry Year in Review", 2006, Solar Energy Industry Association (SEIA)

megawatts.[14] The program is funded at $3.35 billion over 11 years. It also requires the state's municipal utilities to create their own solar rebate programs, totaling $800 million in rebates.[15] Among such programs, the most aggressive solar power rebates on municipal level were introduced in Los Angeles.[16]

Also, funding of $350 million is directed to encourage solar in new-home construction through the New Solar Home Partnership (NSHP). The California Energy Commission is working with builders and developers to foster a market for solar powered homes. The first newly-built solar home communities started to open in fall 2007, and interest in them offset the downward trend in sales of regular homes. As one industry expert pointed out, "new homes equipped with solar systems are selling at about twice the rate as comparable homes in the same neighborhoods".[17]

Industry Size and Growth

With over 75% of the U.S. grid-tied installations in 2006, California is now dominating the national market for solar PV energy[18] (see table). In addition, historical data on the number and capacity of PV Installations during the past several years in California suggest an upward growth trend (see exhibit next page). According to the California Energy Commission, annual growth in the number of new PV installations in California averaged to 50% between 2003 and 2006, and the growth rate in installed kW (kilowatt) capacity was 62%[19]. (See Appendix C for year-by-year data and calculations).

2006 Grid-tied PV

State	Capacity (MW)
California	**63.5**
New Jersey	11.6
New York	2.3
Arizona	1.7
Colorado	0.9
Texas	0.7
Massachusetts	0.5
Nevada	0.5
Oregon	0.3
Connecticut	0.3

Source: Larry Sherwood; IREC

[14] Currently, less than 1% of California's electricity comes from solar photovoltaic systems. Less than 2% of new single-family homes built in California come equipped with solar systems. Source: "Our Solar Power Future: The U.S. Photovoltaics Industry Roadmap through 2030 and Beyond". 2004. Washington DC: Solar Energy Industry Association. www.seia.org/roadmap.pdf

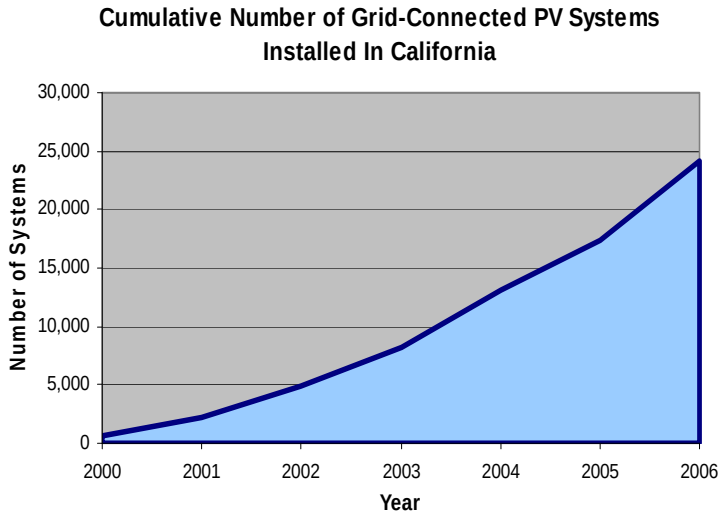
[15] "California Approves Legislation for Million Solar Roofs Plan", August 23, 2006: http://www.eere.energy.gov/inventions/energytechnet/news_detail.html/news_id=10210

[16] Los Angeles Manufacturing Credit offers energy production incentive bonuses of $0.02/kWh for systems <30kW and $0.01/kWh for systems >30kW. Source: Navigant Consulting, www.navigantconsulting.com

[17] Sacramento, CA, USA: Tim Lewis Communities' Amberleigh to Open Solar Powered Energy-Efficient Homes, October 12, 2007, at www.solarbuzz.com

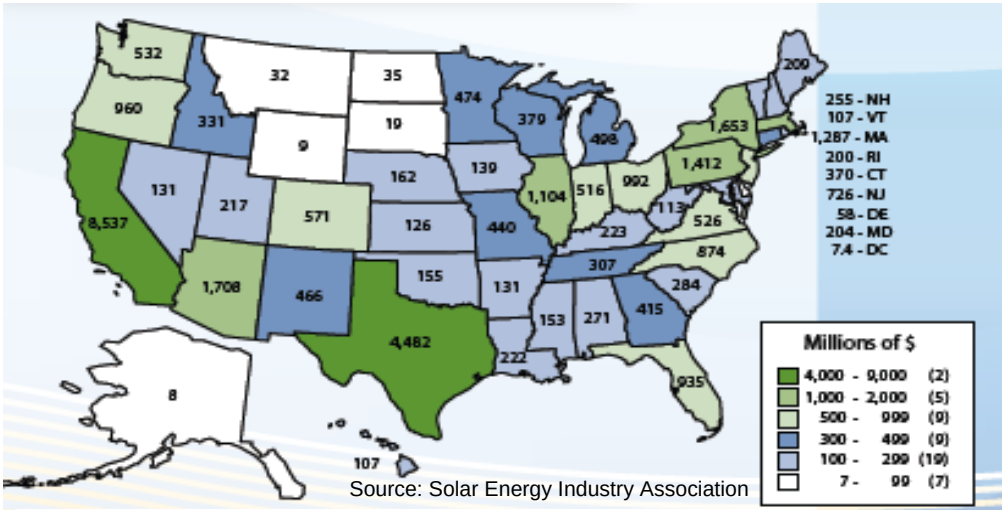
[18] Solar Energy Technician, http://careers.stateuniversity.com/pages/283/Solar-Energy-Technician.html

[19] Average growth rates are calculated only for 2003 through 2006 data and exclude PV installation data in previous years due to extra-ordinarily high numbers during those years. Inclusion of those numbers is statistically irrelevant.



Year	Cumulative Number of Systems Installed	Cumulative Growth in Number of PV Systems
2000	637	-
2001	2138	236%
2002	4879	128%
2003	8135	67%
2004	13096	61%
2005	17368	33%
2006	24098	39%
Average Growth (2003-06)		**50%**

In the next decade, this upward growth trend is expected to continue. According to the U.S. Solar Industry Year in Review (2006), California's solar energy market is projected to bring over $8.5 billion through 2015 (see exhibit below).[20] With growing public awareness of environmental issues, the popularity of solar energy is increasing. According to the February 2007 survey conducted by the investment bank Jefferies & Company, solar was chosen among all renewable energy sources as the primary energy supply by 40% respondents.[21]



Economic Growth from Solar Through 2015

However, as previously mentioned the future growth of the solar industry is directly tied to the resolution of silicon supply challenges. Venture capitalists continue to invest into research and development projects such as First Solar, Q-Cells and Nanosolar. When this ongoing research develops viable alternative solar energy technologies, it will drive

[20] "U.S. Solar Industry Year in Review", *2006*, Solar Energy Industry Association (SEIA)
[21] Occupational Profiles For Solar Industry, Interstate Renewable Energy Council, http://irecusa.org/index.php?id=50

manufacturing costs down and make solar systems more competitive on the energy market. As a result, both sales and employment will go up.[22] Appendix D explores worldwide employment distribution across the solar industry sub-sectors.

