

Job Creation Studies in California for VOTESOLAR

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Executive Summary

Senate Bill SB 199, also known as the Murray Million Solar Homes Bill, proposes to install 1 million photovoltaic (PV) solar roofs in California by 2018, comprising nearly 3,000 peak megawatts (MW_P) of additional power available to the electricity grid. The bill would require the California Energy Commission to award rebates and offer incentives to support the installation of solar energy systems on existing and new residential construction. It is the goal of this report to analyze employment creation in California due to this Bill. The largest fraction of new jobs in the PV industry worldwide will be module assemblers, whereas in California the greatest proportion of employment will be contractors and installers. Five studies were identified that use both analytical and input-output models to find the number of jobs created per MW_P of PV installed. In the analysis of this report, the average of the five models was used, which predicts that approximately 20 manufacturing and 13 installation/maintenance job-years will be created per MW_P of PV installed. 2,700 MW_P of PV will be installed by 2018 if the Murray Bill is implemented. This will result in approximately 19,000 annual jobs created in California by the end of 2017. A comparison of the predicted effects of SB 199 to the past and predicted effects of policies in Japan and Europe is also included.

I. Introduction

SB 199 proposes to install 1 million photovoltaic (PV) solar roofs in California by 2018¹, corresponding to 3,000 peak megawatts (MW_P) of additional power available to the electricity grid. The addition of this large number of electricity generating units would not only have a substantial economic and environmental effect, but would also spur the creation of many new jobs. These jobs can be classified as direct or indirect. Direct employment results from the maintenance, installation, and manufacture of the PV systems. Indirect jobs arise from stimulating other industries affected by the new PV systems. As well, indirect jobs arise from the increased consuming power of direct employees. Currently, there is a lack of a manufacturing base for PV systems in California. Enactment of SB 199 would spur a new center of PV manufacturing, along with installation and maintenance employment, within California.

The number of jobs can be predicted with both mathematical models and case studies. Each model is based on different assumptions about market conditions and industrial effects. Models can be categorized as analytical or input-output. Analytical models use simple spreadsheet type calculations and usually account for only direct jobs. Input-output models describe economic effects more comprehensively, and are able to include multiplier effects and indirect jobs. However, they are more difficult to dissect and analyze assumptions. Two important case studies are the European Union and Japan. Both have employed a program of declining rebates to increase the demand for residential and commercial PV systems. In this paper we will use both models and case

¹ *Senator Kevin Murray*, Senate Bill No. 199, Amended in Assembly August 23, 2004

studies to predict the job creation effect in California of SB 199. We will begin with a description of the bill and a brief overview of jobs in the PV.

The term “job-years” will be used extensively in this report. The definition of a job-year (sometimes called “person-year”) is a single individual who is employed for one year (49 weeks, 40 hours/week). Most employment analyses report jobs created in units of job-years. See Appendix C for information on converting job-years to average number of persons employed during a given time period.

II. California Senate Bill 199

i. Proposed Law

Under SB 199, the Emerging Renewable Resources Account (ERRA) would be renamed the Solar Homes Peak Energy Procurement Account (SHPEPA) and these funds would be made available to the Solar Homes Peak Energy Procurement Program (SHPEPP). The Bill would require the Energy Commission to award rebates, and authorize the Commission to provide incentives to support the installation of solar energy systems on existing and new residential construction. A new non-bypassable rate component (which has a maximum cap of 0.05¢/kWh) would be set by the California Public Utility Commission (CPUC) to fully fund the goal of 3,000MW_P installed PV systems by 2018.

ii. Timeline

The CPUC in consultation with the Energy Commission would be required to complete an investigation and ratemaking procedure to implement the program to invest in residential solar energy systems by December 31, 2007. Beginning January 1, 2008 a seller of production homes would be required to offer a solar energy system option to all customers negotiating to purchase a new “production home” (defined as a single family residence constructed in a development of 25 or more homes/project) and include information regarding estimated total costs and estimated energy savings based on climate zones. The funds from the non-bypassable rate component will be collected over 10 years. The rebate period will end by January 1, 2015. The end goal is to achieve 1,000,000 solar energy systems on rooftops or 3,000MW_P installed by December 31, 2017.

iii. Rebate Program

Beginning on January 1, 2005, 17.5% of the renewable energy segment of the Public Goods Charge (PGC) will be exclusively dedicated to a schedule of declining rebates on

solar energy systems on new or existing residences. The maximum rebate in year number one (2005) shall be no more than \$2.80/W and decline each year at a rate of at least 7%. Systems are eligible for rebates up to the first 3kW of generating capacity per residence.

The funds will be collected from Southern California Edison (SCE), Pacific Gas and Electric (PG&E), and San Diego Gas and Electric (SD G&E) over the 10-year period. Excess revenues and growth in the PGC will be placed in the SHPEPA.

III. A Survey of Jobs in the PV Industry

The renewable energy sector creates more jobs than the petroleum fuel sector per unit energy produced.² One of the renewable energy industries that shows a unique opportunity for skilled laborers in particular is PV. Since most PV systems are on rooftops, installation requires roofers, electricians, sheet metal workers, and others in the building trades, which currently play almost no role in electricity generation. Subsequently, PV would employ workers in a new sector, providing a new source of local jobs.³

Understanding the types of jobs created by the PV industry can be conceptualized by walking through the steps required to transform the raw materials such as Quartzite into a PV system on a rooftop. Figure 1 shows a flowchart of this process.

² Daniel M. Kammen, Kamal Kapadia, and Matthias Fripp, "*Putting Renewables to Work: How Many Jobs Can the Clean Energy Industry Generate?*" Rael Report, University of California, Berkeley (2004)

³ Virinder Singh and Jeffrey Fehrs, "*The Work that goes into Renewable Energy,*" Renewable Energy Policy Project (2001), www.repp.org

