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# **UNDERSTANDING THE GREEN ECONOMY IN CALIFORNIA**

**A Community College Perspective**

JUNE 2009



**CENTERS OF  
EXCELLENCE**

**Economic & Workforce  
Development Program**

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

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

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**The Obama Administration estimates that the \$787 billion American Recovery and Investment Act will create over 400,000 jobs in California, thousands of which will be in the green sectors.<sup>1</sup>**

## Executive Summary

There is perhaps no area creating more interest from economists, legislators, or the general public than “The Green Economy.” This intrigue has created a flurry of reports to address potential impacts to jobs and the economy, as well as strong public investments from local, state, and federal governments. California's community colleges will play a critical role in training a green-collar workforce, and will therefore require a comprehensive understanding of the needs of industry to appropriately meet this challenge.

For all of the interest generated by the green economy, there are equal parts of confusion, skepticism, and misunderstanding. Much of this can be attributed to a lack of consistency in defining green jobs and firms and an inconsistent understanding of the practical implications of the greening of the economy. The Centers of Excellence initiated a study of the green economy in the fall of 2008. The intent of the study was to create a better understanding of the green economy for California community colleges and their workforce development partners. This report will:

- Provide definitions for green jobs and green firms to allow for consistent use and understanding;
- Illustrate the various scenarios for how green is affecting the workforce;
- Demonstrate the green subsectors, traditional occupations and sectors, and emerging occupations and sectors; and
- Provide a framework for additional study to help colleges respond to this new green reality.

This is a statewide report produced collaboratively by multiple regional Centers of Excellence. It is the culmination of months of research, development and validation by industry professionals and subject matter experts. Given the complex nature of the green economy and its continuing evolution, this framework should be considered a “living document” as it will undergo future revisions as more becomes known about the direction of the various green industry sectors and occupations.

## Introduction

Understanding the green economy and the opportunities it provides for preparing the workforce that would meet its demands has been of critical importance to California Community Colleges for some time. Increasing energy and commodity costs, legislative requirements, and consumer demands for a more sustainable environment have all led to a substantial push for a green economy in industries such as energy and utilities, construction, transportation, and manufacturing.

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<sup>1</sup> Online source: [www.recovery.gov](http://www.recovery.gov)

A number of developments in public and private investments and regulations have contributed to this green movement. California's Air Resources Board projects that, as a result of the passage of AB 32 (the state's global warming solutions law) 100,000 new jobs will be created.<sup>2</sup> The Obama Administration estimates that the \$787 billion American Recovery and Reinvestment Act will create over 400,000 jobs in California, thousands of which will be in green sectors.<sup>3</sup> Billions of dollars have been allocated for education and training programs, with over \$500 million earmarked in the Department of Labor alone for training workers for the green economy.<sup>4</sup> Additional monies are being made available through other local, state and federal agencies.

With these recent economic and legislative developments both on federal and state levels, preparing a workforce for the green economy has become a top priority. Community colleges' faculty and administrators are trying to rapidly adapt program and training offerings to align with industries of the green economy in their respective communities. However, the ambiguity around the definitions and classifications of the green job markets and how they relate to the college programs makes this task rather challenging when beginning or updating programs.

To mitigate some of the confusion about the green economy workforce and to support colleges in their pursuit of green educational programs, the Centers of Excellence (COE) have begun the process of determining what relationships exist between emerging green industry sectors, existing traditional industry sectors, jobs within each of those sectors, and existing college programs that could be adapted to address the training needs for such jobs. COE efforts have resulted in this report which outlines such relationships in the form of a crosswalk to guide the community colleges in bringing "green" components into existing training programs, beginning new programs, and in seeking additional resources through the American Reinvestment and Recovery Act, better known as "stimulus funding." Given the continuing evolution of the green economy, this framework should be considered a "living document" as it will undergo future revisions as more becomes known about the direction of the various green industry sectors and occupations.

## Research Methodology

### Purpose and Objectives

The overall purpose of the information presented in this report is to identify, from the California Community College perspective, opportunities for training in green industries using existing industries and occupations as the base. Specifically, this research attempts to:

- Create operational definitions of green firms and green jobs that are relevant to community colleges;
- Classify the green economy into major sectors or areas and develop an outline of green emerging industries and subsectors included in each sector;
- Develop a crosswalk between green industry sectors and green occupations that require specialized training, but currently are not classified under the Standard Occupational Classification (SOC) system;

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<sup>2</sup> California Environmental Protection Agency Air Resources Board: <http://www.arb.ca.gov/newsrel/nr091708.htm>

<sup>3</sup> Online source: <http://www.recovery.gov/?q=contentt/impact>

<sup>4</sup> American Reinvestment and Recovery Act Title VIII(6)

- Outline a list of occupations that currently have an SOC code and could be re-trained for the emerging green jobs within each industry sector; and
- Develop a crosswalk between the specified occupations with SOC codes and community college programs that currently train for those occupations as defined by the California Community College Taxonomy of Occupational Programs (TOP) system.

There is a recognizable need to estimate the number of jobs across the green industries and sectors for most of the identified occupations in this crosswalk, as well as a need to create comprehensive profiles of the occupations that are gaining momentum. The COE initiative will use this green economy framework to begin focused industry and/or occupational studies within the six subsectors identified in the industry crosswalk.

A number of focused industry reports have already been completed by the COE initiative, including solar energy, energy efficiency, green construction, and water technology. These may be accessed and downloaded at [www.coeccc.net](http://www.coeccc.net).

In May 2009, the Employment Development Department, Labor Market Information Division (EDD-LMID) launched a survey of over 51,000 California employers.<sup>5</sup> The Centers of Excellence assisted EDD-LMID in the development and design of the survey. The purpose of the survey, in part, is to estimate the number of green jobs in California and identify emerging green occupations. Efforts are underway by EDD-LMID to gather and report this green labor market information. For more information about the survey, please visit the EDD-LMID website at [www.labormarketinfo.edd.ca.gov](http://www.labormarketinfo.edd.ca.gov).

### Approach

During the fall of 2008, the Centers of Excellence collected, screened and analyzed existing information on the green economy, green jobs and educational programs. A variety of existing research on the green economy was used to form the basis of the green economy framework presented in this report. Of particular interest to the Centers of Excellence in reviewing existing work was the identification of green industry sectors, related occupations, methodology to identify and/or possibly connect the two, and finally, the applicability for community college program modification and/or development. Many of these studies were found through the Employment Development Department, Labor Market Information Division's Green Digest.<sup>6</sup> Please see the References section for a complete listing of these reports.

The compilation of the crosswalk between green industries, occupations and college programs resulted in a four-phase methodological process. The crosswalk became the green economy framework; the methodological process is described below and presented in Figure 1.

1. Working definitions of a green firm and a green job were developed.
2. Referencing the green firm and green jobs definitions, a set of criteria for inclusion into the crosswalk was developed. The criteria include the following:
  - Green clusters, sectors, and occupations align with the definitions identified in this report.
  - Occupations included require new or additional training in green technology.

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<sup>5</sup> EDD-LMID Green Digest, <http://www.labormarketinfo.edd.ca.gov/?pageid=1032>

<sup>6</sup> Ibid.

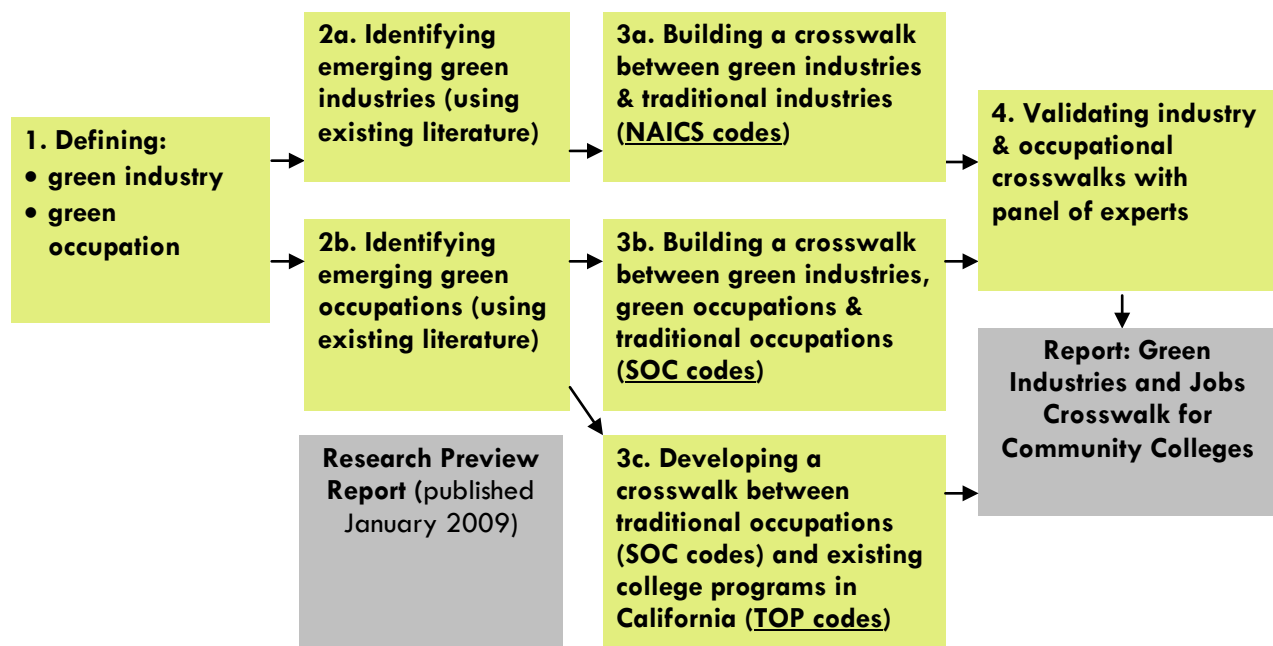
- Occupations included may experience growth in the emerging green economy.
- Occupations directly contribute to minimizing environmental impact, and do not function in a tertiary capacity within a “green firm.”
- Training needs can be reasonably addressed by California Community Colleges and/or offer career pathway options.

3. After establishing green definitions and criteria for inclusion, industries, subsectors, and occupations were determined and grouped. COEs relied on existing classification systems to establish the links between the emerging green subsectors and traditional and emerging jobs. Jobs were identified within the six industry sectors. Thus, three key points of reference were developed. They include the following:

- Green industries were cross referenced to traditional North American Industry Classification System (NAICS) industries;
- Green emerging occupations and traditional occupations were cross referenced to Standard Occupational Codes (SOC); and
- SOC occupations were cross referenced to educational course offerings. For California, this was to California Community College programs (using Taxonomy of Program or TOP codes) that are currently approved. For national application, the corresponding Classification of Instructional Programs (CIP) codes are also referenced in an expanded spreadsheet available at the Center of Excellence website ([www.coecc.net/green](http://www.coecc.net/green)).

