WORKFORCE NEEDS FOR LARGE-SCALE SOLAR PROJECTS

PRESENTED AT
LARGE-SCALE SOLAR PROJECT WORKFORCE NEEDS WORKSHOP
California Environmental Protection Agency

September 15, 2010

By V. John White, Rhonda S. Mills and Alexandra Kravetz
Center for Energy Efficiency & Renewable Technologies
WHY IS SOUTHERN CALIFORNIA THE SOLAR MECCA?

Best solar “fuel” in the Western Hemisphere

Home to large electric demand loads: *Power Hungry Cities*

Most solar projects in Kern, Riverside, San Bernardino and Imperial Counties

Permitting challenges must be overcome to get projects built: Multi-Agency Permitting, Competing Land Use, Transmission Needs, Habitat Protection, Local Government Entitlements and Fees
Over 7,700 MW of Solar Projects Prioritized in Southern California
**KEY SOLAR PROJECTS 2010-2011**
**(PRIORITIZED PERMITTING BY LOCAL, STATE AND/OR FEDERAL AGENCIES)**
**7,737 MW CAPACITY**

<table>
<thead>
<tr>
<th>TECHNOLOGY</th>
<th>DEVELOPER</th>
<th>PROJECT NAME</th>
<th>LOCATION</th>
<th>MW SIZE</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHOTOVOLTAICS</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Chevron</td>
<td>Lucerne</td>
<td>Barstow, Kern</td>
<td>45</td>
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<tr>
<td></td>
<td>First Solar</td>
<td>Topaz Solar Farm</td>
<td>California Valley, San Luis Obispo</td>
<td>550</td>
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<tr>
<td></td>
<td>First Solar</td>
<td>Monte Vista Solar</td>
<td>Mojave, Kern</td>
<td>126</td>
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<tr>
<td></td>
<td>First Solar</td>
<td>Desert Sunlight</td>
<td>Desert Center, Riverside</td>
<td>550</td>
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<td></td>
<td>Granville Homes</td>
<td>Maricopa Sun Solar Project</td>
<td>Kern County</td>
<td>700</td>
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<tr>
<td></td>
<td>NextLight</td>
<td>Antelope Valley</td>
<td>Antelope Valley, East LA County</td>
<td>230</td>
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<tr>
<td></td>
<td>NextLight</td>
<td>Lost Hills</td>
<td>Lost Hills, Kern</td>
<td>307</td>
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<td></td>
<td>Sempra Generation</td>
<td>Rosamond Solar Project</td>
<td>Rosamond, Kern</td>
<td>120</td>
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<tr>
<td></td>
<td>SunPower</td>
<td>California Valley Solar Ranch</td>
<td>California Valley, San Luis Obispo County</td>
<td>250</td>
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<tr>
<td>POWER TOWER</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>SolarReserve</td>
<td>Rice</td>
<td>Blythe, Riverside</td>
<td>150</td>
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<tr>
<td></td>
<td>BrightSource</td>
<td>Ivanpah</td>
<td>Needles, San Bernardino</td>
<td>400</td>
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<tr>
<td>PARABOLIC TROUGH</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>NextEra</td>
<td>Beacon</td>
<td>California City, San Bernardino County</td>
<td>250</td>
</tr>
<tr>
<td></td>
<td>NextEra</td>
<td>Genesis</td>
<td>Blythe, San Bernardino County</td>
<td>250</td>
</tr>
<tr>
<td></td>
<td>Abengoa</td>
<td>Mojave Solar Project</td>
<td>Harper Dry Lake, Kern</td>
<td>250</td>
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<tr>
<td></td>
<td>Solar Millennium</td>
<td>Ridgecrest</td>
<td>Ridgecrest, Kern</td>
<td>500</td>
</tr>
<tr>
<td></td>
<td>Solar Millennium</td>
<td>Blythe</td>
<td>Blythe, Riverside County</td>
<td>1000</td>
</tr>
<tr>
<td></td>
<td>Solar Millennium</td>
<td>Palen</td>
<td>Palen Dry Lake, Riverside County</td>
<td>500</td>
</tr>
<tr>
<td>STIRLING ENGINE</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Teserra Solar</td>
<td>Calico</td>
<td>Barstow, San Bernardino County</td>
<td>850</td>
</tr>
<tr>
<td></td>
<td>Teserra Solar</td>
<td>Imperial Valley Solar</td>
<td>Southern Imperial County</td>
<td>709</td>
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</table>