Silicon Job-Supply Chain for PV Systems

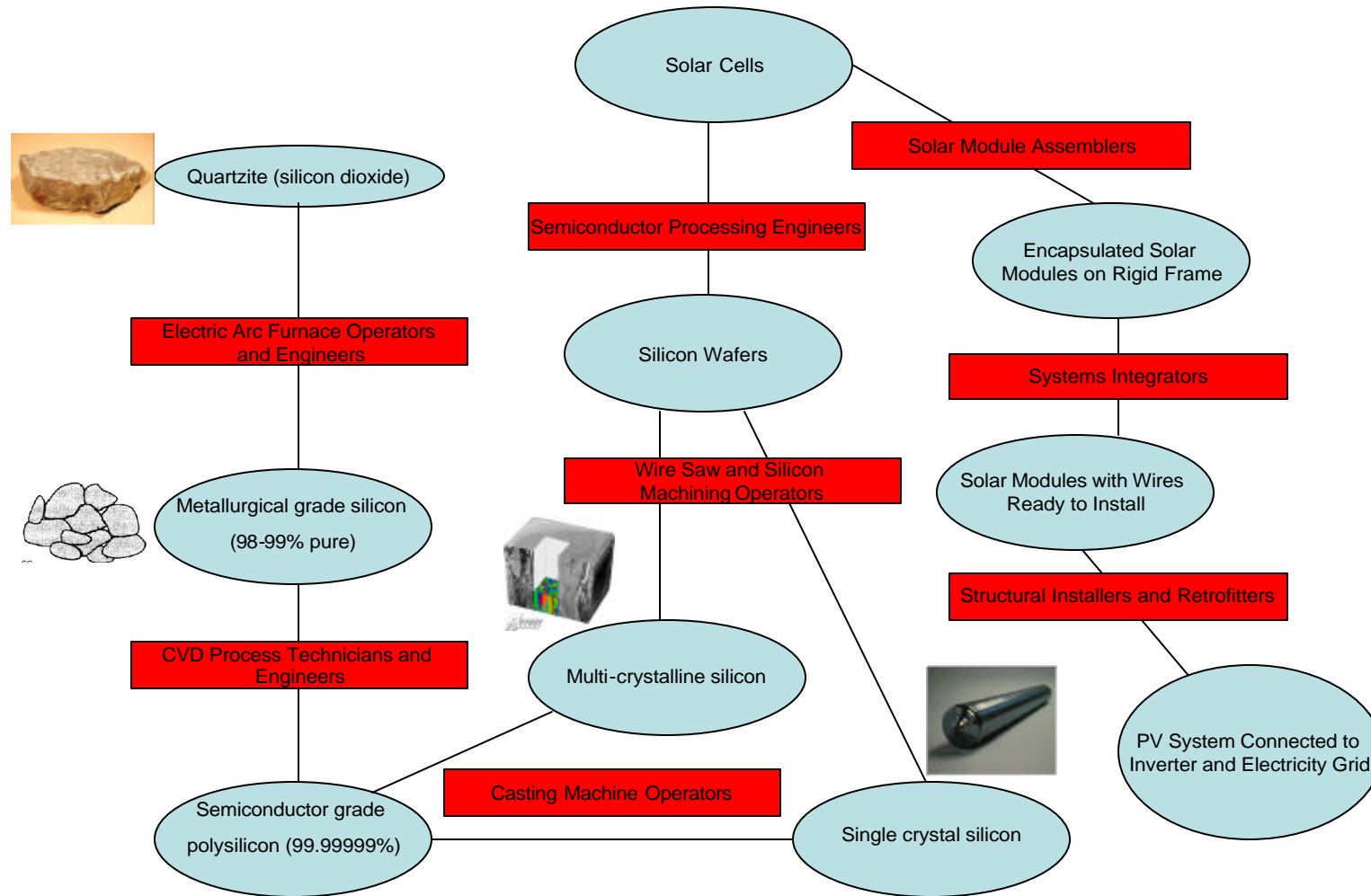


Figure 1: A flowchart showing the processing required to get from Quartzite to a PV System on a rooftop.

The most basic part of a PV system is a solar cell, shown in Figure 2, which is responsible for converting sunlight into electricity. Solar cells are made from semiconductors, most often silicon. The manufacturing of silicon to be used in solar cells accounts for about 8% of the total jobs created by PV. From the silicon, PV cells are manufactured, which accounts for about 5% of the total jobs created by PV.³



Figure 2: A solar cell. Photo courtesy www.wisconsun.org/learn/learn_intro.shtml.

Next, the cells are connected using either glass or plastics, into a PV module as seen in Figure 3. Including the manufacturing of glass and plastic (which accounts for a very small amount of jobs), and the labor required to assemble the module, this accounts for around 30% of the jobs created by PV.³



Figure 3: A solar array, also known as a solar panel. Photo courtesy www.solarpath.com

Given the latitude of California, PV modules are most efficient when they face south, towards the sun. In order for this to happen it is necessary for the module to be embedded in a mounting frame, which is angled toward the south as shown in Figure 4. The production of these mounting frames accounts for approximately 2% of the total jobs created by PV.³



Figure 4: A solar array in a mounting bracket facing south. Photo courtesy www.solarpath.com

Next, the solar panels need to be made compatible with the existing electricity grid. “Systems Integrators” are responsible for this task. It is necessary to connect the module to electric wires, which transmit electricity to an inverter, a device responsible for converting the DC current produced by the PV module to AC current for the electricity grid. Wires are then connected to the inverter and to the grid. “Systems Integrators” account for around 17% of jobs. The manufacturing of the wires accounts for about 3% of the jobs. Manufacturing of inverters accounts for around 7% of the total PV jobs created.³

Another class of workers is known as “installers.” They are responsible for installing the modules on a roof, and connecting all the wires to the inverter and then to the grid. Although it is a common misconception by policy makers that installers are less important than manufacturers in the realm of creating jobs, this is not true. Installers account for about 15% of the total jobs.³

Lastly, PV systems will require a certain amount of servicing over their lifetime. This can include routine maintenance like washing the panels a few times a year, or repair. This accounts for about 7% of the total jobs created by PV.³

All the above information is presented in Figure 5, which shows the proportion of jobs created by each job type.