4. After the identified green sectors and occupations were placed into the crosswalk, the information was validated by a panel of state and national industry and subject matter experts. Please see Appendix C for a list of individuals and organizations who provided input.

**Figure 1 - Process of Building the Crosswalk**





## Operational Definitions

There are no commonly accepted definitions for what constitutes a green job or a green business, which may be due to the different purposes, contexts, and usages of these definitions. The COE's purpose was to look at emerging, changing, and rapidly growing industries, as well as occupations that are completely new (emerging) and/or require new knowledge, skills and abilities (KSAs). Keeping this in mind, the following definitions were developed.

A **Green Firm** is an organization that provides products and/or services that are aimed at utilizing resources more efficiently, providing renewable sources of energy, lowering greenhouse gas emissions, or otherwise minimizing environmental impact.

Green firms with similar activities, production value chains and/ or products can form a green industry, sub-sector or sector. In particular, the COEs have classified all green firms into six green sectors or areas:

- Renewable Energy: Energy Generation, System Installation & Storage
- Green Building and Energy Efficiency
- Biofuels Production & Farming
- Transportation & Alternative Fuels
- Water, Wastewater & Waste Management
- Environmental Compliance & Sustainability Planning

Equally important to understanding the green economy is a common understanding of a green job. For purposes of this report, the following operational definition of a green job was developed.

A **Green Job** is an occupation that 1) directly works with policies, information, materials, and/or technologies that contribute to minimizing environmental impact, and 2) requires specialized knowledge, skills, training, or experience in these areas.

For an occupation to be included in this community college perspective, it must satisfy both criteria. As defined, green jobs play out in a variety of ways in the workplace, but generally fall into one of three scenarios, which have different impacts on community college program development.

**Scenario 1:** Additional critical green skills necessary for continued employment within a traditional occupation. In this scenario, new green skills have become a requirement for employment. For example, the job market in San Diego required that landscapers have water management skills and knowledge and understanding of drought resistant plants due to new mandatory water restrictions on homeowners and businesses. In this scenario, the job title (landscaper) has not changed, but critical skill augmentation has become necessary for employment. For community colleges, existing curriculum for these programs may need revision to incorporate this new skill training.

**Scenario 2:** Additional – but not critical – green skills make traditional workers more employable. In this scenario, new green skills are not requirements of employment but make workers more marketable in the workforce. For example, the job market does not require that plumbers have skills and experience installing solar thermal water systems, but the skill augmentation makes any plumber

with that skill set more employable and competitive. In this scenario, the job title has not changed, but the individual holding the title has a skill upgrade. For community colleges, this scenario may warrant offering fee-based training courses to incumbent workers to green their existing skill set and/or the repackaging of existing courses into new certificates with relatable green skills.

**Scenario 3:** Additional related or unrelated green skills allow for transition to new job with new title. In this scenario, new green skills have led to a completely new occupation. For example, a welder can be trained on geothermal operations and become a geothermal technician. In this scenario, entirely new certificate and/or degree programs need to be developed at the community colleges to address new and emerging occupations.

The first two “green job” scenarios target traditional occupations with existing Standard Occupational Classification (SOC), while the third scenario deals with emerging green occupations. For colleges, the first two scenarios require an analysis of existing education and training programs geared toward traditional occupations experiencing the most impact from the green economy. This can be accomplished most easily by reviewing, modifying, and repackaging current offerings.

O\*NET, the online occupational network, recently issued a publication to study the impact of green activities and technologies on occupational requirements relative to current SOC occupations and new and emerging occupations.<sup>7</sup> In its publication, O\*NET classifies all green occupations into three categories: green increased demand occupations, green enhanced skills occupations, and green new and emerging occupations. This approach aligns well with the conceptual framework of this report, as the COE distinguishes and lists both the enhanced skills occupations and emerging ones in the developed crosswalks. The COE also recognizes that some jobs will be growing due to the developments in green economy, without any changes in skill sets of traditional occupations. According to O\*NET, these are green increased demand occupations. Although they were not the focus of this research, some of these growing occupations were included in the occupational crosswalk.

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### **Green Occupations: O\*NET Approach**

“The ‘greening’ of occupations refers to the extent to which green economy activities and technologies increase the demand for existing occupations, shape the work and worker requirements needed for occupational performance, or generate unique work and worker requirements.”

Based on this definition of “greening” occupations, O\*NET developed three general categories within which to classify green jobs:

**Green Increased Demand Occupations** – increase in demand for an existing occupation; does not entail significant changes in the work and worker requirements; work context may change, tasks themselves do not.

**Green Enhanced Skills Occupations** – significant change to the work and worker requirements of an existing O\*NET-SOC occupation; may or may not result in increased demand; essential purpose remains the same, but tasks, skills, knowledge and possibly credential requirements have been altered.

**Green New and Emerging (N&E) Occupations** – need for unique work and worker requirements, results in generation of a new occupation.<sup>8</sup>

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<sup>7</sup> The National Center for O\*NET Development, Greening of the World of Work: Implications for O\*NET-SOC and New and Emerging Occupations, February 2009 ([www.onetcenter.org/reports/Green.html](http://www.onetcenter.org/reports/Green.html))

<sup>8</sup> Ibid.

## Green Industry Framework

Under the guidance of the green working definitions, the six major sectors/areas of the green economy (referenced above) were identified. Each of the sectors represents a value chain of activities (Research & Development, Manufacturing, Distribution, Installation, Maintenance & Repair), which are clustered around a similar “green” technology and/or purpose. This approach set the parameters for selecting the industry clusters within a “green” technology value chain, and thus looks at a full range of potential employment opportunities. These six major sectors and clusters are presented in the following table.

California’s Green Economy - Industry Overview			
Green Economy area/sector	Industry Sector (2-digit NAICS)	NAICS	Description [notes]
<b>Renewable Energy: Energy Generation, System Installation &amp; Storage</b>	Utilities (22)	221111	Hydroelectric Power Generation
		221119	Other Electric Power Generation
		221121	Electric Bulk Power Transmission and Control
		221122	Electric Power Distribution
		221330	Steam and Air-Conditioning Supply
	Construction (23)	237130	Power and Communication Line and Related Structures Construction
		238160	Roofing Contractors
		238210	Electrical Contractors and Other Wiring Installation Contractors
		238220	Plumbing, Heating, and Air-Conditioning Contractors
	Manufacturing (31-33)	325000	Chemical Manufacturing
		333295	Semiconductor Machinery Manufacturing [Machines to manufacture solar panels.]
		333611	Turbine and Turbine Generator Set Units
		334413	Semiconductor and Related Device Manufacturing [Solar panel and fuel cell manufacturing.]
		334512	Automatic Environmental Control Manufacturing
		335911	Storage Battery Manufacturing
	Wholesalers (42)	423720	Plumbing & Heating Equipment & Supplies (Hydronics) Merchant Wholesalers [Solar panel sales.]
	Professional, Scientific, & Technical Services (54)	541330	Engineering Services
		541370	Survey and Mapping Services
		541380	Testing Laboratories
		541620	Environmental Consulting Services
		541690	Other Scientific and Technical Consulting Services
	Other Services (81)	541712	Research and Development in the Physical, Engineering, and Life Sciences (except Biotechnology)
		811219	Other Electronic and Precision Equipment Repair and Maintenance
811310		Commercial and Industrial Machinery (except automotive and electronic) Repair and Maintenance	

California's Green Economy - Industry Overview			
Green Economy area/sector	Industry Sector (2-digit NAICS)	NAICS	Description [notes]
<b>Green Building and Energy Efficiency</b>	Utilities (22)	221100	Electric Power Generation, Transmission & Distribution [Energy conservation planning & consulting.]
		221200	Natural Gas Distribution
	Construction (23)	236000	Construction of Buildings
		236115	New Single-Family Housing Construction (except Operative Builders)
		236116	New Multifamily Housing Construction (except Operative Builders)
		236117	New Housing Operative Builders
		236118	Residential Remodelers
		236210	Industrial Building Construction
		236220	Commercial and Institutional Building Construction
		238000	Specialty Trade Contractors (incl. Electrical Contractors)
		238210	Electrical Contractors and Other Wiring Installation Contractors
		238220	Plumbing, Heating and Air-Conditioning Contractors
		238350	Finish Carpentry Contractors
		238990	All Other Specialty Trade Contractors
		238990	Roofing Contractors
		Manufacturing (31-33)	333400
	333414		Heating Equipment (except Warm Air Furnaces) Manufacturing
	335110		Electric Lamp Bulb/Parts Mnf
	335121		Residential Electric Lighting Fixture Mnf
	335122		Commercial, Industrial, Institutional Lighting Fixture Mnf
	335129		Other Lighting Equipment Mnf
	Wholesalers (42)	335311	Power, Distribution, and Specialty Transformer Manufacturing
		423720	Plumbing and Heating Equipment and Supplies (Hydronics) Merchant Wholesalers
	Real Estate and Rental & Leasing (53)	531311	Residential Property Managers
		531312	Nonresidential Property Managers
	Professional, Scientific, & Technical Services (54)	541310	Architectural Services
		541320	Landscape Architectural Services
541330		Engineering Services	
541340		Drafting Services	
541350		Building Inspection Services	
541420		Industrial Design Services	
Public Administration (92)	541620	Environmental Consulting Services	
	921000	Cities and Counties	
	924000	Administration of Environmental Programs	

California's Green Economy - Industry Overview			
Green Economy area/sector	Industry Sector (2-digit NAICS)	NAICS	Description [notes]
Biofuels/Farming	Agriculture, forestry, fishing and hunting (11)	111998	All Other Miscellaneous Crop Farming
		112519	Other Aquaculture
		113110	Timber Tract Operations
		113210	Forest Nurseries and Gathering of Forest Products
		115110	Support Activities for Crop Production
		115310	Support Activities for Forestry
	Manufacturing (31-33)	311223	Other Oilseed Processing
		311225	Fats and Oils Refining and Blending
		311613	Rendering and Meat Byproduct Processing
		325221	Cellulosic Organic Fiber Manufacturing
		325300	Pesticide, Fertilizer, and Other Agricultural Chemical Manufacturing
		333298	All Other Industrial Machinery Manufacturing
	Professional, Scientific, & Technical Services (54)	541330	Engineering Services
		541380	Testing Laboratories
		541620	Environmental Consulting Services
		541690	Other Scientific and Technical Consulting Services
		541711	Research and Development in Biotechnology
	Public Administration (92)	924120	Administration of Conservation Programs