Despite this supply issue, all recent studies and industry representatives seem to agree that with the high amounts of solar radiation, our Governor's incentives and California's concerns about sustainable energy sources, our economy will witness explosive growth in the installation of solar panels.

Occupational Overview

Among all solar related occupations, the Solar Technician/ Installer is and will be the fastest growing and most in demand in California. Industry experts claim that since the energy crises of the 1970s, there has been an increasing need for solar energy technicians who can install, maintain, operate and test solar energy systems.[23]

Occupation Definition & Career Ladder

In most sources, Solar Technicians are referred to as Solar Energy System Installers, who are responsible for the installation, commissioning, and servicing of solar electric/PV and solar thermal systems.[24] Working under supervision of project managers, they handle both residential and commercial installations.

Solar Installers include Photovoltaic (PV) Installers and Solar Thermal Installers. ***PV Installers*** install the systems that generate solar electricity to heat and cool entire homes and buildings. ***Solar Thermal Installers*** install and repair hot water and swimming pool heating systems. Both thermal and PV installers mount pre-assembled solar panels or systems and install storage tanks, pumps, valves, pipes, and ducts. They set up and adjust electrical or electronic controls and sometimes do routine maintenance. In new construction, they follow blueprints to connect piping, ducting, controls and wiring.[25]

It is clear from the various job descriptions provided in solar job listings that all Solar Technician jobs can be grouped into three main clusters: Solar Energy System Engineers, Solar Energy Installers, and Solar Energy Foremen (see the exhibit, next page)[26]. A detailed description of job responsibilities is presented in Appendix E.

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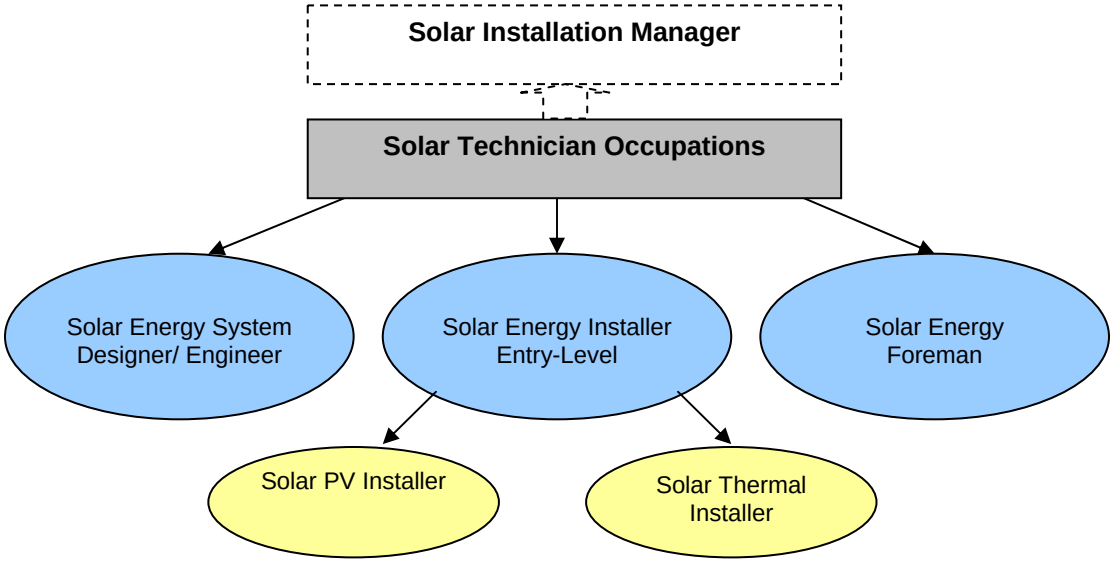
[22] "Solar Companies of All Sizes Race To Develop Cheap, Efficient Panel" by Leila Abboud, Wall Street Journal, June 14, 2007.
[23] Solar Energy Technician, http://careers.stateuniversity.com/pages/283/Solar-Energy-Technician.html
[24] Renewable Energy Access at www.renewableenergyaccess.com
[25] California Employment Development Department, LMID, Information Services Group.
[26] Such job listing can be found at www.reneableenergyacceess.com, http://www.solarenergy.org/resources/jobs.php , www.seco.cpa.state.tx.us/re_pv.htm



This report predominantly focuses on Solar Installers, including both PV and Thermal Installers. However, due to the emerging character of these occupations, they normally do not appear in statistical labor market sources as separate occupations. Some of these sources attach Solar Technicians to "HVAC Installers"[27], and some to "Other Engineering Technicians".[28] This creates limitations for occupational analysis and reinforces the necessity of primary research in this area. Therefore, we use data for some of the broader occupations, such as HVAC Installers and Electricians, to document wage statistics. (Appendix F outlines the occupational and industry classification codes related to Solar Technicians).

Occupational Earnings

Wages of Solar Installers vary, depending on geographical location, education and experience. According to the most recent employers' job postings, the hourly wages for PV Installers in California are:

Entry level:	$12.00 - $15.00
Experienced:	$16.00 - $30.00

These wage levels are comparable with Electrician's wages, which range from $13.13 to $17.38 for entry level and increase to $39.36 for experienced workers (see exhibit, next page). Union electricians are receiving higher wages, but solar companies tend to refrain from hiring them due to the high cost of labor. The median annual income for electricians and PV installers is $49,200.

[27] For example, this approach is taken by California Employment Development Department, Labor Market Information Division, Information Services Group.
[28] U.S. Department for Education, National Center for Educational Statistics, at http://nces.ed.gov/pubs2002/cip2000/occupationallookup.asp

According to Labor Market Information Division (LMID) data, Solar Thermal Installers' earnings are in line with Heating, Ventilation and Air Conditioning (HVAC) occupational wages, which in 2006 ranged from $12.56 to $15.92 for entry-level and from $26.88 to $32.35 for experienced installers in California. The 2006 median annual income was $44,300; 18% above the national level earnings.

Wages for Electricians and HVAC Installers, including Solar Installers, 2006[29]

Location	Pay Period	Median Earnings	
		Electrician	HVAC
United States	Hourly	$20.97	$18.11
	Yearly	$43,600	$37,700
California	Hourly	$23.64	$21.31
	Yearly	$49,200	$44,300

Generally, solar industry employers are not offering very attractive wages to solar technicians as they are concerned about driving down the cost of installation to decrease its price to the consumer. However, employers place a high priority on retaining valuable employees, and therefore offer fast promotion along the career ladder and pay schedules. Solar installers can move up to the next level after the first six month on the job. As an industry representative claims, "[solar companies] are producing the kinds of jobs that any state would want – good pay and good benefits with mission-driven companies"[30].