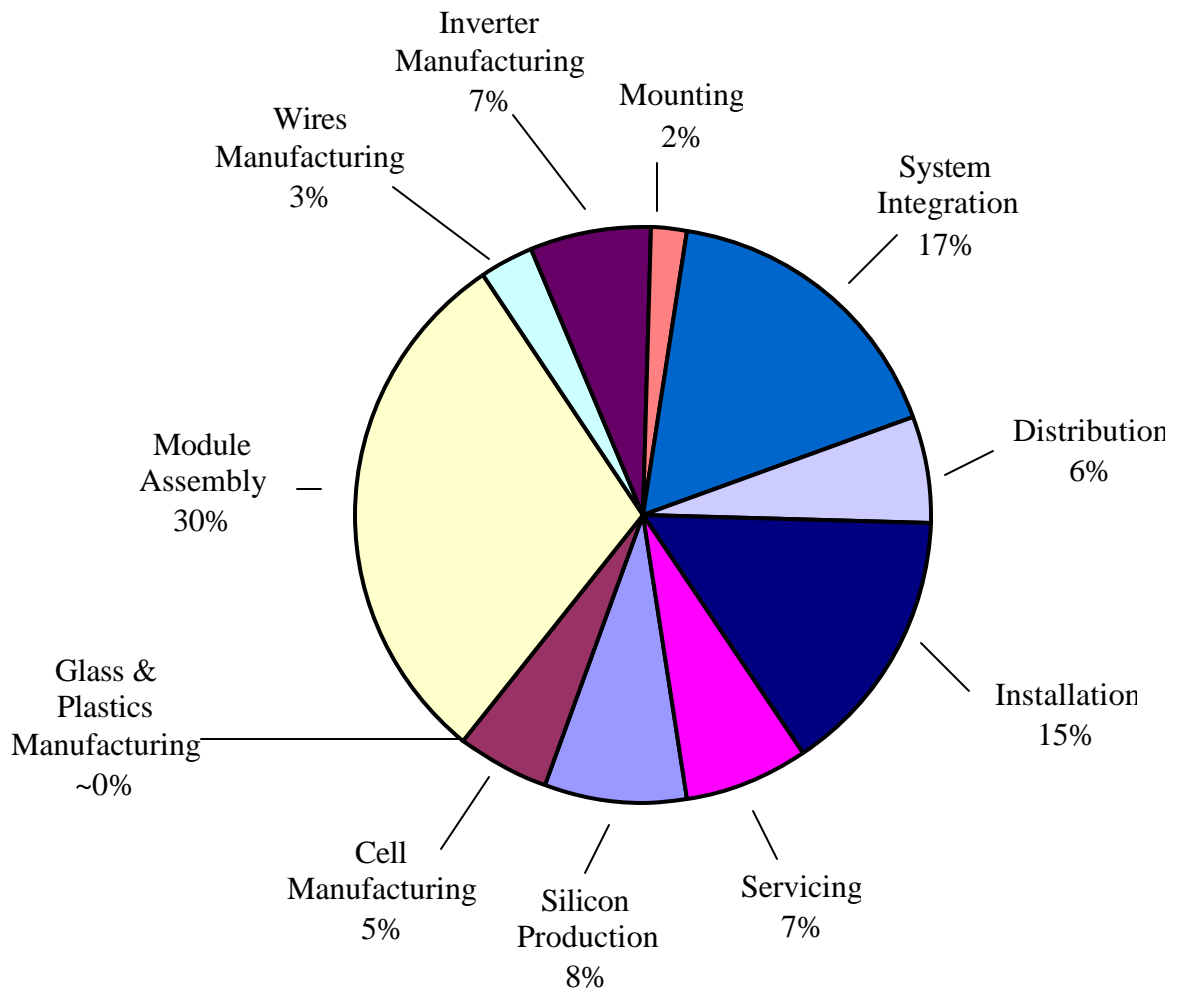


Figure 5: The contribution of each job type to the total jobs created by the PV industry.

Another way to view jobs created by PV is by breaking them down into occupational categories as defined by the U.S. Department of Labor: professional, technical, and managerial work (0/1); clerical and sales (2); service (3); agriculture, fishery, and forestry (4); processing (5); machine trades (6); benchwork (7); structural work (8); and miscellaneous (9). These occupational categories are part of the Dictionary of Occupational Titles system.⁴ The fraction of total jobs created by each occupational category, as well as a short description of each, is provided in Table 1. A pie-chart showing the contribution of each category can be viewed in Figure 6.

⁴ Photius Coutsoukis, *Information Technology Associates* (1995)
<http://www.occupationalinfo.org/contents.html>

Occupational Category	Jobs (%)	Description
Professional, Technical, & Managerial (0/1)	36%	Engineers, Scientists, Administrators, Systems Integration
Clerical & Sales (2)	7%	Secretaries, Clerks, Sales Reps, Contractors
Service (3)	0%	Custodians, Cooks, House-Keepers
Agri, Fishery, Forestry (4)	0%	NA
Processing (5)	11%	Refining silicon, Cell Manufacturers, Machine Operators, Technicians
Machine Trades (6)	5%	Machinists, Metal Workers
Benchwork (7)	15%	Fabrication, Assembly, Repairs
Structural Work (8)	14%	Installers, Welders, Electrical Assembly
Miscellaneous (9)	12%	Transportation, Packaging, Materials Handling, Distribution

Table 1. The fraction of total jobs created by each occupational category

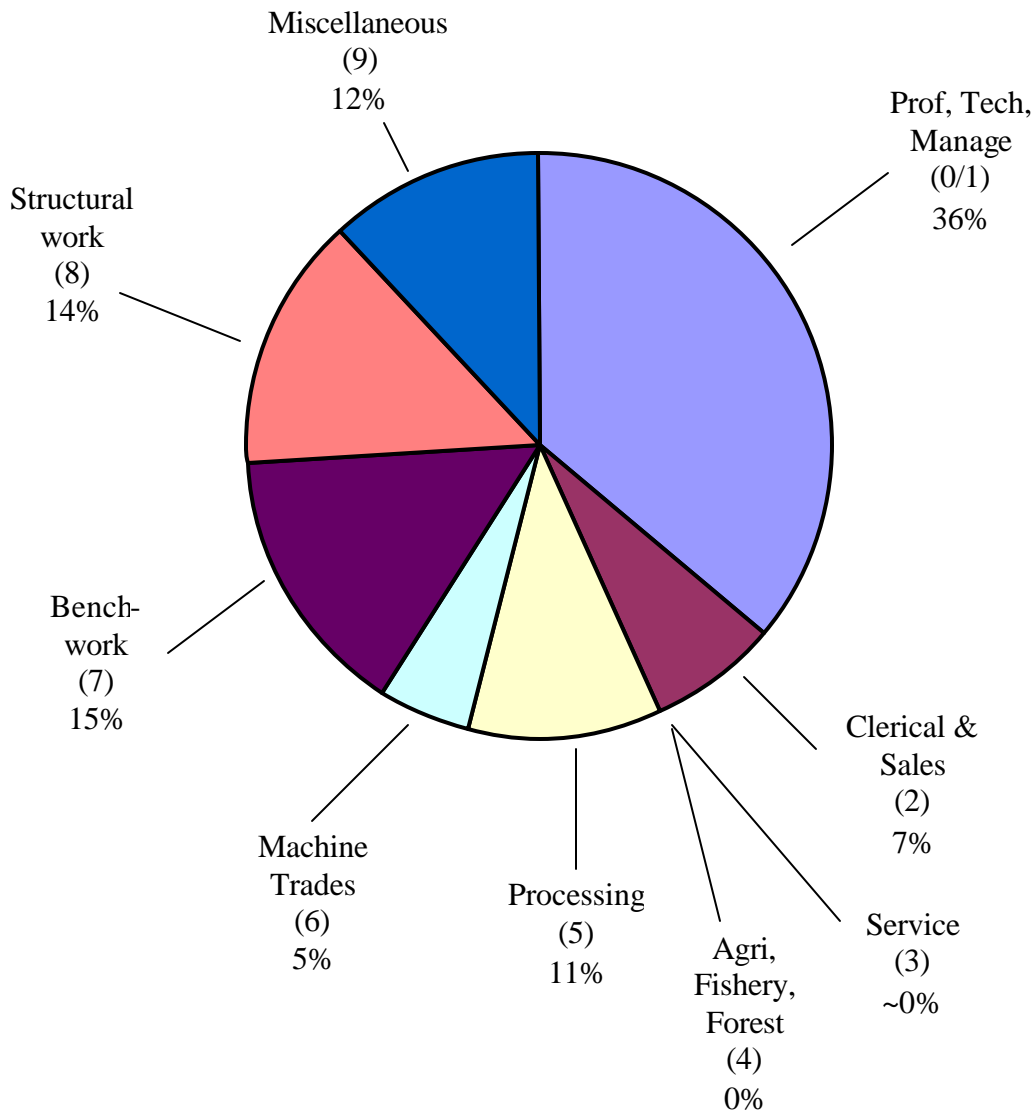


Figure 6: The contribution of each occupational category to the total jobs created by the PV industry.