Prepared by Center for Energy Efficiency & Renewable Technologies
www.ceert.org
19 Key Solar Projects 2010-2011
WE SURVEYED LARGE SOLAR DEVELOPERS TO UNDERSTAND THEIR WORKFORCE NEEDS

<table>
<thead>
<tr>
<th>TECHNOLOGY</th>
<th>PROJECT NAME</th>
<th>MW SIZE</th>
<th>AVG # JOBS FTEs PER MONTH</th>
<th>EMPLOYMENT LENGTH</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ABENGOA</strong></td>
<td>Parabolic Trough</td>
<td>250</td>
<td>830</td>
<td>2 Years</td>
</tr>
<tr>
<td><strong>SOLAR MILLENNIUM</strong></td>
<td>Blythe Solar Power Plant</td>
<td>1,000</td>
<td>604</td>
<td>5.5 Years</td>
</tr>
<tr>
<td><strong>SOLAR MILLENNIUM</strong></td>
<td>Palen Solar Power Plant</td>
<td>500</td>
<td>566</td>
<td>3.5 Years</td>
</tr>
<tr>
<td><strong>SOLAR MILLENNIUM</strong></td>
<td>Ridgecrest Solar Power Plant</td>
<td>250</td>
<td>405</td>
<td>2.5 years</td>
</tr>
<tr>
<td><strong>NEXTERA</strong></td>
<td>Beacon Solar Energy Project</td>
<td>250</td>
<td>507</td>
<td>3.5 years</td>
</tr>
<tr>
<td><strong>NEXTERA</strong></td>
<td>Genesis Solar Energy Project</td>
<td>250</td>
<td>507</td>
<td>2.5 Years</td>
</tr>
<tr>
<td><strong>TESSERA</strong></td>
<td>Stirling Engine</td>
<td>709</td>
<td>360</td>
<td>3.5 years</td>
</tr>
<tr>
<td><strong>PERMACITY</strong></td>
<td>Photovoltaics</td>
<td>25</td>
<td>500</td>
<td>.5 year</td>
</tr>
<tr>
<td><strong>SUNPOWER</strong></td>
<td>California Valley Solar Ranch</td>
<td>250</td>
<td>353</td>
<td>~3 Years</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td>3,484 MW</td>
<td>4,632 JOBS/MONTH COMBINED</td>
<td>~3 YEARS</td>
</tr>
</tbody>
</table>

The survey is a sample, not a census, of all the projects being developed.

Prepared by Center for Energy Efficiency & Renewable Technologies
Monthly Construction Jobs Estimates
From 7 Solar Thermal Projects: ~3,500 MW
Length of Construction: 2.5 – 6 Years

Admin, Construction Mgt, Foremen: 154
Carpenters: 319
Cement Masons, Concrete Crews: 225
Electricians: 375
Engineers: 70
Ironworkers: 256
Laborers, Assembly Workers, Others: 835
Millwrights: 105
Operating Engineers: 313
Pipefitters, Boilermakers, Plumbers: 598
Project Foremen, Managers, Assistants: 107
Sheetmetal Workers, Insulators: 45
Surveyors, Designers: 61
Teamsters, Truck Drivers: 70
Tradesmen: 60
Welders: 140

Source: CEERT
Renewable Powerplants Jobs Survey, 2010

Center for Energy Efficiency and Renewable Technologies,
September 15, 2010
### CONSTRUCTION WORKFORCE NEEDS