California's Green Economy - Industry Overview			
Green Economy area/sector	Industry Sector (2-digit NAICS)	NAICS	Description [notes]
Transportation/ Alternative Fuel	Utilities (22)	221122	Electric Power Distribution
		221210	Natural Gas Distribution
	Manufacturing (31-33)	334512	Automatic Environmental Control Manufacturing for Residential, Commercial, and Appliance Use
		335312	Motor and Generator Manufacturing
		336000	Transportation Equipment Manufacturing
	Retail (44)	441100	Automobile dealers [Service departments.]
		447190	Other Gasoline Stations <sup>1</sup>
	Transportation & warehousing (48-49)	484100	General Freight Trucking
		484200	Specialized Freight Trucking
		485100	Urban Transit Systems [Includes commuter rail systems.]
		485200	Interurban and Rural Bus Transportation
		488310	Port and Harbor Operations
	Professional, Scientific, & Technical Services (54)	541330	Engineering Services
		541370	Survey and Mapping Services
		541380	Testing Laboratories
		541614	Process, Physical Distribution, and Logistics Consulting Services [Relates to logistics.]
		541620	Environmental Consulting Services
	Other Services (81)	811110	Automotive Mechanical and Electrical Repair and Maintenance
		811190	Other Automotive Repair and Maintenance
	Public Administration (92)	925120	Administration of Urban Planning and Community and Rural Development

California's Green Economy - Industry Overview			
Green Economy area/sector	Industry Sector (2-digit NAICS)	NAICS	Description [notes]
Water, Wastewater & Waste Management	Utilities (22)	221310	Water Supply and Irrigation Systems
		221320	Sewage Treatment Facilities
	Construction (23)	237110	Water and Sewer Line and Related Structures Construction
		237990	Other Heavy and Civil Engineering Construction [Relates to channel construction.]
	Manufacturing (31-33)	333312	Commercial Laundry, Drycleaning, and Pressing Machine Manufacturing
		334512	Automatic Environmental Control Mfg. for Residential, Commercial, & Appliance Use
		335222	Household Refrigerator and Home Freezer Manufacturing
	Professional, Scientific, & Technical Services (54)	541330	Engineering Services
		541380	Testing Laboratories
		541620	Environmental Consulting Services
		541690	Other Scientific and Technical Consulting Services
	Administrative & waste services (56)	562111	Solid Waste Collection
		562112	Hazardous Waste Collection
		562119	Other Waste Collection
		562211	Hazardous Waste Treatment and Disposal
		562212	Solid Waste Landfill
		562219	Other Nonhazardous Waste Treatment and Disposal
562910		Remediation Services	
562920		Materials Recovery Facilities	
Public Administration (92)	562998	All Other Miscellaneous Waste Management Services	
	924110	Administration of Air and Water Resource and Solid Waste Management Programs	

California's Green Economy - Industry Overview			
Green Economy area/sector	Industry Sector (2-digit NAICS)	NAICS	Description [notes]
Environmental Compliance and Sustainability Planning	Professional, Scientific, & Technical Services (54)	541370	Survey and Mapping Services
		541380	Testing Laboratories
		541620	Environmental Consulting Services
		541690	Other Scientific and Technical Consulting Services
	Other Services (81)	813312	Environment, Conservation and Wildlife Organizations
	Public Administration (92)	924110	Administration of Air and Water Resource and Solid Waste Management Programs
		924120	Administration of Conservation Programs
		925120	Administration of Urban Planning and Community and Rural Development
		926120	Regulation and Administration of Transportation Programs
		926130	Regulation and Administration of Communications, Electric, Gas, and Other Utilities

The following section defines each green sector, including the core characteristics and key industry clusters.

**Renewable Energy: Energy Generation, System Installation & Storage** includes activities that are aimed at developing, introducing and installing the technologies, which harness, generate, store, and distribute renewable sources of energy. Some of these industries have been established for decades, while others represent a new approach to renewable energy generation, installation and storage.<sup>9</sup> The nine renewable energy industry clusters include:

- **Solar thermal & photovoltaic (PV) systems** is one of the larger renewable energy clusters. Public policy such as AB 118 and AB 32 are drivers in the industry. Although the market has currently slowed, the industry is expected to be one of the most rapidly growing industries in California and in the nation over the next decade. This industry cluster includes firms that are engaged in the development, manufacturing, installation, and servicing of solar energy technology.
- **Wind energy power** is also a rapidly significant contributor to the renewable energy cluster. Since 2000, cumulative wind power capacity has grown an average of 27% per year in the United States. Of the 50 states, California is third only to Texas and Iowa in wind turbine capacity.<sup>10</sup> California's wind capacity is estimated to increase when future energy transmission systems upgrades are complete. The wind energy cluster is primarily comprised of manufacturers of wind turbines, wind farms, and maintenance and operations firms.
- **Hydroelectric power** is a process that has been used for decades. With traditional hydroelectric power, energy is generated by releasing dammed water, which is driven through a turbine and generator. This process is disruptive to the ecosystem, preventing spawning fish access to the river, disrupting the downstream water environment, and producing methane and other greenhouse gases. However, the next generation of hydroelectric power takes steps to reduce environmental impact by eliminating the damming of water as its core process.
- **Geothermal power** plants produce about 4.5 percent of the state's total electricity.<sup>11</sup> In California, geothermal power plants are located in areas with volcanic and seismic activity that produce heat at temperatures of 300 degrees Fahrenheit or greater. There are 14 known geothermal areas in California. In addition, nearly 80 percent of California's counties have lower levels of geothermal activity that can be used for direct use projects.<sup>12</sup> Geothermal power plants and companies that are developing and manufacturing geothermal power systems are the primary contributors of jobs in this industry.
- **Smart grid technology** represents an emerging energy delivery system that will change the way energy is delivered, stored, and utilized. In the last year, there have been several breakthroughs with smart grid technology, such as advanced metering, intelligent transmission and distribution automation devices, substation energy storage, and micro-grids. As the technology advances and smart grid projects are deployed widely, it will greatly improve the utilization of energy as well as provide the infrastructure necessary to optimize renewable energy sources.

<sup>9</sup> Nuclear power is not included in the renewable energy sector due to unresolved challenges related to the storage and disposal of nuclear waste. Nuclear waste remains highly radioactive for thousands of years and must be stored underground in shielded water basins.

<sup>10</sup> Online source: <http://www.windustry.com/news/wind-energy-growth-in-2008>

<sup>11</sup> The U.S. Smart Grid Revolution, KEMA'S Perspective for Job Creation

<sup>12</sup> California Energy Commission, <http://www.energy.ca.gov/geothermal>



- **Hydrogen** is mostly used for generating electricity. It involves a process of joining hydrogen with oxygen to make water, while generating electricity on demand. Hydrogen can be stored in a cell and when activated it passes through a specialized membrane to create electricity, replacing traditional batteries. At this state of hydrogen technology development, the industry predominantly includes research and development firms and some small manufacturers.<sup>13</sup>
- **Energy storage** is one of the key issues facing the renewable energy sector. While there are a few techniques available to store electricity, most renewable energy is utilized at the time of production. Although expensive, one storage technique uses electrical energy to pump water uphill to store until needed. At that point, energy is generated by moving water downhill through a turbine. Fuel cells are another energy storage process. Battery manufacturers and installers as well as fuel cell development and testing laboratories comprise the energy storage cluster.
- **Energy transmission/distribution** is the process that connects renewable energy sources to utilities and consumers. Utilities and energy transmission contractors are the key player in the energy distribution market.
- **Energy services (ESCO)** companies manage full scale projects aimed at improving energy efficiency and ongoing maintenance costs for facilities over a seven to twenty year time period. Most ESCO companies manage the project from start to finish, including equipment installation, securing financing, and monitoring the project's energy savings.<sup>14</sup>

**Green Building and Energy Efficiency** is a category comprised of industries that are clustered around the purpose of making new and existing buildings resource efficient and friendly to the environment. Energy Efficiency, as well as being part of Green Building, also includes private and public agencies responsible for energy planning and management. Thirty nine (39) percent of the total U.S. energy use can be contributed to the construction and operation of residential and commercial buildings.<sup>15</sup> Because buildings are such a significant consumer of energy and contributor to greenhouse gas emissions, they also need to be a focal point for any potential solutions. Further, current state legislation (e.g. AB 32, the state's global warming solutions law) requires that buildings become more energy efficient, which is also creating demand for green product manufacturing. The eight green building and energy efficiency industry clusters include:

- **Green product manufacturing** is considered to have the largest share of employment in the green economy by some researchers. There is a variety of manufacturing sub-sectors that support the green building and energy efficiency sector, including lighting, construction materials, "Smart" systems, water systems, and HVAC/R equipment.
- **Green construction** materials wholesaling supplies green products and materials to builders and energy service organizations.
- **Design and construction of new buildings** contractors produce less waste during the construction cycle and the buildings they design and construct utilize less energy to operate. Although it may be more expensive to build an energy efficient structure, the cost and subsequent savings are achieved over a short period of time. Most contractors

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<sup>13</sup> California Fuel Cell Partnership, <http://www.fuelcellpartnership.org>

<sup>14</sup> National Association of Energy Service Companies, <http://www.naesco.org/>

<sup>15</sup> Energy Information Administration, [www.eia.doe.gov](http://www.eia.doe.gov), 2008

rely on certification specifications and guidelines, such as the Leadership in Energy and Environmental Design (LEED) and the Green Point Rating System.