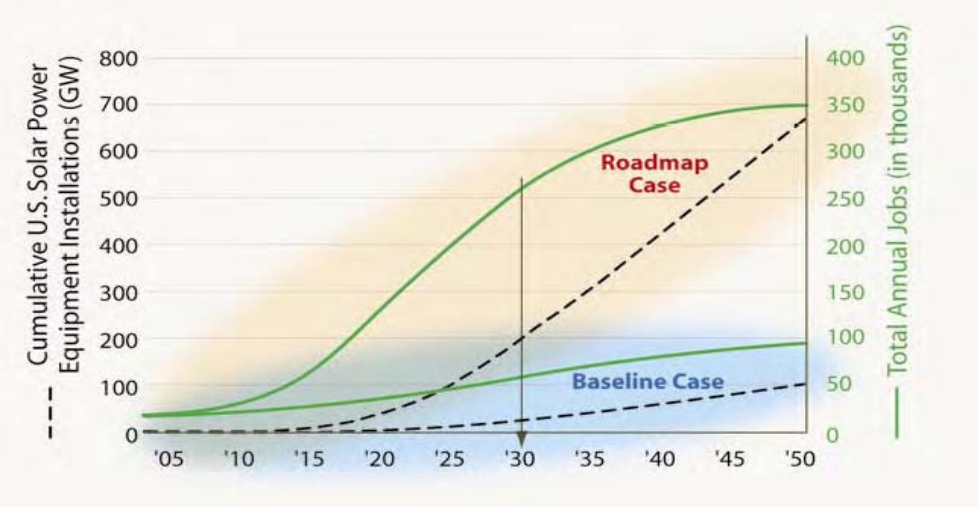
Employment Outlook for Solar Installers

There is little historic information on Solar Energy Installer jobs; however, all the existing sources point to a growth trend, both in the U.S. and in California. Numbers vary significantly due to the fact that future employment in solar industry is tightly connected to the high-tech research successes in solar PV development, as well as prices for oil, gas and other alternative energy sources.

According to the long-term estimates by the federal government under the Roadmap case, direct employment in the solar power industry is projected to reach 260,000 jobs by 2030 and 350,000 by 2050. The Baseline case would only reach 59,000 and 95,000 in 2030 and 2050, respectively (see chart, next page).[31] In the short term, the solar energy industry in the US is projected to contribute 22,000 additional jobs, which will include not only manufacturing and distribution, but also many solid building trade jobs for electricians, plumbers, roofers, designers, and engineers.[32]

[29] America's Career InfoNet, at www.acinet.org
[30] "Training the Renewable Energy Team" by Jeffrey D. Wolfe, Solar Today, September/October 2007.
[31] "Our Solar Power Future: The U.S. Photovoltaics Industry Roadmap through 2030 and Beyond". 2004. Washington DC: Solar Energy Industry Association. www.seia.org/roadmap.pdf
[32] "U.S. Solar Industry Year in Review", 2006, Solar Energy Industry Association (SEIA)

Baseline and Roadmap Cases for Employment
In US Solar Power Industry



In either the Roadmap or Baseline case, California will account for most of the national solar industry employment, due to a number of reasons:

- As mentioned, California presently dominates the U.S. market in PV installations (73% of all national installations in 2006).
- The California Solar Initiative (CSI), signed into law in August 2006, is expected to generate close to 40,000 operations and maintenance jobs (assuming one year of duration for each job) by 2016 in California alone.[33]
- Two of the largest PV plants in the world are in California. The overwhelming majority of new CSP plants, construction of which was announced in 2006, will be located in California (see Appendix B). According to the experts, deployment of these CSP plants would add thousands of new jobs.[34]
- The two U.S. cities most aggressively pursuing PV growth – Sacramento and San Francisco – are in California. Los Angeles has also initiated an aggressive solar rebate program that has attracted manufacturing capacity to the city.[35]

For PV Installers, in particular, California is anticipated to create 3,578 new jobs by 2015. For Solar Thermal Technicians, this number is expected to be significantly smaller, at 780 new jobs.[36] This is explained by the fact that growth is projected to occur in photovoltaic system installations. Solar thermal installations for hot water heaters and pools have leveled off as tax credits have dried up.

[33] "Solar: California's Rising Star" by Claudia Graziano, November 10, 2006, Renewable Energy Access.Com, at www.renewableenergyaccess.com
[34] "U.S. Solar Industry Year in Review", 2006, Solar Energy Industry Association (SEIA)
[35] Employment Impacts of Developing Markets for Renewables in California, Environment California Research and Policy Center, July 2003
[36] Employment Impacts of Developing Markets for Renewables in California, Environment California Research and Policy Center, July 2003

Another approach to look at the employment outlook for construction jobs in solar industry is proposed by the Electric Power Research Institute. It estimates job creation from renewable energy development based on existing and planned projects in California and the market outlook of project developers and equipment manufacturers. Using this approach, with a target of 3,000MW of PV installations in 10 years in California, there will be a need for about 13,000 solar installers by 2016. With a projected average annual industry growth rate of 35%, California will need about 40,000 installers by 2016.[37]

There are over 300 Solar Energy Contractors licensed by the California Contractors' Board currently, but as the industry grows this number should increase. Electrical, plumbing, and general contractors can also install solar systems. With passive collection and cooling methods for new homes and buildings, future job opportunities for Solar Installers should expand in the residential building construction sector as well.[38]

Licensing and Certification

According to the California Contractors' State License Board, the activity of solar energy installers should be licensed in accordance with C-46 Solar Contractor classification description (refer to Appendix G).

There are also non-state organizations that offer voluntary certification to solar technicians. The most common and highly recognized is the North American Board of Certified Energy Practitioners (NABCEP). The NABCEP process has been developed and designed carefully following professional credentialing guidelines. Standards developed by subject matter experts have been established and the eligibility requirements are reasonably achievable being based on extensive input from stakeholders and deliberation among installers. NABCEP offer two certificate types: PV and Solar Thermal.

Currently, there are 135 NABCEP Certified Solar Technicians in California, with 130 certificates being in PV, and only 5 in solar thermal. Before granting certification, NABCEP requires that applicants receive appropriate training. They have a listing of their approved training providers posted throughout the entire country.[39]

Skill Sets and Training Requirements

Unlike other occupations, solar installers are not included in the typical skills and knowledge profiles on the popular O'NET informational resource. The best source that defines a general set of knowledge, skills and abilities required of solar installers is the

[37] "Meeting the PV Installer Demand" presentation by Bernie Kotlier, September 27, 2007, Solar Power 2007 Conference, Long Beach, California.
[38] California Employment Development Department, Labor Market Information Division, Information Services Group.
[39] The list can be found at http://www.nabcep.org/approvedproviders.cfm

NABCEP Task or Job Analysis.[40] Detailed information on skill sets is available in Appendix H, while here we present only a short summary.