IV. Job Creation

i. Total jobs created per MW PV installed

Several studies have been done calculating the number of jobs created per MW_P of PV installed. Five such studies have been identified which use both analytical and input-output models. They generally do not include indirect jobs, which support but are not part of the PV industry. Figure 7 shows the job creation predicted by each model. For more information on each model refer to Appendix A.

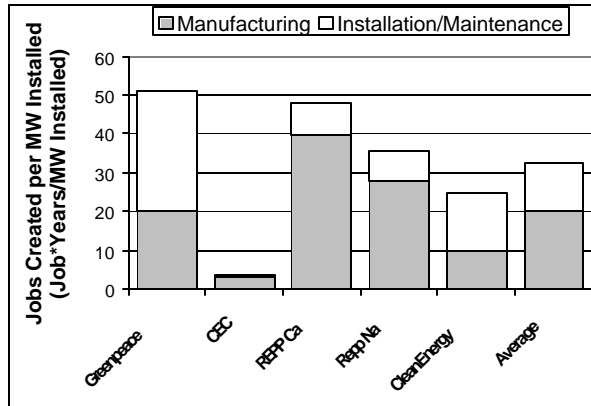


Figure 7: Estimation for jobs created per MW_P installed from various studies. See Appendix A for more information on the specific models.

Figure 7 shows that there is significant variation in the estimates for job creation per MW_P installed, both in terms of the total number of jobs created and the division of jobs between manufacturing and installation/maintenance. This variation is partly because PV is a relatively new industry with little actual job creation data available. In this analysis the average of the five models will be used, which predicts that approximately 20 manufacturing and 13 installation/maintenance job-years will be created for every MW_P of PV installed.

Note that the estimate from the CEC model is extremely low and deserves special mention. It comes from a report by the California Energy Commission and is regarded as a very conservative calculation.

ii. Worldwide Job Creation by SB 199

The prediction is that 20 manufacturing and 13 installation/maintenance jobs will be created for every MW_P of PV installed. The year by year volume of PV installed and global job impact is summarized in Table 2 below.⁵ It assumes one million homes with PV installed by 2018, comprising approximately 2,700 MW_P.

⁵ See Appendix A for a more complete derivation of average job creation.

Year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
MW Installed	25	34	50	77	125	174	215	265	304	335	353	369	384
Manufacturing	504	689	1018	1548	2510	3155	3896	4813	5517	6087	6413	6696	6967
Installation / Maintenance	329	450	665	1011	1640	2184	2697	3332	3820	4214	4440	4636	4824
Total	833	1140	1683	2559	4151	5339	6593	8145	9337	10302	10853	11331	11791

Table 2: Estimate of total jobs created worldwide. All units are job-years. Note that MW installed figures are taken from Julia Blunden’s (KEMA-Xenergy, 2004) analysis of the impact of the Murray Bill.

iii. California Direct Job Creation: Manufacturing

Table 2 splits the jobs created into two categories. Manufacturing refers to those jobs required in the manufacturing process of PV modules. Installation/maintenance refers to the jobs required to install and maintain the PV. Distinguishing between these two categories is helpful when trying to determine where the jobs will be located. We are primarily interested in knowing how many jobs are located in California.

Manufacturing jobs are located where the PV module is created and assembled. It may be in California, in another state, or somewhere overseas. In 2002, nearly 80% of the PV installed in the United States was manufactured in the United States,⁶ and California manufactured approximately 47% of the US PV modules and cells.⁷ Therefore we estimate that 80% of 47%, or 38% of the PV installed in California was and will continue to be manufactured in California. While the trend to outsource manufacturing to other countries could lower this percentage over time, we believe the impact will be offset by an increased preference for manufacturers to produce in California as local demand surges due to implementation of the Murray Bill.

Year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
California	191	262	387	588	954	1199	1480	1829	2096	2313	2437	2544	2648
Other States	212	290	427	650	1054	1325	1636	2021	2317	2557	2693	2812	2926
Outside U.S.	101	138	204	310	502	631	779	963	1103	1217	1283	1339	1393

Table 3: Estimate of total manufacturing jobs created in California, in other states and in other countries. All units are job-years.

iv. California Direct Job Creation: Installation/maintenance

It is reasonable to assume that all of the installation and maintenance jobs will be located in California and close to the installation site. We can estimate exactly where these jobs will be created by looking at new home construction in counties across the state, which is shown below in Table 4.

⁶ Energy Information Administration, *Renewable Energy Annual 2002*, downloadable at http://www.eia.doe.gov/cneaf/solar.renewables/page/rea_data/rea.pdf

⁷ From private communication with Joseph McCabe of CEC.

Area	Percent New Units	Area	Percent New Units	Area	Percent New Units	Area	Percent New Units	Area	Percent New Units	Area	Percent New Units	Area	Percent New Units
Alameda County	2.31%	Fresno County	3.07%	Los Angeles County	10.89%	Napa County	0.33%	San Diego County	9.36%	Sierra County	0.01%	Tuolumne County	0.18%
Alpine County	0.01%	Glenn County	0.07%	Madera County	0.63%	Nevada County	0.47%	San Francisco County	0.81%	Siskiyou County	0.11%	Ventura County	1.86%
Amador County	0.21%	Humboldt County	0.22%	Marin County	0.36%	Orange County	4.76%	San Joaquin County	3.55%	Solano County	1.37%	Yolo County	0.90%
Butte County	0.93%	Imperial County	0.62%	Mariposa County	0.07%	Placer County	2.68%	San Luis Obispo County	1.14%	Sonoma County	1.20%	Yuba County	0.31%
Calaveras County	0.35%	Inyo County	0.01%	Mendocino County	0.20%	Plumas County	0.13%	San Mateo County	0.67%	Stanislaus County	2.13%		
Colusa County	0.10%	Kern County	3.12%	Merced County	1.51%	Riverside County	15.52%	Santa Barbara County	0.83%	Sutter County	0.51%		
Contra Costa County	3.52%	Kings County	0.50%	Modoc County	0.02%	Sacramento County	7.07%	Santa Clara County	3.83%	Tehama County	0.22%		
Del Norte County	0.06%	Lake County	0.28%	Mono County	0.16%	San Benito County	0.05%	Santa Cruz County	0.61%	Trinity County	0.03%		
El Dorado County	0.99%	Lassen County	0.08%	Monterey County	0.71%	San Bernardino County	6.46%	Shasta County	0.68%	Tulare County	1.22%		

Table 4: New homes constructed in California by county in 2002.⁸

Assuming that the trend in new home construction does not vary significantly from the 2002 data, we can use Table 4 to find the approximate number of installation and maintenance jobs that will be created in each county. For example, Santa Clara County accounted for 3.83% of new homes in California. We therefore estimate that an equivalent percentage of installation and maintenance jobs will be created in Santa Clara County. This calculation is shown explicitly and year by year in Table 5. A similar calculation can be done for all other counties.