- **Retrofitting & retro-commissioning of existing structures** represent a significant opportunity to reduce energy usage across the state. One of the primary objectives of the American Recovery and Reinvestment Act is to invest in retrofitting public and private structures to reduce energy consumption. In the next year, billions of dollars are being invested in this effort. The California Home Energy Rating System (HERS) Program is the main rating system for residential dwellings; commercial dwellings typically utilize the LEED rating systems.<sup>16</sup>
- **Deconstruction** involves disassembling a building or structure to salvage select components for re-use or recycling. This sub-sector primarily includes builders and contractors that are providing such services.
- **Green building operations and maintenance** is used to ensure that existing buildings remain energy efficient over time. This industry cluster largely focuses on identifying operating inefficiencies, reducing waste, and integrating sustainable materials and systems.
- **Green landscaping** reduces the consumption of natural resources by integrating native plants and grasses that require less watering and maintenance.<sup>17</sup> The services of green landscaping are provided by some architectural firms specializing in landscape design and planning.
- **Energy services (ESCO)** companies manage full scale projects aimed at improving energy efficiency and ongoing maintenance costs for facilities over a seven to twenty year time period. Most ESCO companies manage the project from start to finish, including equipment installation, securing financing, and monitoring the project's energy savings.<sup>18</sup>

**Biofuels Production & Farming** is an area associated with producing alternative fuels and/or energy from biological products and waste, as well as incorporating environmentally friendly practices and principles in the overall farming process. The five biofuels production and farming industry clusters include:

- **Biofuels production** companies focus on manufacturing fuels that are typically derived from crops high in sugar or vegetable oils/fats. In the U.S., these fuels are primarily used to power vehicles.<sup>19</sup>
- **Biomass energy** is derived from recently living organism, such as plants, animals, or animal byproducts.<sup>20</sup>
- **Organic farming** is a form of agriculture that limits the use of synthetic fertilizers and pesticides, promotes crop rotation, and cultivates soil productivity with natural manure and compost. One of the key goals is to ensure sustainable agriculture — the ability to produce on the land indefinitely.<sup>21</sup>

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<sup>16</sup> California Energy Commission, <http://www.energy.ca.gov/HERS/index.html>. U.S. Green Building Council, <http://www.usgbc.org/DisplayPage.aspx?CMSPageID=1988>

<sup>17</sup> U.S. Environmental Protection Agency, <http://www.epa.gov/greenacres>

<sup>18</sup> National Association of Energy Service Companies, <http://www.naesco.org/>

<sup>19</sup> Green Jobs: Towards decent work in a sustainable, low-carbon world

<sup>20</sup> National Renewable Energy Laboratory, <http://www.nrel.gov/biomass/>

<sup>21</sup> National Sustainable Agricultural Information Services, <http://attra.ncat.org/organic/html>

- **Biomethane production** plants are involved in producing energy from landfills and animal waste. Landfill gas contains about 50 percent methane, which can be purified and fed into a natural gas grid.<sup>22</sup> Animal waste also produces methane.
- **Sustainable fisheries** focus on conserving marine ecosystems and fish populations to ensure that they remain accessible to future generations.<sup>23</sup>

Biofuels is separated from the Renewable Energy cluster to highlight the relationship among agriculture, farming, and biofuels production. This distinction is especially important in determining the scope of college programs. Most biofuels are produced from corn, sugarcane, and palm oil crops, which generate harmful greenhouse emissions and threaten biodiversity. Therefore, it is important to consider environmentally friendly agricultural and farming practices, as well as alternative methods to producing biofuels (such as the use of waste or forest byproducts).

**Transportation & Alternative Fuels** focuses on developing the technology, manufacturing and servicing vehicles that run on alternative fuels, and “greening” transportation infrastructure and logistics processes. Growth in this sector is largely being driven by legislative policies. Assembly Bill 118 has set aside millions of dollars for research and development of alternative fuels and vehicle technologies with the goal of improving California’s air quality.<sup>24</sup> The California Global Warming Act of 2006 (AB 32) mandates a statewide reduction of greenhouse gas emissions to 1990 levels by 2020, which will require a change in current vehicle emission standards.<sup>25</sup> The six transportation and alternative fuels industry clusters include:

- **Alternative fuel engine designs** are aimed at lowering greenhouse gas emissions or eliminating them altogether. The most common engine designs include hydrogen, electricity, biofuels, or hybrid.
- **Alternative vehicle manufacturing** is the mass production of alternative fuel vehicles. In California, smaller private organizations are beginning to compete with the traditional automobile companies by offering electrical, hydrogen, and other alternative fuel vehicles at increasingly reasonable prices.
- **Repair & maintenance services** are needed for a variety of alternative vehicles including hybrid/electrical, hydrogen/fuel cells, biofuels, and natural gas. Since alternative vehicles operate differently than traditional combustion engines, it requires a new set of skills, knowledge and abilities.
- **Fueling stations** (natural gas, hydrogen, electric, etc.) are necessary to service alternative fuel vehicles. In California, ethanol and biodiesel fuels are beginning to be offered at traditional gas stations. Liquid Natural Gas (LNG) and Compressed Natural Gas (CNG) fueling stations are typically privately owned and operated.
- **Electric Public Transit systems** use less energy and are less carbon intensive than automobiles. New design concepts in public transit are beginning to emerge, such as systems that service business parks to shorten overall commute times.
- **Logistics** involves implementing strategies to minimize the environmental impact of freight transport, warehousing, and materials handling. For example, GIS and scheduling

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<sup>22</sup> Energy Information Administration, Official Energy Statistics from the U.S. Government, <http://www.eia.doe.gov/>

<sup>23</sup> National Marine Fisheries Service, Office of Sustainable Fisheries, <http://www.nmfs.noaa.gov/sfa/>

<sup>24</sup> Assembly Bill No. 118, Nunez. Alternate fuels and vehicle technologies: funding programs

<sup>25</sup> Assembly Bill No. 32, Nunez. Air pollution: greenhouse gases: California Global Warming Solutions Act of 2006.

software are often used to schedule deliveries that help companies respond to changing road conditions. This helps to minimize costs as well as greenhouse gas emissions.<sup>26</sup>

**Water, Wastewater & Waste Management** includes the development and operation of systems, connected with treatment and conservation of water, recycling of wastewater, and solid waste management. California is experiencing a severe drought, which has resulted in water rationing, fewer agricultural crops, the loss of thousands of jobs, and an overall decline in the state's economic health.<sup>27</sup> Further, the demand for water continues to increase as the state's population grows. As such, water conservation and waste management efforts are necessary to ensure that future generations have access to freshwater. The six water, wastewater and waste management industry clusters include:

- **Water shed conservation and management** involves implementing strategies to protect water quality, natural resources, and wildlife habitats.
- **Water supply and distribution** is an important function to water management. To optimize water use, several techniques are available including storm water capture, graywater recycling, ground-water replenishment and water conservation.
- **Water treatment** uses safe, low-toxic chemicals and/or non-chemical treatment systems to protect and treat water for consumption or continued use.
- **Wastewater treatment & management** uses environmentally friendly methods to clean waste water before returning it to the environment. Engineered wetlands are one of the greenest methods of performing this task.<sup>28</sup>
- **Solid waste management/recycling** converts solid waste into usable products, such as pellets that can be burned to generate heat.
- **Hazardous waste management/recycling** takes steps to ensure that hazardous materials are contained and do not cause environmental damages.

**Environmental Compliance & Sustainability Planning** contains establishments and governmental agencies that plan, establish, execute and control environmental quality standards, usually in regards to air, water, land, and other environmental resources. These agencies also play a significant role in guiding and shaping the developments of the other five clusters.

- **Pollution prevention rule development and enforcement** is a role often taken on at a state level. In California, oversight or implementation may involve the California Environmental Protection Agency, Air Resources Board and Energy Commission. New legislation is typically assigned to a state agency to plan, establish, and implement guidelines that accomplish the objectives of the bill.
- **Conservation, cleanup and safety** are regulated to ensure the proper disposal of harmful substances/byproducts as well as the conservation of natural resources.
- **Urban planning** incorporates "smart growth" concepts to decrease pollution, strains on water supplies, as well as protect wildlife, farmland and open spaces.
- **Transportation systems planning** increases the efficiency of, and access to public transportation systems.

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<sup>26</sup> Green Logistics, <http://www.greenlogistics.org/>

<sup>27</sup> California Department of Water Resources, Drought Conditions, 2009. <http://www.water.ca.gov/drought>

<sup>28</sup> U.S. Environmental Protection Agency, <http://www.epa.gov/ovm/>

## Green Jobs Framework

The range of opportunities to work in the green economy is continuing to expand and the ultimate size and scope of the green job market is still unknown. The green occupational overview presented in the following table is designed to present a framework to create relationships between the green industry sectors and clusters discussed in the previous section; potential new/emerging green occupations; and traditional occupations that have the potential to go green in the future. Occupations selected for inclusion in this section support the value chain activities (Research and Development, Manufacturing, Distribution, Installation, and Maintenance & Repair) of the designated industry sectors and comply with the aforementioned criteria.

Green Economy area/sector	Green Industry Clusters	Emerging Green Occupations	Occupations with SOC Code
<b>Renewable Energy: Energy Generation, System Installation &amp; Storage</b>	Solar thermal & photovoltaic (PV) systems	<b>Solar power &amp; PV systems:</b> Solar systems engineers Solar systems engineering technicians Solar manufacturing technicians Solar sales estimators Solar thermoelectric plant managers Solar systems designers Solar commercial installation engineers Solar installation electricians Solar installation electrician foremen Solar thermal system installers Solar PV installers ( <i>Proposed SOC: 49-9022 Solar panel installers and repairers</i> )	<b>Engineers (including civil and electrical engineers*):</b> 17-2041 Chemical Engineers 17-2051 Civil Engineers 17-2071 Electrical Engineers 17-2072 Electronics Engineers 17-2081 Environmental engineers 17-2112 Industrial Engineers 17-2131 Materials engineers 17-2141 Mechanical engineers
	Wind energy power	<b>Wind energy power:</b> Wind farm electrical systems designers Wind power plant project engineers Wind turbine electrical engineers Wind turbine mechanical engineers Wind power manufacturing technicians Wind turbine maintenance technicians Wind field technicians Wind turbine machinists	<b>Mapping technicians (17-3031.02)</b>  <b>Technicians/Electrical technicians:</b> 17-3023 Electrical & electronics engineering technicians 17-3024 Electro-mechanical technicians 17-3025 Environmental engineering technicians 17-3027 Mechanical engineering technicians 17-3029 Engineering technicians, except drafters, all other
	Hydro-electric power	<b>Next generation hydro power:</b> Ocean wave power turbine technicians	<b>Commercial and industrial designers (27-1021)</b>  <b>Assemblers:</b> 51-2022 Electrical and electronic equipment assemblers 51-2023 Electromechanical equipment assemblers 51-2031 Engine and other machine assemblers 51-2091 Fiberglass laminators and fabricators 51-2092 Team assemblers
	Geothermal power	<b>Geothermal power:</b> Geothermal electrical engineers Geothermal operations engineers Geothermal mechanical engineers	<b>Machinists, operators and inspectors:</b> 51-4041 Machinists 51-8012 Power distributors 51-8013 Power plant operators 51-8021 Stationary Engineers and Boiler Operators 51-9061 Inspectors, testers, sorters and weighers
	Smart grid		
	Hydrogen power		
	Energy storage		
	Energy transmission/distribution		
	Energy services (ESCO)		