NABCEP-Certified *Solar PV installers* are required to specify, configure, install, inspect and maintain a solar electric system that meets the performance and reliability needs of customers, incorporates quality craftsmanship, and complies with all applicable safety codes and standards. The following is a partial list of employer defined training needs which are unique to PV installers[41]:

- Site assessment as it pertains to system performance
- Photovoltaic cell and module characteristics as they apply to the design and performance of integrated systems
- Calculating system characteristics, such as wire sizes, to minimize power losses and maximize energy production
- Applicable wiring methods and technologies
- Mounting techniques and technologies
- PV system maintenance, diagnostic and troubleshooting techniques
- Customer education practices.

The NABCEP *Solar Thermal* Task Analysis covers 12 task areas that deal with designing and installing solar hot water and pool heating equipment, including solar collectors, water heater and storage tanks, pipes, mechanical/plumbing equipment, and the like, as well as performing site assessments and system troubleshooting.

Most Solar Installers are trained on-the-job by their employers, starting as helpers to more experienced installers. Some manufacturers sponsor intensive training sessions on their products. If an applicant has completed high school shop courses in electricity and wood working, and held summer jobs as construction helpers for plumbers, electricians, roofers, or swimming pool/spa contractors, he/she can qualify as a Solar Installer trainee.

Many workers in the solar energy field are experienced construction trade workers who have completed an apprenticeship program. Sheet metal worker/electrician apprenticeship programs are available in a few areas. Apprentices receive special training in solar energy technology through programs offered by unions, vocational schools and community colleges.

Training Programs Offered in California

All existing programs in solar system installation, which last from several days to a year, usually offer a certificate of completion. Most of the training programs, either in the form of workshops or courses, are offered by various non-profit and for-profit agencies.

[40] Source: www.nabcep.org/Monticello/userfiles/File/PVTaskAnalysisFinal06.pdf
[41] Occupational Profiles For Solar Industry, Interstate Renewable Energy Council, http://irecusa.org/index.php?id=50

Northern American Board of Certified Energy Practitioners (NABCEP)

The highly regarded panel of solar industry experts that offer voluntary certification in solar systems installations is NABCEP. Its Entry Level Certificate of Knowledge program is based on a set of learning objectives developed by a NABCEP committee of subject matter experts. The skills identified in this analysis do not replace electrical trades, technician, technologist or engineering training. The Entry Level Certificate Program is designed for those individuals wanting to get into the solar field and is a way for them to show that they have achieved basic knowledge, comprehension and application of key terms and concepts of PV/Solar Thermal system operations. The certificate demonstrates that the student has passed an industry-designed exam based on learning objectives developed by subject matter experts.[42]

NABCEP entry-level certificate program preparation is offered through a number of approved institutions nationwide. In California, there are only two: Diablo Valley College and East LA Skills Center.

> **Diablo Valley College,** Tom Chatagnier, tchatagnier@dvc.edu, (925) 685-1230, Ext. 2522
>
> **East Los Angeles Skills Center,** Los Angeles Unified School District, Brian Hurd, Bob Bower, bhhurd@sbcglobal.net, (323) 224-5970

The list is not restricted, and any college can be granted a right to deliver entry-level NABCEP training in solar technology, provided that the college meets all the NABCEP requirements for such.

Solar Energy International[43]

Solar Energy International (SEI) offers a series of PV workshops focused largely on hands-on instruction. In their PV Design and Installation workshop, students spend a week in the classroom learning about PV and a week out in the field learning how to install a system. SEI offers workshops in several states and internationally. The prices for these programs range from $150 for a 1 to 2 day workshop to $1,600 for 1 to 2 week training sessions.

Solar Living Institute[44]

In Hopland, California, the Solar Living Institute offers short, weekend workshops such as beginner's PV courses for non-electricians and do-it-yourselfers. Their Solar Living Center features a 132-kilowatt grid-tied PV array, as well as a number of other solar energy technologies.

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[42] For more information on NABCEP entry-level certificate overview, process and policies, refer to www.nabcep.org.
[43] www.solarenergy.org
[44] www.solarliving.org

IBEW/NECA

The Los Angeles County Chapter of the National Electrical Contractors Association (NECA) and International Brotherhood of Electrical Workers (IBEW) Local Union 11 have developed a PV Installation training for IBEW journey-level electricians. It is a three-day PV Immersion Training with classroom instruction and hands-on stations. The training is offered at 26 training centers throughout California to IBEW electricians. The goal of this training is to provide PV education to at least 17,000 union member electricians in California and thus meet the solar industry demand for a qualified workforce over the next 10 years.

In addition to immersion courses, IBEW/NECA uses two large PV powered facilities to provide photovoltaic training: Electrical Training Institute of Southern California (ETI) in Los Angeles and San Diego Electrical Training Center. Both facilities are utilized in the PV installation training.

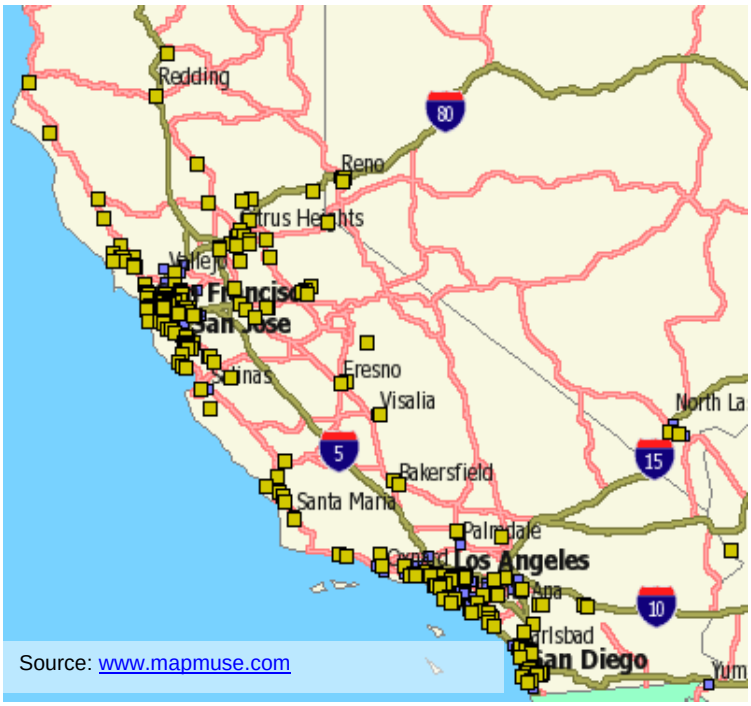
Employer Needs and Challenges

In California there are about 850 solar installation/ system integration businesses, according to California Solar Energy Industry Association. However, most of them are small contractors with 1-3 employees. Geographically, California's solar energy contractors are clustered around four areas: the Bay area, Los Angeles & Orange counties, San Diego and Sacramento.