Year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
California	329	450	665	1011	1640	2184	2697	3332	3820	4214	4440	4636	4824
Santa Clara County	13	17	25	38	62	83	102	127	145	160	169	176	183

Table 5: Table shows that approximately 4% of new PV installation and maintenance jobs will be located in Santa Clara County. All units are job-years.

v. California Direct Job Creation: Industry Breakdown

The REPP report³ estimated job creation in twelve separate sectors of the PV industry as a percentage of total jobs created. See section III for definitions of each category and Figure 5 for the overall percentage of jobs created in each category.

⁸ From RAND California at <http://ca.rand.org/cgi-bin/homepage.cgi>.

	Glass	Plastic	Silicon	Manufacturer Cell	Manufacturer Module	Wires	Inverters	Mounting Frame	Systems Integration	Distributor	Contractor/ Installer	Servicing
% Jobs Created	0.2%	0.2%	3.7%	2.3%	14.1%	1.4%	3.3%	0.9%	8.0%	2.8%	43.0%	20.0%
2005	1	1	20	12	73	7	17	5	41	15	224	104
2011	10	10	157	98	587	59	137	39	333	117	1795	837
2017	17	17	280	175	1050	105	245	70	595	210	3209	1498

Table 6: Job creation in California broken down by industry for 2005, 2011 and 2017 using data from REPP report shown in Figure 5. Note that percentages in Figure 5 are worldwide and therefore differ. Note also that only Contractor/Installer and Servicing are included in Installation/Maintenance jobs. All units are job-years.

vi. California Indirect Job Creation

We have discussed direct employment resulting from the Murray Bill, including PV manufacturing, installation and maintenance jobs. It is also important to consider other jobs that will be created indirectly in other industries that support the new jobs, such as the producers of the raw materials. The California Commerce and Economic Development Program makes available a set of Regional Input-Output Modeling System (RIMS II) multipliers which calculate the total change in employment in the state which results from the addition of one job in a specified industry. The appropriate multiplier for a PV manufacturing job is 3.8555. This means that for every job created to manufacture PV, 2.8555 more jobs will be created in other segments of the economy. The multiplier for PV service and maintenance is 1.8010.⁹ Table 7 shows the indirect job creation estimated by these multipliers.

Year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Indirect Manufacturing	547	748	1104	1679	2723	3423	4227	5222	5985	6604	6957	7264	7559
Indirect Installation / Maintenance	264	361	533	810	1314	1749	2161	2669	3060	3376	3556	3713	3864
Total	810	1109	1637	2489	4037	5172	6387	7891	9045	9980	10514	10977	11423

Table 7: Jobs created in other industries due to employment in PV sector as calculated by RIMS II multipliers. All units are job-years.

⁹ Multiplier taken from Table 1 at <http://www.film.ca.gov/ttca/pdfs/detail/ersi/Multipliers.pdf>. PV manufacturing job is classified under ‘Electronics and other electric equipment’, while the service and maintenance jobs are under the heading “Miscellaneous service”. See website for more information.

vii. Total California Job Creation

Table 8 below summarizes the total estimated job creation in California.

Year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
California Manufacturing	191	262	387	588	954	1199	1480	1829	2096	2313	2437	2544	2648
California Installation / Maintenance	329	450	665	1011	1640	2184	2697	3332	3820	4214	4440	4636	4824
Total California Indirect Jobs	810	1109	1637	2489	4037	5172	6387	7891	9045	9980	10514	10977	11423
Total	1331	1821	2688	4089	6632	8555	10565	13052	14961	16508	17390	18157	18894

Table 8: Total annual employment in California due to enactment of Murray Bill, all units are job-years.

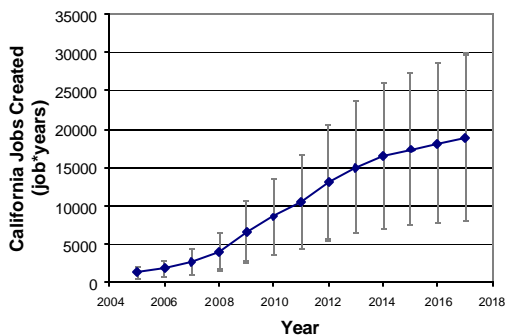
viii. Error Analysis

In the beginning of the analysis it was pointed out that there is significant variation among the different estimates of job-years created per MW_P of PV installed (figure 7). To determine how much error this variation introduces into the result, we calculated that the average job-years created per MW_P PV installed is 33 ± 19 , where 19 is the standard deviation.

As discussed above, because the CEC model is very conservative the standard deviation is quite large. Assuming the CEC model is an outlier, we can exclude it and repeat our calculations. In this case it was found that the job-years per MW_P installed is 41 ± 13 , where 13 is the standard deviation.

Figure 8 shows how our job prediction will change assuming the actual outcome is either one standard deviation above or below the expected job creation estimate, both with and without the CEC estimate. The result shows considerable job growth even in the worst case scenario.

(a) Including CEC Estimate



(b) Excluding CEC Estimate

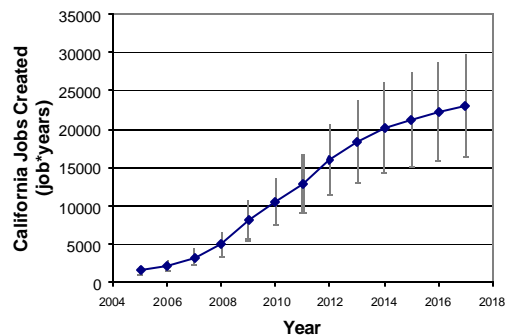


Figure 8. The error bars show one standard deviation variation from the mean job-years per MW_P PV. Figure 8 (a) shows error estimate using all five models. Figure 8 (b) shows the error estimate excluding the CEC data, which is a low outlier.