Green Economy area/sector	Green Industry Clusters	Emerging Green Occupations	Occupations with SOC Code
<p><b>Renewable Energy: Energy Generation, System Installation &amp; Storage, continued</b></p>		<p>Geothermal power plant structural engineers                      Geothermal plant efficiency operators                      Geothermal plant installation technicians                      Geothermal heat pump machinists</p> <p><b>Hydrogen</b>                      Hydrogen plant operator and operations managers                      Hydrogen fuel cell engineers</p> <p><b>All renewables:</b>                      Instrumentation/Controls/Electrical (ICE) systems technicians                      Renewable energy technicians                      Other energy engineers (<i>Proposed SOC 17-2179 Other energy engineers</i>)</p>	<p><b>Electrical and electronics repairers, powerhouse substation and relay (49-2095)</b></p> <p><b>Industrial machinery mechanics</b> (hydroelectric machinery mechanics) (49-9041)</p> <p><b>Managers:</b>                      11-1021 General and operations managers                      11-9041 Engineering managers</p> <p><b>Roofers (47-2181)</b></p> <p><b>Plumbers:</b>                      47-2152 Plumbers, pipefitters, and steamfitters                      47-3015 Helpers-pipelayers, plumbers, pipefitters, and steamfitters</p> <p><b>Sheet metal workers (47-2211)</b></p> <p><b>Installers &amp; Energy efficiency specialists:</b>                      17-3012 Electrical drafters                      49-9012 Control and valve installers and repairers, except mechanical door                      49-9021 Heating, air conditioning, and refrigeration mechanics and installers                      49-9051 Electrical power-line installers and repairers</p> <p><b>Sales representatives:</b>                      41-4011 Sales representatives, wholesale and manufacturing, technical and scientific products                      41-9031 Sales engineers                      41-9041 Telemarketers</p> <p><b>Accountants (KSA of tax incentives, rebates, etc):</b>                      13-2011.01 Accountants</p> <p><b>Meter readers, utilities (43-5041)</b></p> <p><b>Hydrogeologists:</b>                      19-2042 Geoscientists</p> <p><b>Maintenance workers:</b>                      49-9042 Maintenance and repair workers, general                      49-9043 Maintenance workers, machinery                      49-9098 Helpers-installation, maintenance and repair workers</p>

Green Economy area/sector	Green Industry Clusters	Emerging Green Occupations	Occupations with SOC Code
<p><b>Green Building and Energy Efficiency</b></p>	<p>Green product manufacturing:</p> <ul style="list-style-type: none"> <li>• Lighting</li> <li>• Construction materials</li> <li>• “Smart” systems &amp; equipment</li> <li>• Water systems</li> <li>• HVAC/R equipment</li> </ul> <p>Green construction materials wholesaling</p> <p>Energy services (ESCO)</p> <p>Design and construction of new buildings</p> <p>Retrofitting &amp; retro-commissioning of existing structures</p> <p>Deconstruction</p> <p>Green building operations and maintenance</p> <p>Certifications (LEED)</p> <p>Green landscaping</p>	<p><b>Green product manufacturing:</b> Other energy engineers (<i>Proposed SOC 17-2179 Other energy engineers</i>)</p> <p><b>Energy services:</b> Field energy consultants Energy conservation representatives Energy managers and analysts Compliance analysts or Energy regulation specialists Residential energy field auditors (<i>Proposed SOC 25-9022 Home energy auditors</i>) Commercial and industrial energy field auditors</p> <p><b>Design and construction of new green buildings/Retrofitting of existing buildings/Deconstruction:</b> Green building and retrofit architects Renewable energy consultants Industrial green systems and retrofit designers Environmental construction engineers Green building and retro-fitting project managers</p> <p><b>Green building operations and maintenance:</b> Water purification systems service technicians Green building operators and engineers Green building maintenance engineer Building performance specialists:</p> <ul style="list-style-type: none"> <li>• Weatherization specialists or technicians</li> <li>• Weatherization operations managers</li> <li>• Residential air sealing technicians</li> <li>• Building controls system technicians</li> </ul> <p>Resource conservation or Energy efficiency managers</p>	<p><b>Engineers:</b> 17-2051 Civil engineers (including structural design) 17-2071 Electrical engineers (including Lighting product and equipment engineers) 17-2112 Industrial Engineers 17-2131 Materials engineers 17-2141 Mechanical engineers (including Water systems designers and engineers, and HVAC/R engineers) 17-2151 Mining and geological engineers</p> <p><b>Technicians/Electrical technicians:</b> 17-3012 Electrical drafters 17-3023 Electronics &amp; electrical engineering technicians (including lighting product manufacturing technicians) 17-3024 Electro-mechanical technicians 17-3027 Mechanical engineering technicians (including HVAC/R product manufacturing technicians) 17-3029 Engineering technicians, except drafters, all other</p> <p><b>Fabricators and welders:</b> 51-2041 Structural metal fabricators and fitters 51-4121 Welders, cutters, solderers, and brazers</p> <p><b>Interior designers (27-1025)</b></p> <p><b>Architects:</b> 17-1011 Architects, except landscape and naval 17-1012 Landscape architects 17-3011 Architectural and civil drafters</p> <p><b>Maintenance and repair workers:</b> 49-9042 Maintenance and repair workers, general</p> <p><b>Construction supervisors:</b> 11-9021 Construction managers (including Project manager for construction and design work) 47-1011 First-line supervisors/managers of construction trades and extraction workers</p> <p><b>Cement masons and concrete finishers (47-2051)</b></p> <p><b>Carpenters:</b> 47-2031 Construction carpenters</p>

Green Economy area/sector	Green Industry Clusters	Emerging Green Occupations	Occupations with SOC Code
<p><b>Green Building and Energy Efficiency, continued</b></p>		<p><b>Green landscaping:</b> Green landscape architects</p>	<p>47-3012 Helpers-carpenters</p> <p><b>Roofing and skylight installers:</b> 47-2121 Glaziers 47-2181 Roofers</p> <p><b>Insulation installers:</b> 47-2131 Insulation workers, floor, ceiling and wall</p> <p><b>Electricians:</b> 47-2111 Electricians 47-3013 Helpers-electricians</p> <p><b>Plumbers &amp; HVAC/R:</b> 47-2152 Plumbers, pipefitters, and steamfitters 47-3015 Helpers-pipe layers, plumbers, pipefitters, and steamfitters 49-9021 Heating and air conditioning and refrigeration mechanics and installers</p> <p><b>Sales representatives:</b> 41-4011 Sales representatives, wholesale and manufacturing, technical and scientific products 41-9031 Sales engineers</p> <p><b>Cost estimators (13-1051)</b></p> <p><b>Energy efficiency specialists:</b> 17-3012 Electrical drafters</p> <p><b>Inspectors:</b> 47-4011 Construction and building inspectors</p>



Green Economy area/sector	Green Industry Clusters	Emerging Green Occupations	Occupations with SOC Code
<b>Biofuels &amp; Farming</b>	<p>Biofuels production</p> <p>Biomass</p> <p>Organic farming practices</p> <ul style="list-style-type: none"> <li>• Natural pesticides</li> </ul> <p>Biomethane production</p> <ul style="list-style-type: none"> <li>• Energy from animal waste</li> <li>• Energy from landfills</li> </ul> <p>Sustainable fisheries</p>	<p><b>Biofuel production &amp; Biomass:</b></p> <p>Biofuel plant field technicians</p> <p>Biofuel production technicians</p> <p>Biodiesel/Biofuel technology &amp; product development managers</p> <p>Biofuel plant field &amp; operations engineers</p> <p><b>Landfill gas to energy (LGE):</b></p> <p>Landfill gas collection system operators</p> <p>Landfill gas system technicians</p> <p><b>Energy from animal waste:</b></p> <p>Biomethane gas collection system technicians</p> <p>Biomethane gas collection system operators</p> <p><b>Sustainable fisheries:</b></p> <p>Sustainable development specialists</p>	<p><b>Farmers and ranchers</b> (11-9012)</p> <p><b>Agricultural engineers</b> (17-2021)</p> <p><b>Civil engineers</b> (17-2051) – agriculture/irrigation/water supply</p> <p><b>Lab technicians:</b></p> <p>19-4011.01 Agricultural technicians</p> <p>19-4021 Biological technicians</p> <p>19-4031 Chemical technicians</p> <p><b>Scientists:</b></p> <p>19-1013 Soil and plant scientists</p> <p>19-1020 Biologists</p> <p><b>Managers:</b></p> <p>11-9011 Farm, ranch and other agricultural managers</p> <p>45.1011.07 First-line supervisors/managers of agricultural crop and horticulture workers</p> <p><b>Agricultural inspectors</b> (45-2011)</p>

Green Economy area/sector	Green Industry Clusters	Emerging Green Occupations	Occupations with SOC Code
<b>Alternative Fuel Transportation</b>	<p>Alternative fuel engine design (hydrogen electrical, biofuels, hybrid)</p> <p>Alternative vehicle manufacturing</p> <p>Repair &amp; maintenance of alternative vehicles</p> <ul style="list-style-type: none"> <li>• Hybrid/electrical</li> <li>• Hydrogen/fuel cells</li> <li>• Biofuels</li> <li>• Natural gas, LNG &amp; CNG</li> </ul> <p>Fueling stations (natural gas, hydrogen, electric, etc.)</p> <p>Electric Public Transit</p> <p>Logistics</p>	<p><b>Alternative fuel engine design and vehicle manufacturing:</b></p> <p>Hybrid powertrain development engineers            Powertrain control systems &amp; software engineers            Automotive power electronics engineers</p> <p><b>Repair &amp; maintenance of alternative vehicles:</b></p> <p>Alternative fuel vehicle diagnosticians            Natural gas vehicle technicians            Biodiesel technicians            Electrical or hybrid vehicle technicians            Hydrogen/fuel cell vehicle technicians  <i>(Proposed SOC 49-3024 Hybrid and fuel cell automotive technicians and mechanics)</i></p> <p><b>Fueling stations:</b></p> <p>Program managers, environmental construction            Alternative fueling station designers &amp; project engineers            Fueling facility technicians<sup>29</sup>            Emission control technology specialist</p>	<p><b>Engineers:</b></p> <p>17-2071 Electrical engineers            17-2072 Electronics engineers            15-1030 Computer software engineers</p> <p><b>Assemblers &amp; fabricators:</b></p> <p>51-2031 Engine and other machine assemblers            51-2041 Structural metal fabricators and fitters            51-2092 Team assemblers</p> <p><b>Electronic equipment installers, repairers, motor vehicles (49-2096)</b></p> <p><b>Technicians:</b></p> <p>17-3023 Electronics and electrical engineering technicians            17-3025 Environmental engineering technicians            17-3027 Mechanical engineering technicians</p> <p><b>Welders:</b></p> <p>51-4121 Welders, cutters, solderers and brazers            51-4122 Welding, soldering, and brazing machine setters, operators and tenders</p> <p><b>Electricians (47-2011)</b></p> <p><b>Automotive mechanics:</b></p> <p>49-3020 Automotive technicians and repairers            49-3031 Bus and truck mechanics and diesel engine specialists</p> <p><b>Mapping technicians (17-3031.02)</b></p>

Skills set may vary depending on type of fueling station/facility.