The largest solar installation employers in California are:

- Borrego Solar, Inc.
- REC Solar, Inc.
- Akeena Solar
- REgrid Power
- SPG Solar
- Power Light Corporation
- Sun Light & Power

As some of these companies claimed at the 2007 Solar Power Conference, consumer demand for solar in California is going to expand, pushing



Source: www.mapmuse.com

growth in the industry[45]. Industry also agrees that the greatest workforce challenge they are and will be facing is shortage of trained solar installers. Due to the lack of the skilled workforce in this trade, companies have to hire workers from other construction trades and then provide in-house training to prepare them for solar installation jobs. Economically, employers would prefer other options for meeting their workforce needs.

Some of the needed skills for solar PV installers that companies articulated were: mechanical installation (including roofing, carpentry, labor), electrical installation (wiring), and understanding PV system design. For entry-level installers basic knowledge of photovoltaic and solar cells is very important. However, **California employers do not feel that a two-year program will be needed to meet their workforce training needs.** They are more interested in several specific courses devoted solely to PV or Solar Thermal. Unfortunately, companies are not generally aware of community colleges as potential providers of such courses. There is also a general agreement that NABCEP certification is desired for solar technicians.

Community College Response and Issues

Lane Community College in Oregon maintains the most highly regarded Solar Technology program by solar industry experts in the U.S.[46] Its program offers a two-year associate of applied science degree in renewable energy technology, under their Energy Management Technician program. Lane's program prepares students for careers in the energy management field or as renewable energy system installers, with courses in electrical theory, PV design and installation, and energy efficient methods. Students learn to evaluate energy use patterns and make energy efficient retrofit recommendations for both residential and commercial buildings, as well as implement PV design protocol. In addition to coursework, students complete a cooperative education requirement, which provides relevant field experience and networking opportunities with professionals. Their curriculum can serve as a model for community colleges aspiring to start a similar program or offer individual courses in selected areas.

According the Chancellor's Office Taxonomy of Programs, only 5 community colleges in California currently offer alternative energy courses, and only 3 colleges provide solar energy training at the time of this report's printing:

Golden West College	0303.00 Environmental Technology **-** Solar Energy
San Diego City College	0999.00 Other Engineering and Industrial Technologies - Solar Turbines Inc. Apprenticeship
Diablo Valley College	Photovoltaic System Design and Installation (AET 130)

[45] Solar Power Conference 2007 took place in Long Beach, CA, in September 2007. Event coverage can be found at http://www.solarpowerconference.com/event-coverage/

[46] Get Your Renewable Energy Start by Laurie Stone, Solar Energy International, December 22, 2006 http://www.renewableenergyaccess.com/rea/news/story?id=46929

Diablo Valley College offers a 2 unit, 54 hour course called "Photovoltaic Systems Design and Installation". It is an experiential course in which students learn to do site evaluations, set up two grid-tie systems, two off-the-grid systems, and set up a pole mount and tracker systems. The course is NABCEP approved and the students can take the NABCEP Entry Level Certification exam if they choose. Also, Diablo Valley College will be starting the development of an Energy Management program in 2007-2008.

Golden West College has Environmental Studies and Engineering Technology programs, and is currently working on converging these programs into a Renewable Energy curriculum. In 2006 they started offering several renewable energy courses: General Renewable Energy Overview (including PV, Thermal, wind), Wind Energy Installation, and PV Installation. The College has an advisory committee to support its curriculum development process as well as provide support with donations and equipment. The advisory committee combines active members, including industry representatives, city government officials, members of the community and students, and passive members, such as NABCEP and representatives of the National Renewable Energy Lab. This advisory committee can serve as a model for other colleges that are looking into starting a solar program.

For a complete list of California community colleges that offer solar related programs and their contact information, refer to Appendix I.

Colleges which are offering renewable energy programs or training seem to agree that it is important to have necessary facilities ready in order to provide relevant hands-on experience. Potential solutions to this challenge are to either partner with solar companies that will help design a model installation (Golden West College model), or have a real PV installation done on campus (Los Angeles Community College District).

Financing opportunities for training providers in solar industry will be available on the national level. The Solar Energy Technologies Program is anticipating releasing a new Funding Opportunity Announcement (FOA) this year for education, training and certification, the details of which will be released at a later date. Interested parties are encouraged to visit the Funding Opportunities section of the Solar America Initiative web site at www.eere.energy.gov/solar/solar_america[47]

Conclusion and Recommendations

Analysis of the existing sources of information has revealed a future gap between the demand and supply of qualified solar energy technicians. There are only three colleges in all of California that offer specific solar energy programs or courses, and only one offers the NABCEP approved certificate. Many employers, thus, have to hire entry-level technicians with some construction-related knowledge and provide on-the-job training or

[47] U.S. Department of Energy, Energy Efficiency and Renewable Energy.

organize solar system installations workshops, conducted by a non-profit or for-profit training organization.

California Community Colleges have a strategic opportunity to provide training for solar technicians. Colleges should focus on hands-on programs in solar installation which would offer training mostly in PV Systems. Adding Solar Thermal Systems to the study program will enhance employment opportunities for program graduates. Many employers are looking for technicians qualified in both types of systems. The best model to follow here is that of Diablo Valley College, which provides a training program in association with NABCEP.

The other possible approach is partnering with solar industry companies to provide an apprenticeship program in Solar Technician. Such an apprenticeship program would yield additional funding and support from the California Community College Chancellor's Office, and become the base for sound industry partnerships with employers, which in turn will ensure that the program meets industry's needs for qualified technicians.

Another effective approach would be to establish a Renewable Energy curriculum, which would cover not only solar installations, but also wind, fuel cells and other alternative energy sources. A model for such curriculum is provided by Lane Community College. These programs are recommended because the future funding and support for all the renewable energy industries are projected to grow in the future, which multiplies employment opportunities for program completers.

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Appendix A – How to Utilize this Report

About Us - Description of BWPI

The Business and Workforce Performance Improvement (BWPI) initiative is focused on building the capacity of the colleges in the area of economic and workforce development to enhance their ability to deliver education and training services to businesses and workers in high growth industries, new technologies, and other clusters of opportunities.

The Centers of Excellence (COE) within BWPI provide information regarding workforce trends, increasing awareness and visibility about the colleges economic and workforce development programs and services, and building partnerships with business and industry.

The difference this will make to the colleges is that it will position them as THE workforce partners of choice to business and industry and ensure that college programs are current and responsive. This will contribute to the overall economic vitality of the communities in which they serve.

How to Use This Environmental Scan Report

The Centers of Excellence within the Business and Workforce Performance Improvement Initiative of the California Community College Economic and Workforce Development Program have undertaken Environmental Scanning to provide targeted and valuable information to community colleges on high growth industries and occupations.