V. Foreign Case Studies

i. European Forecast

The effort of the European Union to promote solar power as an alternative energy source is worth mentioning for comparison and reference. In 1993, the European Union approved the ALTENER (Alternate Energy) plan, which was developed to promote renewable energy sources in Europe and increase trade in renewable products internationally. With a budget of 40 million ECU (European Currency Unit), the plan corresponded to the objective of stabilizing Europe's carbon dioxide emission at the 1990 level by the year 2000 to offset worsening global warming.¹⁰

A strategic action plan was prepared by AGORES (A Global Overview of Renewable Energy Sources), a subsidiary of the European Commission. The time frame of this plan extends to the year 2010. The study, named ALTENER PV2010, proposed to connect 500MW to the European grid and expected a total of 2,000 MW_P of PV installed in Europe by 2010. Annual world PV shipments are predicted to reach 630 MW_P/yr in 2010. The predicted world annual PV shipment is plotted in Figure 9.¹⁰

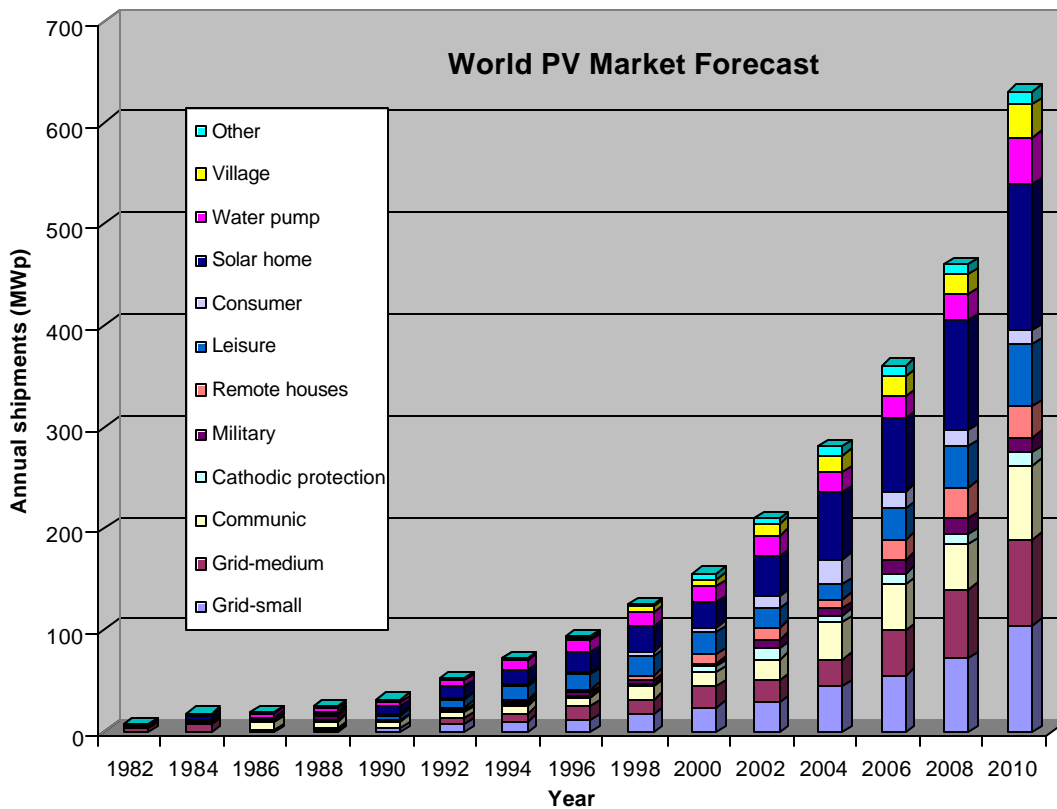


Figure 9: The forecast of world PV shipments until 2010, breaking down by applications¹⁰

¹⁰ *Photovoltaics in 2010 PV2010 – A Strategic Plan for Europe*, AGORES (1994), www.agores.org

The strategic plan points out enormous employment benefits to the world and the European Union. The jobs generated have been estimated separately for the area of origin of PV equipment (including PV and balance of system manufacturing, services, and wholesales) and for the areas of destination (local retailers, installation, and maintenance). It was estimated that more than 2,500 people were employed in the European PV sector in 1993. Assuming the *Business as Usual* scenario, which means the current trend and policies continue without any new developments, the study expects the total world employment in the PV industry to be 150,000 job-years by the year 2010 (cumulative, assuming 15% growth in the market), with 32,000 job-years in Europe. If the proposed target of 2,000 MW_P of PV installed is achieved in 2010, a minimum of 56,000 jobs will be created in Europe according to the report. The predicted employment outlook until 2010, assuming a *business as usual* scenario, is plotted in Figure 10.¹⁰ Possibly due to the different job function definitions or models applied, the break-down of employment areas is different from our study, with a larger portion of employment in the maintenance of all existing PV systems (accounts for 70% of all employment). The European prediction corresponds to job creation of 56,000 job-years/2000MW_P = 28 job-year/MW_P, which is consistent with the results presented in Table 7.

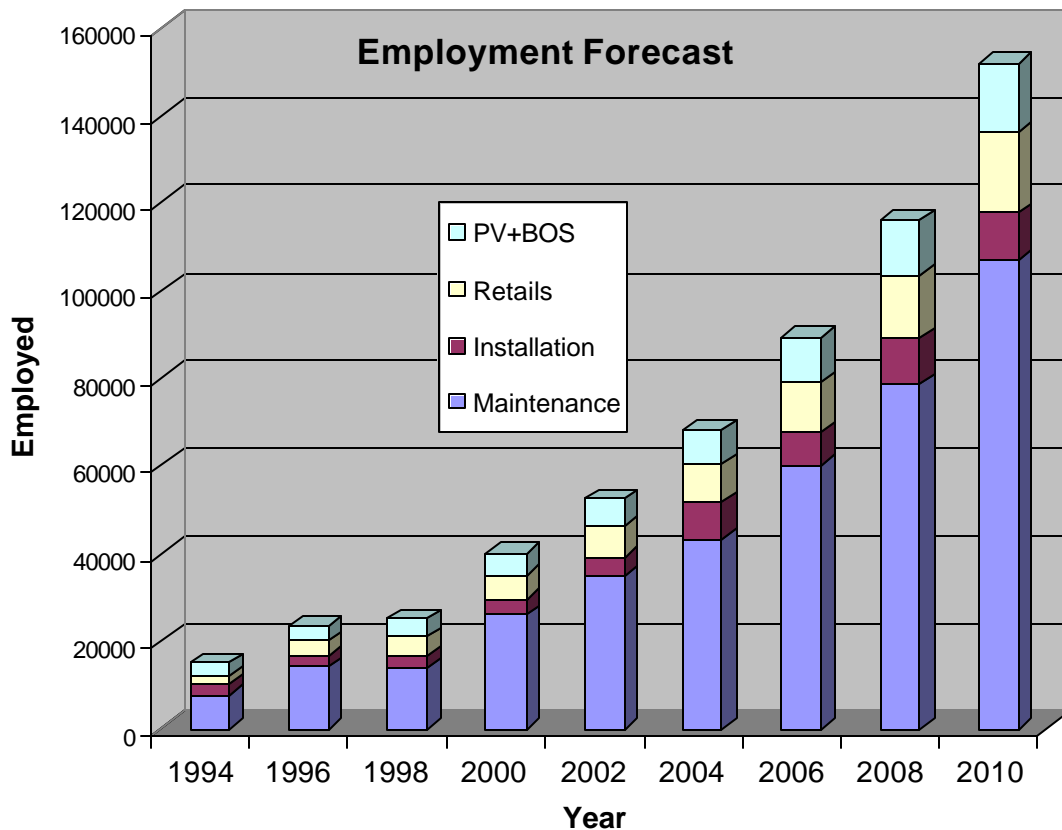


Figure 10: The world-wide employment forecast in the PV sector until 2010, assuming a *business as usual* case.¹⁰ Unit of employment is cumulative job-years.