**1,000 MW PARABOLIC TROUGH PROJECT**

Construction Period: ~6 Years

<table>
<thead>
<tr>
<th>Job Description</th>
<th>AVERAGE Monthly Workforce (FTEs)</th>
<th>PEAK Monthly Workforce (FTEs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Administrators and Support Personnel</td>
<td>11</td>
<td>14</td>
</tr>
<tr>
<td>Carpenters</td>
<td>57</td>
<td>90</td>
</tr>
<tr>
<td>Cement Masons and Concrete Crews</td>
<td>59</td>
<td>95</td>
</tr>
<tr>
<td>Construction Management, Supervisors, Planners</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Electricians</td>
<td>58</td>
<td>81</td>
</tr>
<tr>
<td>Engineers</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>Ironworkers</td>
<td>24</td>
<td>50</td>
</tr>
<tr>
<td>Laborers, Assembly Workers, Misc. Crews</td>
<td>106</td>
<td>271</td>
</tr>
<tr>
<td>Millwrights</td>
<td>14</td>
<td>18</td>
</tr>
<tr>
<td>Operators</td>
<td>57</td>
<td>152</td>
</tr>
<tr>
<td>Pipefitters, Boilermakers, Plumbers</td>
<td>136</td>
<td>299</td>
</tr>
<tr>
<td>Project Foremen, Managers and Assistants</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Surveyors and Designers</td>
<td>8</td>
<td>20</td>
</tr>
<tr>
<td>Teamsters, Truck Drivers</td>
<td>18</td>
<td>43</td>
</tr>
<tr>
<td>Other Skilled Tradesmen</td>
<td>12</td>
<td>66</td>
</tr>
<tr>
<td>Welders</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Others (Oilers, Security, Sprinklerfitters, Tech Advisors)</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>577</strong></td>
<td><strong>1004</strong></td>
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</table>

Source: CEERT Renewable Powerplants Jobs Survey, 2010
**OPERATION AND MAINTENANCE JOBS**  
**250 MW SOLAR THERMAL POWERPLANT**

<table>
<thead>
<tr>
<th>Job Description</th>
<th>Annual Workforce</th>
<th>Salary (Average)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>General:</strong> Office Personnel, Administration, Managers</td>
<td>10</td>
<td>$126,500</td>
</tr>
<tr>
<td><strong>Engineering:</strong> Controls, Electrical, Mechanical, Plant and Resource Engineers, Project Analyst, Chemical Technician, Engineering Technician, Operations Supervisors</td>
<td>6</td>
<td>$117,500</td>
</tr>
<tr>
<td><strong>Maintenance:</strong> Mechanical Technicians, Electricians, Equipment Operators, Welders, Machinists, Planners, Equipment Washing Technicians, Auto Mechanics</td>
<td>25</td>
<td>$87,800</td>
</tr>
<tr>
<td><strong>Operations:</strong> Shift Supervisor, Control Operator, Plant Operator, etc.</td>
<td>22</td>
<td>$91,100</td>
</tr>
<tr>
<td><strong>Unskilled Labor</strong></td>
<td>5</td>
<td>$25,000</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>68</td>
<td>$92,600</td>
</tr>
</tbody>
</table>

Source: CEERT  
Renewable Powerplants Jobs Survey, 2010
**Monthly Construction Jobs Estimates**

*From 2 Solar PV Projects: 275 MW*

*Length of Construction: 0.5 – 3 Years*

<table>
<thead>
<tr>
<th>Occupation</th>
<th>Jobs Estimate</th>
</tr>
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<tbody>
<tr>
<td>Admin, Construction Mgt, Foremen</td>
<td>136</td>
</tr>
<tr>
<td>Carpenters</td>
<td>22</td>
</tr>
<tr>
<td>Cement Masons, Concrete Crews</td>
<td>68</td>
</tr>
<tr>
<td>Electricians</td>
<td>94</td>
</tr>
<tr>
<td>Engineers</td>
<td>22</td>
</tr>
<tr>
<td>Laborers, Assembly Workers, Others</td>
<td>209</td>
</tr>
<tr>
<td>Operating Engineers</td>
<td>31</td>
</tr>
<tr>
<td>Surveyors, Designers</td>
<td>9</td>
</tr>
<tr>
<td>Teamsters</td>
<td>20</td>
</tr>
<tr>
<td>Tradesmen</td>
<td>30</td>
</tr>
<tr>
<td>Welders</td>
<td>73</td>
</tr>
</tbody>
</table>

*Source: CEERT Renewable Powerplants Jobs Survey, 2010*

*Center for Energy Efficiency and Renewable Technologies, September 15, 2010*
## Construction Workforce Needs