This report is intended to assist the decision-making process of California community college administrators and planners in addressing local and regional workforce needs and emerging job opportunities in the workplace as they relate to college programs. The information contained in this report can be used to guide program offerings, strengthen grant applications, and support other economic and workforce development efforts. This report is designed to provide current industry data that will:

- Define potential strategic opportunities relative to an industry's emerging trends and workforce needs;
- Influence and inform local college program planning and resource development; and
- Promote a future-oriented and market responsive way of thinking among stakeholders.

This Environmental Scan included a review of the California Regional Economies Project reports and Employment Development Department (EDD) Labor Market Information (LMID) projections that cover the communities in this region, as well as many other sources as referenced.

Important Disclaimer:

All representations included in this Environmental Scan product/study have been produced from a 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. The purpose of the Environmental Scan is to assist the California Community Colleges to respond to emerging market needs for workforce performance improvement. However, neither the Business and Workforce Performance Improvement Centers of Excellence, COE host college or California Community Colleges Chancellor's Office are responsible for applications or decisions made by recipient community colleges or their representatives based upon this study including components or recommendations.

Additional Information

The Business and Workforce Performance Improvement Initiative is funded in part by the Chancellor's Office, California Community Colleges, Economic and Workforce Development Program. The total grant amount (grant number 07-305-013 for $205,000) represents compensation for multiple documents or written reports through the Centers of Excellence.

Our mission is to strengthen California's workforce and advance economic growth through education, training and job development.

Appendix B – Announced CSP Plant Construction

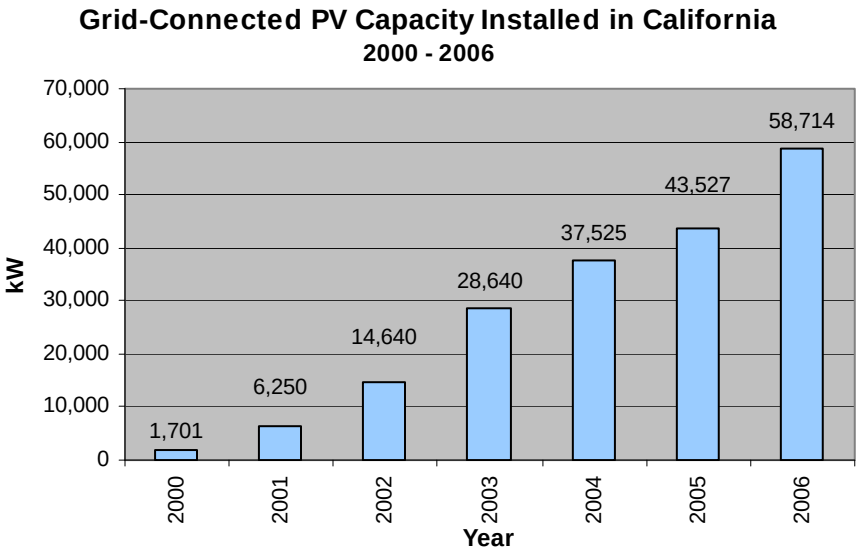
Source: U.S. Solar Industry Year in Review, 2006, Solar Energy Industry Association (SEIA)

Announced CSP Plant Construction

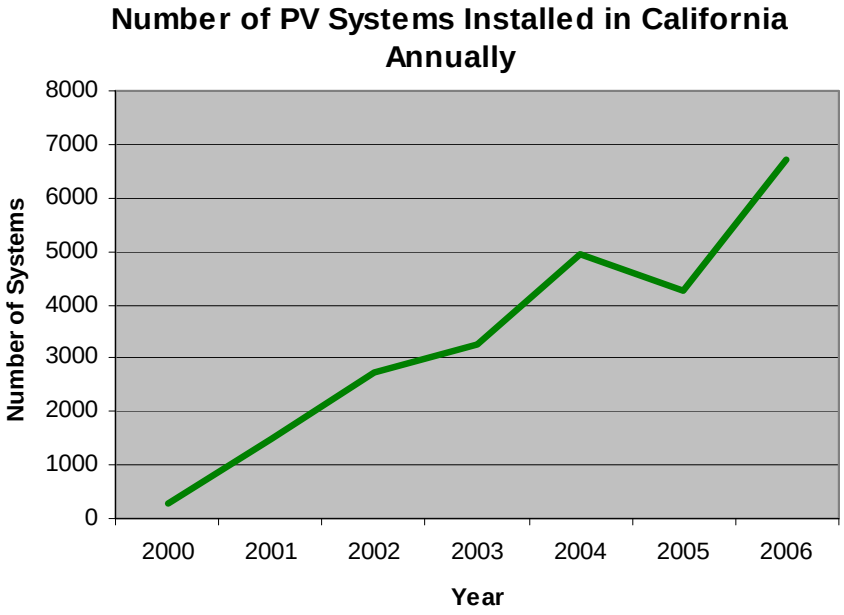
Utility / State	Capacity (MW)	Developer Name / Complete Dates
Arizona Public Service	1	Solargenix-Acciona/2006
Florida Power & Light SEGS, California	24	Solel/2007
Nevada Power & Light	64	Solargenix-Acciona/2007
Southern California Edison	500	SES/2012
Southern California Edison	350	SES/2014
San Diego Gas & Electric	300	SES/2012
San Diego Gas & Electric	600	SES/2014
Pacific Gas & Electric	500	Luz II/unknown
Total 2006 US CSP contract potential	**2,339**	

Appendix C – Historic Data on Number and Capacity of Solar Power Systems Installed, from 2000 till 2007

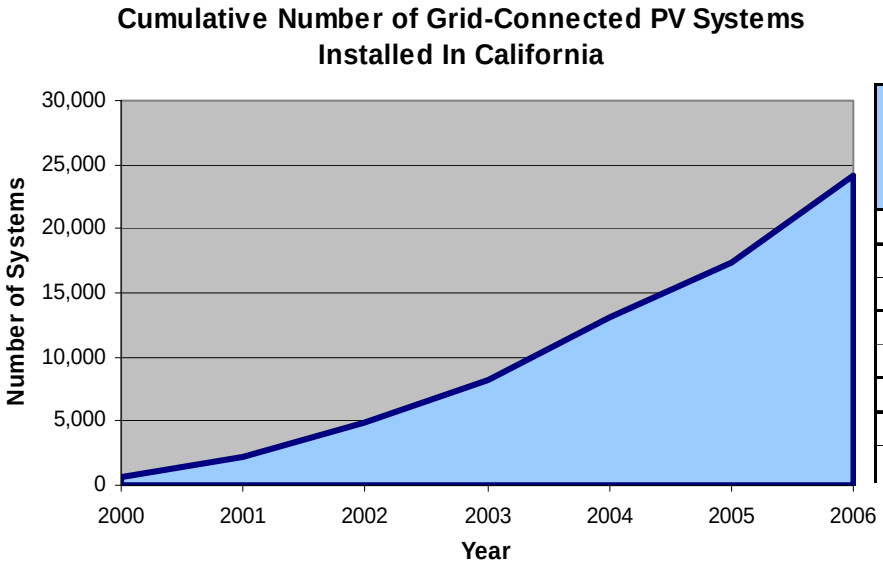
Source: Charts are based on California Energy Commission data