A government subsidy funds a relatively large component of the project's cost. The proposed public funding support is proposed to be 49% and drops off linearly to zero in 2006.¹⁰

In the execution of the plan, the member states of the union are obligated to report the progress of implementation and the success of the method chosen every two years. The first five year term of ALTENER (1993-1997) was successful and was followed by ALTENER II (1998-2003), which was extended in activities and larger in scale. Currently the program is in a third phase, ALTENER III (2003-2006), with more emphasis on "intelligent energy," or the non-technological aspects (public policy, for example) in the field of energy. In the PV Status Report 2003 by European Commission Directorate General Joint Research Centre, the target is raised to a total capacity of 3,000 MW_P by 2010.¹¹ The new target would correspond to a total of about 89,000 job-years in the European Union from the AGORES study.

ii. The Japanese Rebate Program

In Japan, the effort of promoting the PV industry dates back to the Sunshine Project starting in 1974, during the first oil crisis in the seventies. It was followed by the 1993 New Sunshine Project, which laid down the target of installing 400MW_P in Japan by 2000. The target was met with only one year of delay. Due to a reform of governmental structure, the Japanese New Energy Development Organization (NEDO) reviewed the New Sunshine Project, and replaced it by the "Advanced PV Generation" program, effective in 2001. The program's guidelines include reducing the almost 100% dependence on petroleum imports, reducing its heat-trapping gas emission by 6% from 2008 to 2012 (compared to 1990 levels), and establishing a prospering international PV market. The specific target for the program is 4.8 GW_P PV installed in 2010.¹¹

To stimulate the demand for PV, the Japanese government provided a significant amount of rebates to PV users. The so-called "Monitoring Program for Residential PV Systems" was first initiated by the New Energy Foundation from 1994 to 1996. The program provided a subsidy for 50% of the installation cost of PV systems. The program was met with great success: from 1994 to 1996, the cost of PV was reduced from 2 million to 1.2 million ¥/KW_P, the program budget increased from 2 billion to 4 billion ¥, and the installation increased from 539 to 1986 systems. The rebate program continued as the "Program for the Development of the Infrastructure for the Introduction of Residual PV Systems" of 1997, with a budget increase from 11.11 billion ¥ in 1997 to 23.5 billion ¥ in 2001. The budget decreased slightly in 2002 and 2003 due to extra funds from previous years. The development of Japanese PV roof top systems from 1994 to 2003, including the budget and subsidy, is plotted in Figure 11.¹¹ The success of the program also includes employment benefits: it is estimated that at the end of 2002, the total

¹¹ Arnulf Jager-Waldau, "PV Status Report 2003 – Research, Solar Cell Production and Market Implementation in Japan, USA and European Union," European Commission Directorate General, Joint Research Centre (2003)

employment Japanese PV industry was about 9,800 jobs.¹² By 2002, 360 MW_P of PV were installed in Japan. Thus, their direct employment rate was approximately 27.2 job-years/MW_P, which is in relatively close to the global estimate of 33 job-years/MW_P installed for California, and larger than the in-state direct employment for California (20.6 job-years/MW_P).

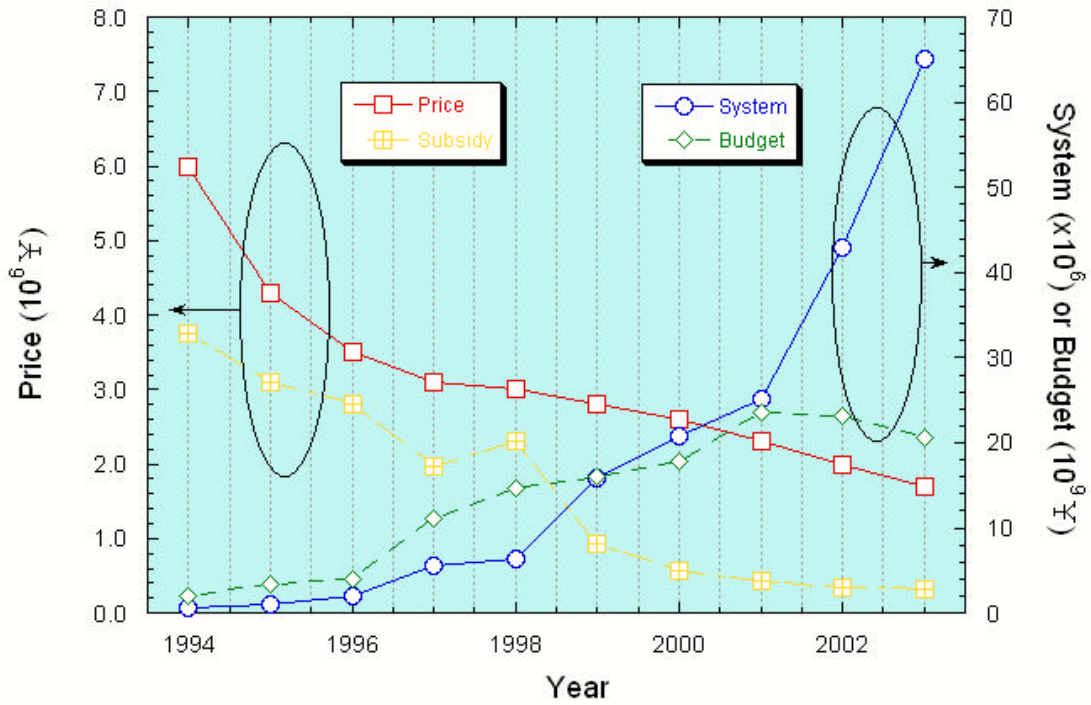


Figure 11: Development of Japanese PV rooftop systems.¹¹

¹² Kiyoshi Shino, "National Survey Report of PV Power Applications in Japan 2002," New Energy and Industrial Technology Development Organization (2002)

VI. Conclusions

It has been found that SB 199 will lead to approximately 3 GW_p of PV installed by 2018, resulting in an estimated 19,000 new jobs in California. The largest fraction of new jobs in the PV industry worldwide will be module assemblers, whereas in California the greatest proportion of new employees will be contractors and installers. In terms of the Occupational Categories as defined by the U.S. Dept. of Labor, the largest fraction of new jobs will be created in the Professional, Technical, and Managerial (0/1) category. There was larger than desired error in the final job estimate due to differences in expert opinion and lack of experience in estimating job creation by PV. As a comparison, case studies of already implemented policies were done. The AGORES strategic plan has set up a target of 2000 MWP installed in Europe by 2010, which will bring a total European employment of 56,000. In addition, the 1993 Japanese rebate program has been successful in stimulating PV industry growth. The target is to achieve 4.8 GWP of rooftop PV installed by 2010.