Green Economy area/sector	Green Industry Clusters	Emerging Green Occupations	Occupations with SOC Code
<p><b>Water and Wastewater Management</b></p>	<p>Water shed conservation and management                      Water supply and distribution (storm water capture, water recycling, ground-water replenishment and water conservation)                      Water treatment                      Wastewater treatment &amp; management                      Solid waste management/recycling                      Hazardous waste management/recycling</p>	<p><b>Water shed conservation and management:</b>                      Water conservation consultants                      Sustainable development specialists  <b>Water supply and distribution:</b>                      Water resource consultants                      Water conservation or water efficiency specialists                      GIS Technicians                      GIS Analysts  <b>Water and wastewater treatment:</b>                      Water/wastewater consultants                      Environmental chemists                      Environmental biologists  <b>Solid waste management/recycling:</b>                      Waste reduction consultants                      Destruction technicians</p>	<p><b>Engineers:</b>                      17-2081 Environment engineers                      17-2141 Mechanical engineers (including water systems designers and engineers)  <b>Technicians:</b>                      17-3025 Environmental engineering technicians                      17-3027 Mechanical engineering technicians  <b>Instrument and control technicians:</b>                      49-9012 Control &amp; valve installers and repairers, except mechanical door  <b>Industrial machinery mechanics (49-9041)</b>  <b>Machinists (51-4041)</b>  <b>Inspectors, testers, sorters, and weighers (51-9061)</b>  <b>Maintenance and repair workers:</b>                      49-2092 Electric motor, power tool and related repairers                      49-9042 Maintenance and repair workers, general                      49-9043 Maintenance workers, machinery                      49-9098 Helpers-installation, maintenance, &amp; repair workers  <b>Plumbers:</b>                      47-2152 Plumbers, pipefitters, and steamfitters                      47-3015 Helpers-pipe layers, plumbers, pipefitters, &amp; steamfitters  <b>Meter readers, utilities (43-5041)</b>  <b>Water and water treatment plant operators:</b>                      51-8021 Stationary engineers and boiler operators                      51-8031 Water &amp; liquid waste plant &amp; system operators  <b>Soil and water conservation specialists:</b>                      19-1031 Conservation scientists                      19-4091 Environmental science &amp; protection techs, incl. health  <b>Refuse and recyclable material collectors (53-7081)</b>  <b>Hazardous materials removal workers (47-4041)</b>  <b>Environmental health &amp; safety engineers and technicians:</b>                      13-1041.01 Environmental compliance inspectors                      29-9011 Occupational health and safety specialists  <b>Hydrologists (19-2043)</b></p>

Green Economy area/sector	Green Industry Clusters	Emerging Green Occupations	Occupations with SOC Code
<p><b>Environmental Compliance and Sustainability Planning</b></p>	<p>Pollution prevention rule development and enforcement</p> <p>Conservation, cleanup and safety</p> <p>Urban planning</p> <p>Transportation systems planning</p>	<p><b>Pollution prevention rule development and enforcement:</b>            Climate change and energy policy specialist            Conservation policy analysts            Alternative fuels policy analysts            Air emissions permitting engineer            Energy trading specialist</p> <p><b>Conservation, cleanup and safety:</b>            Environmental researchers            Environmental laboratory technicians            Sustainability program specialists (<i>Proposed SOC 13-1112 Sustainability program specialists</i>)</p> <p><b>Urban planning &amp; transportation systems planning:</b>            Urban renewal managers            Alternative fuels policy analysts            Sustainability planners            Sustainability program specialists (<i>Proposed SOC 13-1112 Sustainability program specialists</i>)            Energy trading specialist            Air emissions permitting engineer</p>	<p><b>Environmental inspectors and auditors:</b>            13-1041.01 Environmental compliance inspectors</p> <p><b>Environmental health &amp; safety engineers and technicians:</b>            17-2081 Environmental engineers            17-2111.01 Industrial safety and health engineers            17-2151 Mining and geological engineers, including mining safety engineers            17-3025 Environmental engineering technicians            19-2041 Environmental scientists and specialists, including health            19-4021 Biological technicians            19-4031 Chemical technicians            19-4091 Environmental science and protection technicians, including health            29-9011 Occupational health and safety specialists            29-9012 Occupational health and safety technicians</p> <p><b>Urban and regional planning specialists (including transportation planning aides):</b>            11-3071.01 Transportation managers            15-2041 Statisticians            19-3011 Economists            19-3051 Urban and regional planner            19-4061.01 City and regional planning aides            53-6041 Traffic technicians</p> <p><b>Soil and water conservation technicians:</b>            19-1031.01 Soil and water conservationists            19-4093 Forest and conservation technicians</p> <p><b>Farm and home management advisors (25-9021)</b></p>

The Standard Occupational Classification (SOC) system is used by Federal statistical agencies to classify workers into occupational categories for the purpose of collecting, calculating, or disseminating data.<sup>30</sup> Workers are classified into specific occupations according to their occupational definition. The green occupational framework presents occupations with SOC codes (traditional occupations) as well as emerging green occupations. The occupations with SOC codes are included based on the assumption that these jobs will require new or additional training in the emerging green economy. Although the emerging green occupations will also require new or additional knowledge, skills and abilities, they are primarily defined as 'emerging' by the distinction that they have not yet been classified into the SOC system and therefore no employment information can be easily obtained for them. There are several emerging green occupations listed that show proposed SOC codes. These proposed codes have been developed by the California Employment Development Department.

It is the intent of the occupational crosswalk to look at the green economy as a whole, but also to segregate the information by industry sectors and clusters to better understand the individual clusters and the specific occupations and job opportunities that may exist within each area. As a result, many job titles are duplicated throughout the table since they impact multiple green sectors.

Upon closer examination, it should be noted that the occupations within the individual industry sectors represent the value chain of activities associated with the specific industry sectors. For example, occupations associated with the Renewable Energy: Energy Generation, System Installation & Storage sector include the following:

- Engineers, Commercial and Industrial Designers (Research and Development);
- Assemblers and Machinists (Manufacturing);
- Sales Representatives, Sales Engineers, and Telemarketers (Distribution);
- Installers and Energy Efficiency Specialists (Installation); and
- Technicians and Maintenance Workers (Maintenance and Repair).

Similar patterns exist across each of the industry sectors.

Positions such as human resources, payroll, office management, etc. have not been included in the Green Jobs Framework. While individuals employed in these occupations may work for green firms, they will not typically be working directly with new green technologies and the successful performance of their jobs will not require new knowledge, skills and abilities. It should also be noted that some of the occupations presented in the crosswalk (e.g. machinists and assemblers) may experience growth in certain industries without a need for new or additional training. For example machinists may experience increased production of bolts to meet an increased demand for wind turbines. While the occupation itself may experience growth, no new skills will be needed for successful job performance. These occupations would be classified into the O\*NET Green Increased Demand Occupations referenced earlier in this report.

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<sup>30</sup> Online source: [www.bls.gov](http://www.bls.gov)

## Taxonomy of Programs Crosswalk

The occupational framework described above identifies those industries and occupations that fit within the six defined green sectors. Ultimately, community colleges have expressed interest in utilizing the framework to identify:

- Which existing courses offered are, or could be contributors to training a green workforce?
- Given that many green occupations are interdisciplinary, within which college departments should green programs be housed?
- Which departments should be convened to adopt or repackage existing programs?
- How many green courses/programs/completers is a given college, or the California Community College system, providing to the state's economy?

To address these questions appropriately, a clear distinction must be made between 'traditional' and 'emerging green occupations' as well as the methodology and challenges inherent in identifying college programs for each. 'Traditional occupations' include those presented as **Occupations with SOC Codes** in the Green Jobs Framework. The argument can be made that some of the occupations classified as **Emerging Green Occupations** may also be viewed as traditional occupations in that they are not necessarily new. For example, solar manufacturing technicians have been serving the solar industry for at least 20 years, yet this occupation is still classified as an emerging green occupation because it does not have a unique SOC code.

### Traditional Green Occupation Programs

Traditional green occupations are not necessarily new to the community college system. In fact, there is a multitude of training programs already in place for the 101 traditional green occupations (those with SOC codes) identified herein. To identify the courses and programs that train for these green jobs, the crosswalk previously co-developed by the California Community College Chancellor's Office (CCCCO) and the California Employment Development Department (EDD) was referenced.<sup>31</sup> This three-step crosswalk linked community college courses [using the Taxonomy of Program (TOP) system] to nationally adopted instructional program codes Classification of Instructional Programs (CIP), and finally to existing occupations (using the SOC system).

#### **What is a TOP Code?**

The Taxonomy of Program (TOP) is a system of numerical codes used within the state of California to collect and report information on programs and courses in different community colleges throughout the state that have similar outcomes. First published in 1979, the TOP was designed to aggregate information about programs. However, a TOP code must also be assigned to every course in our system.<sup>1</sup>

#### **What is a CIP Code?**

The Classification of Instructional Programs (CIP) was originally developed by the U.S. Department of Education's National Center for Education Statistics in 1980 to provide a taxonomic scheme that will support the accurate tracking, assessment, and reporting of fields of study and program completions activity. CIP codes are used nationwide in K-14 systems. The 2000 edition used for this crosswalk is the third revision of the taxonomy which presents an updated taxonomy of instructional program classifications and descriptions

<sup>31</sup> This crosswalk is available at: <http://labormarketinfo.edd.ca.gov/CommColleges/>

The purpose of the previous crosswalk, however, was different from our present research objectives. Thus there were some data limitations and missing TOP codes when constructing our “Green TOPs” crosswalk. For example, since the CIP codes were used to link California’s college programs and the occupations, there are some occupations that are not included in the EDD/CCCCO crosswalk (e.g. many engineering positions). In order to fill these gaps, the Centers of Excellence checked every occupation and TOP code for accurate linkages. The Chancellor’s Office staff reviewed and verified the draft crosswalk and, in many instances assigned the XX99.00 TOP code since there is not an assigned TOP code for all new courses and programs developed to meet the educational and training needs of new and emerging technologies.

The result is a listing of community college programs specifically linked to each traditional green occupation and each corresponding green sector found in Appendix D. Community colleges can use this listing to identify existing programs that can be repackaged into interdisciplinary green programs and the CCCCCO can reference this listing in reporting the number of for-credit green programs within the system.<sup>32</sup> Colleges outside of California and K-12 educational partners can access an expanded version of the spreadsheet that includes CIP codes for the occupations listed in the crosswalk. This spreadsheet is available at [www.coecc.net/green](http://www.coecc.net/green).