Year	Annual PV Capacity Installed in CA, kW	Annual Growth in PV Capacity
2000	1,701	-
2001	6,250	268%
2002	14,640	134%
2003	28,640	96%
2004	37,525	31%
2005	43,527	16%
2006	58,714	35%
Average Growth (2003-06)		**62%**



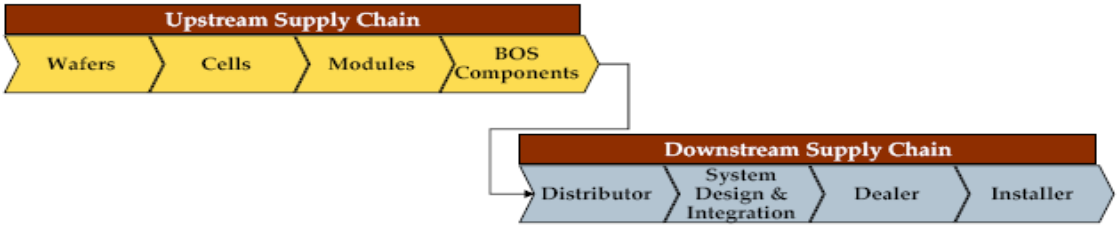
Year	Number of PV Systems Installed in California	Growth in Number of Annual PV Installations
2000	296	-
2001	1501	407%
2002	2741	83%
2003	3256	19%
2004	4961	52%
2005	4272	-14%
2006	6730	58%
Average Growth (2003-06)		**29%**



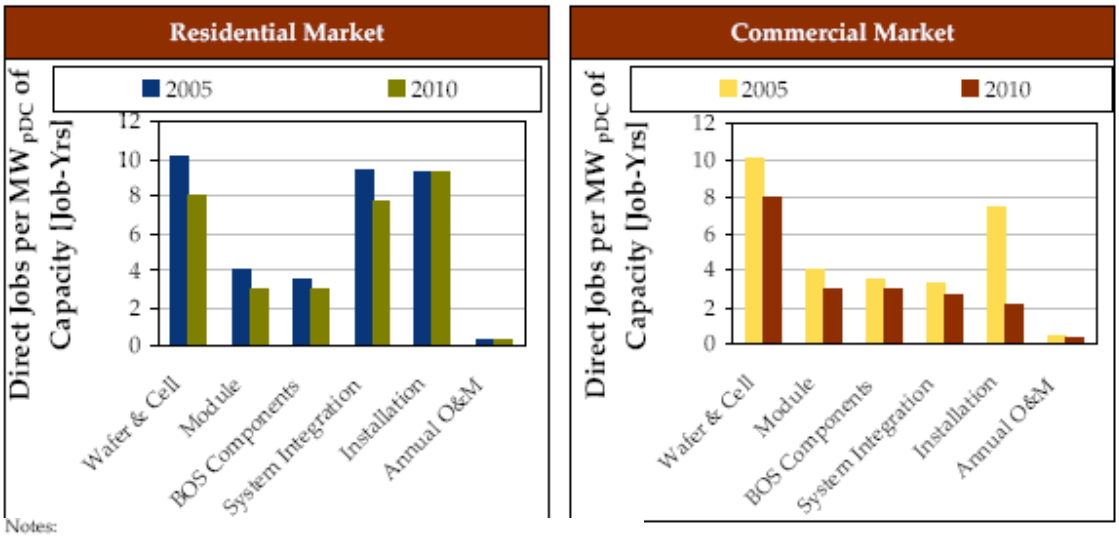
Year	Cumulative Number of Systems Installed	Cumulative Growth in Number of PV Systems
2000	637	-
2001	2138	236%
2002	4879	128%
2003	8135	67%
2004	13096	61%
2005	17368	33%
2006	24098	39%
Average Growth (2003-06)		**50%**

Appendix D – Labor Intensity along Solar Industry Value Chain and Estimate of Worldwide Direct PV Employment

Source: Navigant Consulting, Inc.



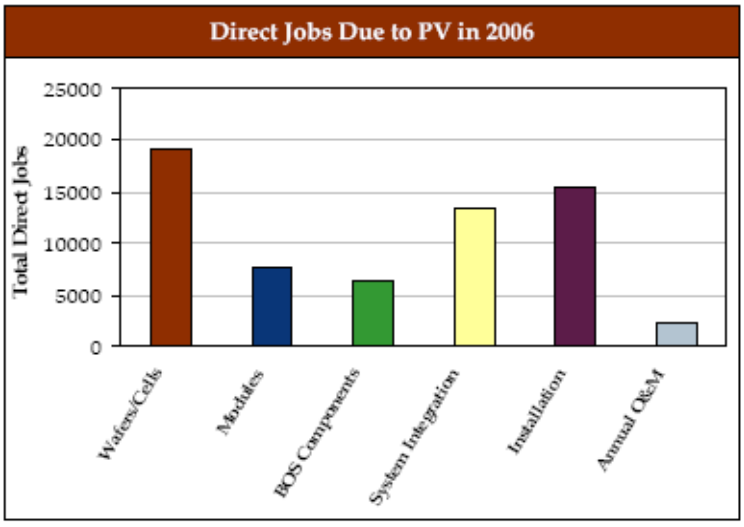
NCI expects employment rates to decline over time as PV manufacturing becomes more automated and installation practices mature.



Notes:
1. One job-year is equal to 1960 hours (40 hours per week, 49 weeks per year)
2. System Integration includes system integration, design, and distribution
3. Details on NCI's method are in the appendix
Source: Navigant Consulting, Inc. estimates, June 2006.

Applying NCI's PV employment analysis to PV market data puts the direct employment due to PV at ~64,000 jobs, worldwide in 2006.

Segment	2006 Total (MW)
Demand/Supply	1,984
Installations	1900
Installed Base*	7134



Appendix E – Description of Solar Energy Jobs

Solar Energy Engineer/ Designers are primarily responsible for generating system designs and supporting documentation for PV and solar hot water systems. This includes production of plans for building permit applications and construction, specification of components, design of systems, and mechanical and electrical points of connection. The position works with a multi-disciplined team to design and produce construction plans for photovoltaic or solar thermal projects.

A Solar Energy System Installer is responsible for the installation of solar electric, hot water and pool heating systems. Installers are required to perform some of the following tasks: electrical wiring, rooftop panel mounting, carpentry and handyman tasks, system troubleshooting, customer interaction, and miscellaneous labor work.