Appendix A. Summary of Job Creation Estimates

Overview of Five Job Creation Estimates					Overview of Estimate for Job Creation in Caunder Murray Bill													
Plan	Source	Job Creation Estimated (job*years per MW installed)		Comments	Year:	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
		Manufacturing	Installation and Maintenance		MW Installed:	25	34	50	77	125	174	215	265	304	335	353	369	384
Greenpeace	Greenpeace: Murray Cameron and Sven Teske, "Solar Generation – Solar Electricity of Over 1 Billion People and 2 Million Jobs by 2020," European Photovoltaic Industry Association and Greenpeace Renewable Energy Campaign (2001)	20 before 2010 10 after 2010	31 before 2010 28 after 2010	a. Analytical model b. Created by discussion with industry	Manufacturing	500	684	1010	1536	2491	1738	2146	2651	3039	3353	3532	3688	3837
					Installation & Maintenance	775	1060	1565	2380	3861	4865	6008	7423	8508	9388	9890	10326	10745
					Total	1275	1744	2575	3916	6352	6603	8154	10073	11547	12741	13422	14014	14582
CEC	CEC: same as CALPIRG	3.18	0.73	a. Input-output model b. Very conservative	Manufacturing	80	109	161	244	396	553	682	843	966	1066	1123	1173	1220
					Installation & Maintenance	18	25	37	56	91	127	157	194	222	245	258	269	280
					Total	98	134	197	300	487	679	839	1037	1188	1311	1381	1442	1500
REPP CA	REPP CA (CALPIRG): Brad Heavner and Susannah Churchill, "Renewable Work – Job Growth from Renewable Energy Development in California," CALPIRG Charitable Trust (2002)	39.90	11.32	a. Analytical model b. Direct employment only c. CA specific	Manufacturing	998	1365	2015	3064	4969	6933	8562	10577	12124	13378	14093	14714	15312
					Installation & Maintenance	283	387	572	869	1410	1967	2429	3001	3440	3795	3998	4175	4344
					Total	1281	1752	2586	3933	6379	8900	10991	13578	15564	17173	18091	18889	19656
REPP National	REPP: Virinder Singh and Jeffrey Fehrs, "The Work that goes into Renewable Energy," Renewable Energy Policy Project (2001), www.repp.org	27.70	7.80	a. Analytical model b. Direct employment only	Manufacturing	693	947	1399	2127	3450	4813	5944	7343	8417	9287	9784	10215	10630
					Installation & Maintenance	195	267	394	599	971	1355	1674	2068	2370	2615	2755	2876	2993
					Total	888	1214	1792	2726	4421	6168	7618	9411	10787	11902	12539	13092	13623
Clean Edge	The result of a study by CleanEdge "Bringing Solar to Scale", July 2002, http://www.cleannedge.com/	10.00	15.00	a. We take the midpoint of this range, at 15 jobs per MW	Manufacturing	250	342	505	768	1245	1738	2146	2651	3039	3353	3532	3688	3837
					Installation & Maintenance	375	513	757	1152	1868	2606	3219	3976	4558	5029	5298	5532	5756
					Total	625	855	1262	1920	3114	4344	5365	6627	7597	8382	8830	9220	9594
Average					Manufacturing	504	689	1018	1548	2510	3155	3896	4813	5517	6087	6413	6696	6967
					Installation & Maintenance	329	450	665	1011	1640	2184	2697	3332	3820	4214	4440	4636	4824
					Total	833	1140	1683	2559	4151	5339	6593	8145	9337	10302	10853	11331	11791

Note: all employment figures are in job-year

Appendix B. Background of SB 199

i. Prior Law

Existing law requires a non-bypassable rate component labeled as a Public Goods Charge (PGC) to be collected on the basis of usage from electricity consumers. This rate component has a maximum value based on the level in effect on January 1, 2000. These funds are used to support cost effective energy efficiency and conservation activities, public interest research and development not adequately provided in competitive and regulated markets, and renewable energy resources. Currently, 17.5% of the renewable energy PGC are allocated for the Emerging Renewable Resources Account (ERRA) under the Renewable Resource Trust Account. The State Energy Resources Conservation and Development Commission (Energy Commission) is required by law to implement a budget grant program to make solar energy systems cost competitive with alternate energy until January 1, 2006.

17.5% of the renewable energy PGC collected is used for a multi-year, consumer-based program to foster the development of emerging renewable technologies in distributed generation applications. On or prior to December 31, 2004, these funds will be used to support emerging technologies in a competitive, market-based process, to provide rebates, buydowns or equivalent incentives to purchasers, lessees, lessors, or sellers of eligible electricity generating systems. These systems include PV, solar thermal electric, fuel cell technologies that utilize renewable fuel, wind turbines less than 50kW, and other technologies that meet the eligibility requirements.

ii. Rebate Program Funding

The funds will be collected from SCE, PG&E, and SD G&E over the 10-year period in the amount of \$228M/yr for energy efficiency and conservation, \$135M/yr for renewable energy, and \$62.5M/yr for R&D and demonstration. The total amount collected per year will be at least \$425.5M (which will increase with inflation or electric commodity sales based adjustments). Excess revenues will be placed in the SHPEPA. 17.5% of the \$135M/yr allocated to renewable energy is \$23.6M/yr for the consumer-based rebate and buy down program.

Net energy metering for customer generators using solar energy systems will be made available by the electric service provider until the total peak demand of all customer generators exceeds 5% of the aggregate customer peak demand for that electric service provider. Annual home production rates are assumed to be =150,000 homes/yr in the bill.

Appendix C. Converting Jobs -years to Jobs

The term “job-years” will be used extensively in this report. The definition of a job-year (sometimes called “person-year”) is a single individual who is employed for one year (49 weeks, 40 hours/week). Thus, 150 job-years could mean 150 people employed for one year, or 15 people employed for 10 years. Most employment analyses report jobs created in units of job-years. When cumulative jobs created over some time frame are reported in this way, the average number of persons employed during that time period can be obtained by dividing the cumulative figure by the time span of interest. The actual number of individuals employed during a specific year is simply the quantity of job-years for that year.