### 250 MW Photovoltaic System

Construction Period Length: ~3 Years

<table>
<thead>
<tr>
<th>Job Description Average</th>
<th>Average Monthly Workforce (FTEs)</th>
<th>Peak Monthly Workforce (FTEs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Administrators</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Carpenters</td>
<td>12</td>
<td>15</td>
</tr>
<tr>
<td>Cement Masons</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>Construction Staff</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>Electricians</td>
<td>25</td>
<td>50</td>
</tr>
<tr>
<td>Engineers</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Laborers</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>Operating Engineers</td>
<td>7</td>
<td>15</td>
</tr>
<tr>
<td>Operators</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>Project and Construction Managers</td>
<td>7</td>
<td>10</td>
</tr>
<tr>
<td>Solar Field Craft: Incl’s Apprentices, Assistants and Helpers</td>
<td>90</td>
<td>133</td>
</tr>
<tr>
<td>Surveyors</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>Teamsters</td>
<td>20</td>
<td>30</td>
</tr>
<tr>
<td>Welders</td>
<td>15</td>
<td>30</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>212</strong></td>
<td><strong>353</strong></td>
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</table>

Source: CEERT Renewable Powerplants Jobs Survey, 2010
UNEMPLOYMENT RATES REMAIN HIGH IN SOLAR PROJECT COUNTIES

<table>
<thead>
<tr>
<th>County</th>
<th>Rate</th>
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<tbody>
<tr>
<td>Imperial</td>
<td>31.30%</td>
</tr>
<tr>
<td>Kern</td>
<td>14.40%</td>
</tr>
<tr>
<td>Los Angeles</td>
<td>12.50%</td>
</tr>
<tr>
<td>Riverside</td>
<td>15.30%</td>
</tr>
<tr>
<td>San Bernardino</td>
<td>14.80%</td>
</tr>
<tr>
<td>San Luis Obispo</td>
<td>9.70%</td>
</tr>
</tbody>
</table>

Source: July 2010 Statistics
CA EDD, Labor Market Information Division
<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
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</thead>
<tbody>
<tr>
<td>IMPERIAL</td>
<td>Jobs lost: 200 09-10 Change: -14.3%</td>
<td>Jobs lost: 400 09-10 change: -3.9%</td>
<td>360 Jobs 3.5 Years</td>
</tr>
<tr>
<td>KERN</td>
<td>Jobs lost: 1,600 09-10 change: -12.6%</td>
<td>Jobs lost: 100 09-10 change: -0.2%</td>
<td>1,287 Jobs 2.5 – 4 Years</td>
</tr>
<tr>
<td>LOS ANGELES</td>
<td>Jobs lost: 13,400 09-10 change: -11.7%</td>
<td>Jobs lost: 7,300 09-10 change: -1%</td>
<td>200 Jobs 0.5 Year</td>
</tr>
<tr>
<td>RIVERSIDE</td>
<td>Jobs lost: 10,000 09-10 change: -14.7%</td>
<td>Jobs lost: 3,300 09-10 change: -1.2%</td>
<td>2,528 Jobs 3.5 – 6 Years</td>
</tr>
<tr>
<td>SAN BERNARDINO</td>
<td>Jobs lost: 700 09-10 change: -13.7%</td>
<td>Jobs lost: 500 09-10 change: -2.7%</td>
<td>212 Jobs 3.5 Years</td>
</tr>
<tr>
<td>SAN LUIS OBISPO</td>
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</tr>
</tbody>
</table>

Source: July 2010 Statistics
CA EDD, Labor Market Information Division

Center for Energy Efficiency and Renewable Technologies,
September 15, 2010
SOLAR PROJECTS

JOBS

ECONOMIC BENEFITS

INBOUND INVESTMENTS
Typical Powerplant
$250M - $1.5B

TAXES & FEES
Local, State, Federal
Sales, Property, Tx-CUP Fees

SITE LABOR
100s-1000s Employed Per Month to Build

SKILLED & NON-SKILLED LABOR
Carpentry-Ironwork
Operators-Electrical
Cement-Millwright

OPERATIONS
20-40 Years

Construction Length
Typically 1 - 4 Years

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