A Solar Energy Foreman leads installation teams on residential and commercial PV/ thermal systems. Working as an installer, with some additional office planning time, the foreman is responsible for installation, commissioning, troubleshooting and repair as well as managing the job site, reviewing and finalizing system design, managing equipment and materials, and writing safety plans. Both Installers and Foremen can be specialists either in solar electric or solar thermal equipment. The main professional advancement for all three groups is to move to a Solar Installation Manager position.

Solar Installation Operation Managers provide project management for the installations, the oversight of installation services, and the training of the project management team. The Manager also provides guidance and contributes to the development of the supply chain strategy and system design activities.

Appendix F – Classification Codes Relevant to Solar Technician Occupation

2000 Census Occupation Code:	155 Engineering Technicians, Except Drafters
BLS Occupational employment Statistics Classification:	17-3029 Engineering Technicians, Except Drafters, All Other
Employment and Training Administration – O'Net Classification:	17-3029.00 Engineering Technicians, Except Drafters, All Other
National Skills Standards Board – Industry Cluster:	7 Manufacturing, Installation and Repair
Department of Education – Career Cluster:	2 Architecture and Construction 13 Manufacturing
Classification of Instructional Programs (CIP), 2000	15.0505 Solar Tech/ Technician
Dictionary of Occupational Titles (DOT), 4th ed., Rev. 1	637.261-030 Solar Energy Systems Installer
Occupational Employment Statistics (OES) System	859020 Heating and Air Conditioning Mechanics and Installers
Most common North American Industry Classification System (NAICS) codes employing Solar Technicians	237130 Power and Communication Line and Related Structures Construction 238160 Roofing Contractors 238210 Electrical Contractors 238220 Plumbing, Heating, and Air-Conditioning Contractors 423720 Plumbing and heating equipment and supplies merchant wholesalers

Appendix G – Solar Contractor License Classification Description

C-46 Solar Contractor

A solar contractor installs, modifies, maintains, and repairs active solar energy systems. An active solar energy system consists of components which are thermally isolated from the living space for collection of solar energy and transfer of thermal energy to provide electricity and/or heating and cooling of air or water. Active solar energy systems include, but are not limited to, forced air systems, forced circulation water systems, thermo-siphon systems, integral collector/storage systems, radiant systems, evaporative cooling systems with collectors, regenerative rock bed cooling systems, photovoltaic cells, and solar assisted absorption cooling systems.

A licensee classified in this section shall not undertake or perform building or construction trades, crafts or skills, except when required to install an active solar energy system. (832.46 CCR)[48]

[48] California Contractors' State License Board http://www.cslb.ca.gov/services/GClass.asp#C-46Class

Appendix H – Solar Employer Skills, Knowledge and Abilities (as defined by NABCEP)

NABCEP-Certified Solar PV installers are required to specify, configure, install, inspect and maintain a solar electric system that meets the performance and reliability needs of customers, incorporates quality craftsmanship, and complies with all applicable safety codes and standards.

For the purposes of developing training curricula, assessment mechanisms and certification criteria, specific tasks are classified as either cognitive or psychomotor skills.

The NABCEP PV Task Analysis covers 8 major areas:

1. Working Safely with PV Systems
2. Conducting a Site Assessment
3. Selecting a System Design
4. Adapting the Mechanical Design
5. Adapting the Electrical Design
6. Installing Subsystems and Components at the Site
7. Performing a System Checkout and Inspection
8. Maintaining and Troubleshooting a System

The July 2003 report prepared for the Massachusetts Technology Collaborative titled "Needs Assessment for Training and Certification within the Photovoltaic Industry," further discusses training needs for photovoltaic installers. The report states, "The type of training that is unique to the solar industry extends beyond the normal craft of building trades … [and includes] considerations of system design and execution for performance. The following is a partial list of training needs which are unique to photovoltaic installers:

- Training in site assessment as it pertains to system performance (assessing the effects of shading obstructions, tilt and azimuth angles, etc.)
- Training in photovoltaic cell and module characteristics as they apply to the design and performance of integrated systems
- Training in calculating system characteristics, such as wire sizes, to minimize power losses and maximize energy production
- Training in applicable wiring methods and technologies
- Training in mounting techniques and technologies
- Training in PV system maintenance, diagnostic and troubleshooting techniques
- Training in customer education practices."

In addition to the tasks listed above, training should also include fundamental electrical skills, understanding of the electrical grid, and understanding of roof applications and ceilings.

For solar thermal, the best source that defines a general set of knowledge, skills and abilities typically required of practitioners who install and maintain solar hot water or pool heating systems is the NABCEP Task or Job Analysis.

The NABCEP Solar Thermal Task Analysis covers 12 major areas:

1. Working safely with solar hot water and pool heating systems
2. Identifying systems and their components
3. Adapting a system design
4. Conducting a site assessment
5. Installing solar collectors
6. Installing water heater and storage tanks
7. Installing piping, pipe insulation and connecting system piping
8. Installing mechanical/plumbing equipment and other components
9. Installing electrical control systems
10. Installing operation and identification tags and labels
11. Performing a system checkout
12. Maintaining and troubleshooting a solar thermal system

This task list assumes the installation contractor starts with an approved solar system design package, complete with major components, manufacturer installation manual, system schematics, and assembly and troubleshooting instructions. While the solar installation contractor may not design the system, in many cases they must be knowledgeable about many aspects of systems design, and may be required to adapt certain designs to fit a particular application or customer need.

Appendix I –California Community Colleges Offering Energy and Solar Energy programs

College	Program	City	Telephone	Degree Type	Year Approved	Web-site	Comments
De Anza College	0946.10 Energy Systems Technology - Energy Management and Climate Policy	Cupertino 95014	408-864-5678	A	1996	www.deanza.edu	
Merritt College	0946.10 Energy Systems Technology- Environmental Design and Energy Technology	Oakland, CA 94619	(510) 531-4911	S (29 units)	1981	www.merritt.edu	Primarily oriented toward energy auditing and energy efficiency in buildings.
Golden West College	0303.00 Environmental Technology - Environmental Studies - Solar Energy	Huntington Beach 92647-2748	714-892-7711	Certificate	2006	www.gwc.info	
San Diego City College	0999.00 Other Engineering and Industrial Technologies - Solar Turbines Inc. Apprenticeship	San Diego, 92101	(619) 388-3400	S (40 units)	1995	www.sdcity.edu	Apprenticeship only. Several trades: master machinist; general maintenance mechanic, plaster patternmaker, tool and die maker; precision machine tool mechanic; gas turbine experimental mechanic (sheet metal).
Diablo Valley College	Photovoltaic System Design and Installation (AET 130)	Pleasant Hill 94523	(925) 685-1230, Ext. 2522	Certificate			e-mail: tchatagnier@dvc.edu