### **Emerging Green Occupations**

By definition, the emerging green occupations listed herein do not have a prescribed Standard Occupation Code to aid in identifying related instructional programs. Although previous environmental scans completed by the Centers of Excellence list many TOP codes and instructional programs that train for specific emerging green occupations (see Appendix B for a listing of completed reports), providing a comprehensive program listing similar to the traditional TOPs crosswalk requires extensive additional research to ensure programs are not unintentionally excluded.

Moving forward, the Centers of Excellence will collaborate with the California Community College Chancellor’s Office to revise the existing TOPs crosswalk and to identify programs that contribute to the training and education of emerging green occupations. The Centers of Excellence will also reach out to community college subject matter experts to help identify the TOP codes and programs which help prepare California’s labor force for the six green industry sectors presented in this report.

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<sup>32</sup> This listing excludes of green TOPs excludes not-for-credit, fee-based, and contract education courses and/or programs which also provide training for many green occupations. A comprehensive evaluation of the community colleges’ contribution to the green economy should take this into account. These program completion statistics are presently collected separately from the system’s Management Information System.

## Conclusion

The Green Economy Framework presented in this report is a valuable resource for community colleges as they begin to tackle the complexities of “going green” and what that means in terms of providing training and educational services. At a minimum, this report is designed to help community colleges reduce the confusion, skepticism, and misunderstanding of the green economy. Optimally, it will help community colleges better understand the green economy at a relevant and meaningful level so they are positioned and ready to respond to its needs. The American Reinvestment and Recovery Act (ARRA) has dramatically increased interest in the green movement. Additionally, the current California budget crisis will force community colleges to make difficult decisions about course offerings and programs.

On a more practical level, community college administrators, career and technical education (CTE) faculty, grant writers, and institutional researchers will be able to begin to evaluate training programs and courses relative to the emerging green economy. This framework can be used to:

- Identify existing occupational training programs related to traditional occupations with SOC codes (e.g. Machinist);
- Relate those occupational programs to new and emerging occupational areas (e.g. Wind Turbine Machinists)
- Get a sense of how those occupational programs relate to emerging industry clusters and sectors (Wind Energy Power); and
- Understand how they relate to the six major green industry sectors identified in the crosswalk (Renewable Energy: Energy Generation, System Installation & Storage).
- Use this information to create regional partnerships and responses to green industry needs.

This information can provide a starting point for program modification and new program planning. This type of evaluation and assessment will become even more important through the lens of the ARRA dollars. Significant ARRA resources have been identified for green building and energy efficiency. Figure 2 provides an example of how the framework might be applied starting with Green Building and Energy Efficiency as the major green industry sector and culminating in new community college programs to meet specific industry needs.

**Figure 2: Occupational Program Development Utilizing the Green Economy Framework**





At this time reliable labor market data is not available, even for occupations that are classified under SOC codes, as not all jobs within an SOC category are necessarily “green” but rather potentially green. For this reason, employment projections are not being attached to this framework at this time. However, California’s Employment Development Department is conducting its survey of employers to begin to get a sense of the types and numbers of green jobs in today’s economy. The Centers of Excellence have completed a number of environmental scans focusing on various green industry sectors and occupations. These scans generally include primary research and provide meaningful data and information on new and emerging industries and occupations. A complete list of these scans can be found in Appendix B of this report. They are all available to download at the Center of Excellence website at [www.coecc.net/green](http://www.coecc.net/green).

This framework is a “living document” for the Centers of Excellence; the same can be said for community colleges. The Center of Excellence initiative will use this green economy framework to begin focused industry and/or occupational studies within the six subsectors identified in the industry crosswalk. These studies will include primary research to identify statewide, regional and local green economy workforce development needs. Community colleges are encouraged to use the framework to evaluate and assess their current course and program offerings for future planning.

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- The Future of Geothermal Energy, Massachusetts Institute of Technology
- National Association of Energy Companies, <http://www.naesco.org/default.htm>
- U.S. Department of Labor ETA – Occupational Outlook ([www.doleta.gov](http://www.doleta.gov))

## Appendix A: How to Utilize this Report

This report is designed to provide a framework to define and understand the green economy. It:

- Creates operational definitions of green firms and green jobs that are relevant to community colleges;
- Classifies the green economy into major sectors or areas and develop an outline of green emerging industries and subsectors included in each sector;
- Develops a crosswalk between green industry sectors and green occupations that require specialized training, but currently are not classified under the Standard Occupational (SOC) system;
- Outline a list of occupations that currently have an SOC code and could be re-trained for the emerging green jobs within each industry sector; and
- Builds a crosswalk between the specified occupations with SOC codes and community college programs that currently train for these occupations as defined by the California Community College Taxonomy of Occupational Programs (TOP) systems.

The information in this report has been validated by a panel of employers, economic development professionals, and educators. Given the complex nature of the green economy and its continuing evolution, this framework should be considered a starting point as it will undergo future revisions as more becomes known about the direction of the various green industry sectors and occupations.

### ***About the Centers of Excellence***

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

The Centers of Excellence Initiative is funded in part by the Chancellor's Office, California Community Colleges, Economic and Workforce Development Program. The total grant amount (grant number 08-305-021 for \$205,000) represents funding for multiple projects and written reports through the Center of Excellence. The Centers aspire to be the premier source of regional economic and workforce information and insight for California's community colleges. More information about the Centers of Excellence is available at [www.coecc.net](http://www.coecc.net).

### ***Important Disclaimer***

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

**Appendix B: Environmental Scans, Focus on the Green Economy**

<b>Energy Efficiency Occupations</b>	This report focuses on occupations related to energy efficiency in the residential, commercial and industrial buildings sector. These jobs are projected to grow significantly in the Bay Area as employers and individuals invest in energy efficiency projects.
At-a-Glance Bay Area /2007	
<b>Energy Efficiency Occupations</b>	In 2009, the San Francisco Bay and Greater Silicon Valley Centers of Excellence studied eight energy efficiency occupations that are most relevant to community colleges. This environmental scan’s findings are based on survey responses from more than 700 firms that have energy efficiency workers in the 12-county Bay Area. Employers are projected to add as many as 13,000 new jobs over the next three years in this cluster of occupations.
Bay Area /2009 <i>Key Findings report also available.</i>	
<b>Green Building</b>	This publication augments the environmental scan entitled Green Building and Construction: Los Angeles County.
Occupation Profiles Los Angeles /2007	
<b>Green Building</b>	This publication augments the environmental scan entitled Green Building and Construction: Los Angeles County.
Related Programs Los Angeles /2007	
<b>Green Building and Construction</b>	A recent survey of construction companies in Southern California found that 25% have worked on a green project, a number expected to increase to 50% over the next several years.
Scan Los Angeles /2007	
<b>Green Economy Workforce Study</b>	Based on a 2008 survey of Central Valley businesses in energy, building and design services, engineering and environmental services, as well as government and public administration, over 79% of employers indicated that the green economy will be important in focusing their future products and services.
Scan Central Valley /2008 <i>Key Findings report also available.</i>	
<b>Green Industries &amp; Jobs in California</b>	The Green Industries & Jobs report previews a study of the green economy and green jobs launched in 2008 by the Centers of Excellence. This document details the COE approach to identifying green industries and occupations, and includes, where possible, preliminary data and information, and related existing community college training programs.
Preview Report California – Statewide /2009 <i>Key Findings report also available.</i>	

Green Study webpage → [www.coecc.net/green](http://www.coecc.net/green)

<p><b>Heating, Ventilation, and Air Conditioning Occupations</b></p>	<p>California's long-term energy goals call for transforming heating, ventilation and air conditioning (HVAC) to ensure optimal energy performance for the state's climate. In Los Angeles, more than 600 annual job openings are projected for the four HVAC occupations profiled. By 2014, over 20,000 people will be employed in these positions in the county.</p>
<p>Scan Los Angeles /2008</p>	
<p><b>Line Installers and Repairers</b></p>	<p>The line installers and repairers report intersects two industries—electric power and telecommunications. With above average earnings and a projected growth and replacement rate of almost 60%, this represents a training opportunity for community colleges.</p>
<p>At-a-Glance Greater Sacramento /2007</p>	
<p><b>Solar Energy</b></p>	<p>California is emerging as the world's third largest solar market. Industry and financial analysts forecast 20% annual growth in solar energy and projections estimate an increase of between 22,400 and 41,600 solar industry jobs by 2020.</p>
<p>At-a-Glance Bay Area /2006</p>	
<p><b>Solar Industry</b></p>	<p>Based on a 2008 survey of solar and solar-related businesses in the Bay, solar occupations in greatest demand will grow by an average of nearly 50% over the next 12 months. This growth is projected to create almost 1,900 new jobs in the Bay.</p>
<p>Scan Bay Area /2008 <i>Key Findings report also available.</i></p>	
<p><b>Solar Industry</b></p>	<p>Based on a 2008 survey of solar and solar-related businesses in the Greater Sacramento area, solar occupations in greatest demand will grow by an average of nearly 40% over the next 12 months. This growth is projected to create almost 310 new jobs in the Greater Sacramento area.</p>
<p>Scan Greater Sacramento /2008 <i>Key Findings report also available.</i></p>	
<p><b>Solar Industry</b></p>	<p>Based on a 2008 survey of solar and solar-related businesses in the Los Angeles and California, solar occupations in greatest demand will grow by an average of nearly 77% in the 6-county southern California. This growth is projected to create almost 750 new jobs in the Los Angeles solar industry.</p>
<p>Scan Southern California /2008 <i>Key Findings report also available.</i></p>	
<p><b>Solar Technicians</b></p>	<p>With the accelerated growth of the solar industry, demand for installers and repairers is high. California presently accounts for 73% of all solar installations nationwide and is projected to create more than 4,000 installer and technician jobs by 2015.</p>
<p>Scan California - Statewide /2008 <i>Key Findings report also available.</i></p>	

Solar Study webpage → [www.coecc.net/solar](http://www.coecc.net/solar)

<b>Utilities Industry</b> Scan Los Angeles County /2008	Consistent with California's average, approximately one in 143 workers (0.7%) in Los Angeles County was employed by the utilities industry in 2006. Utilities employment in Los Angeles is projected to increase 4.5% from 2006 to 2014, resulting in 1,290 new jobs.
<b>Water Efficiency Technology</b> Scan Greater Sacramento /2008	A recent survey of plumbing employers in the Greater Sacramento area revealed that nearly half (48%) of plumbing businesses in the region will add new employees while more than one-third (38%) expect to stay the same size in the next 12 months.
<b>Water Operators</b> Scan Los Angeles County /2008	There are 2,350 Water Operators in Los Angeles County, and many of them are Baby Boomers who will soon leave the industry. Forecasts indicate a need for 578 new Water Operators in the next five years.
<b>Wind Energy</b> At-a-Glance Bay Area /2005	Transitioning from a fossil fuel-based economy to a renewably powered one is projected to yield over 3.3 million jobs over a period of 10 years with a \$300 billion investment. In California, the potential exists to create thousands of jobs.

Download reports at the COE website → [www.coeccc.net/products\\_industry\\_scans](http://www.coeccc.net/products_industry_scans)

## **Appendix C: Industry, Economic Development and Educational Partners**

The following individuals served on a panel to validate the industry and occupational matrices that became the green economy framework presented in this report. Their collective subject matter expertise across the green economy was instrumental in the production of this report.

Tim O'Connor, Environmental Defense Fund

Gregory Freeman, LA County Economic Development Corporation (LAEDC)

Bonnie Graybill and Staff, EDD Labor Market Information Division

Jon Dougal, Solar Energy Council

Linda Parker, Kern Wind Energy Association

Curtis Cormane, Main Street Architects

Bill Buratto, Ventura County Economic Development Association

Kristine Mazzel, Valley Vision

Jose Ramirez, Sacramento Regional County Sanitation District, Sacramento Area Sewer District

Greg Newhouse, Advanced Transportation Technology & Energy Center (ATTE), California Community Colleges

Richard Della Valle, Environment, Health, Safety & Homeland Security Centers, California Community Colleges

Larry Dutto, College of the Sequoias, Career & Technical Education

## Appendix D: Crosswalk between Green Occupations and College Programs

### TOP Code

The Taxonomy of Program (TOP) is a system of numerical codes used within the state of California to collect and report information on programs and courses in different community colleges throughout the state that have similar outcomes. First published in 1979, the TOP was designed to aggregate information about programs. However, a TOP code must also be assigned to every course in the California Community College System. The Center of Excellence green occupations crosswalk uses the 6<sup>th</sup> edition which is publicly available at [www.cccco.edu](http://www.cccco.edu).

### CIP Code

The Classification of Instructional Programs (CIP) was originally developed by the U.S. Department of Education’s National Center for Education Statistics in 1980 to provide a taxonomic scheme that will support the accurate tracking, assessment, and reporting of fields of study and program completion activity. CIP codes are used nationwide by K-14 systems. The 2000 edition used for this crosswalk is the third revision of the taxonomy which presents an updated taxonomy on instructional program classifications and descriptions. Crosswalks specifically for CIP codes are publicly available at [nces.ed.gov](http://nces.ed.gov)

Crosswalk between Related Green Occupations and College Programs (TOP codes)			
Green Economy area/sector	Green Occupations with SOC code*	Related TOP Code	TOP Program Title
<b>Renewable Energy: Energy Generation, System Installation &amp; Storage</b>	11-1021 General and operations managers	050100	Business and Commerce, General
		050500	Business Administration
		050600	Business Management
		050800	International Business and Trade
		210200	Public Administration
	11-9041 Engineering managers	090100	Engineering, General
	13-2011.01 Accountants	050200	Accounting
		050210	Tax Studies
	17-2041 Chemical Engineers	092400	Engineering Technology, General
	17-2051 Civil Engineers	092400	Engineering Technology, General
	17-2071 Electrical engineers	092400	Engineering Technology, General
	17-2072 Electronics engineers	092400	Engineering Technology, General
	17-2081 Environmental engineers	099900	Other Engineering & Related Industrial Tech
	17-2112 Industrial engineers	099900	Other Engineering & Related Industrial Tech
	17-2131 Materials engineers	099900	Other Engineering & Related Industrial Tech
17-2141 Mechanical engineers	092400	Engineering Technology, General	
17-3024 Electro-mechanical technicians	094330	Vacuum Technology	



Crosswalk between Related Green Occupations and College Programs (TOP codes)				
Green Economy area/sector	Green Occupations with SOC code*	Related TOP Code	TOP Program Title	
<b>Renewable Energy: Energy Generation, System Installation &amp; Storage, continued</b>		099900	Other Engineering & Related Industrial Tech	
	17-3025 Environmental engineering technicians	099900	Other Engineering & Related Industrial Tech	
	17-3027 Mechanical engineering technicians	094500	Industrial Syst. Technology and Maintenance	
	17-3029 Engineering technicians, except drafters, all other		093480	Laser and Optical Technology
			094330	Vacuum Technology
			094610	Energy Systems Technology
			095420	Plastics and Composites
			096100	Optics
			099900	Other Engineering & Related Industrial Tech
	19-2042 Geoscientists	193000	Earth Science	
	41-4011 Sales representatives, wholesale and	050940	Sales and Salesmanship	
	41-9031 Sales engineers	050940	Sales and Salesmanship	
	41-9041 Telemarketers	059900	Other Business and Management	
	47-2152 Plumbers, pipefitters, and steamfitters	095230	Plumbing, Pipefitting and Steamfitting	
	47-2181 Roofers	095290	Roofing	
	47-3015 Helpers-pipelayers, plumbers, pipefitters, and	095230	Plumbing, Pipefitting and Steamfitting	
	49-2095 Electrical and electronics repairers, powerhouse	093440	Electrical Systems and Power Transmission	
	49-9012 Control and valve installers and repairers,	099900	Other Engineering & Related Industrial Tech	
	49-9021 Heating, A/C, and refrig. mechanics & installers	094600	Environmental Control Technology	
	49-9041 Industrial machinery mechanics (hydroelectric)	095630	Machining and Machine Tools	
	49-9042 Maintenance and repair workers, general	095700	Civil and Construction Management Technology	
	49-9043 Maintenance workers, machinery	095630	Machining and Machine Tools	
	49-9051 Electrical power-line installers and repairers	093440	Electrical Systems and Power Transmission	
	49-9098 Helpers-installation, maint. & repair workers	099900	Other Engineering & Related Industrial Tech	
	51-2022 Electrical and electronic equipment assemblers		93420	Industrial Electronics
			093430	Telecommunications Technology
	51-2023 Electromechanical equipment assemblers	093500	Electro-Mechanical Technology	
	51-2031 Engine and other machine assemblers	094720	Heavy Equipment Maintenance	
	51-2091 Fiberglass laminators and fabricators	099900	Other Engineering & Related Industrial Tech	
	51-2092 Team assemblers	099900	Other Engineering & Related Industrial Tech	
	51-4041 Machinists	095630	Machining and Machine Tools	
	51-8012 Power distributors	099900	Other Engineering & Related Industrial Tech	
51-8013 Power plant operators	099900	Other Engineering & Related Industrial Tech		
51-8021 Stationary engineers and boiler operators	099900	Other Engineering & Related Industrial Tech		
51-9061 Inspectors, testers, sorters and weighers	095680	Industrial Quality Control		

**Crosswalk between Related Green Occupations and College Programs (TOP codes)**

Green Economy area/sector	Green Occupations with SOC code*	Related TOP Code	TOP Program Title
Green Building and Energy Efficiency	11-9021 Construction managers	050500	Business Administration
		050100	Business and Commerce, General
		050600	Business Management
	13-1051 Cost estimators	050100	Business and Commerce, General
		050500	Business Administration
		050600	Business Management
	17-1011 Architects, except landscape and naval	029900	Other Architecture and Environmental Design
	17-1012 Landscape architects	020110	Landscape Architecture (transfer)
	17-2051 Civil Engineers	092400	Engineering Technology, General
	17-2071 Electrical engineers	092400	Engineering Technology, General
	17-2112 Industrial engineers	099900	Other Engineering & Related Industrial Tech
	17-2131 Materials engineers	099900	Other Engineering & Related Industrial Tech
	17-2141 Mechanical engineers	092400	Engineering Technology, General
	17-2151 Mining & geological engineers, incl. mining	099900	Other Engineering & Related Industrial Tech
	17-3011.01 Architectural & civil drafters	020100	Architecture and Architectural Technology
		095300	Drafting Technology
		095310	Architectural Drafting
		095320	Civil Drafting
	17-3012 Electrical drafters	095330	Electrical, Electronic, & Electro-Mech. Drafting
	17-3023 Electrical & electronics engineering technicians	093400	Electronics and Electric Technology
	17-3024 Electro-mechanical technicians	094330	Vacuum Technology
		099900	Other Engineering & Related Industrial Tech
	17-3027 Mechanical engineering technicians	094500	Industrial Systems Technology and Maintenance
	17-3029 Engineering technicians, except drafters, all other	093480	Laser and Optical Technology
		094330	Vacuum Technology
		094610	Energy Systems Technology
		095420	Plastics and Composites
		096100	Optics
	27-1025 Interior designers	130200	Interior Design and Merchandising
	41-4011 Sales representatives, wholesale and	050940	Sales and Salesmanship
	41-9031 Sales engineers	050940	Sales and Salesmanship
47-1011 First-line supervisors/managers of construction trades and extraction workers	093440	Electrical Systems and Power Transmission	
	095210	Carpentry	

**Crosswalk between Related Green Occupations and College Programs (TOP codes)**

Green Economy area/sector	Green Occupations with SOC code*	Related TOP Code	TOP Program Title
Green Building and Energy Efficiency, continued		095220	Electrical
		095230	Plumbing, Pipefitting and Steamfitting
		095240	Glazing
		095260	Masonry, Tile, Cement, Lath and Plaster
		095270	Painting, Decorating, and Flooring
		095280	Drywall and Insulation
		095290	Roofing
		095700	Civil and Construction Management Technology
		095720	Construction Inspection
		210210	Public Works
		095210	Carpentry
		095260	Masonry, Tile, Cement, Lath and Plaster
		095220	Electrical
		095240	Glazing
		210210	Public Works
		095230	Plumbing, Pipefitting and Steamfitting
		095290	Roofing
		095210	Carpentry
		095220	Electrical
		095230	Plumbing, Pipefitting and Steamfitting
		095720	Construction Inspection
		094600	Environmental Control Technology
		095700	Civil and Construction Management Technology
		095640	Sheet Metal and Structural Metal
		095650	Welding Technology

**Crosswalk between Related Green Occupations and College Programs (TOP codes)**

Green Economy area/sector	Green Occupations with SOC code*	Related TOP Code	TOP Program Title
<b>Biofuels/Farming</b>	11-9011 Farm, ranch and other agricultural managers & 11-9012 Farmers and ranchers	010200	Animal Science
		010220	Artificial Inseminator (Licensed)
		010230	Dairy Science
		010300	Plant Science
		010310	Agric. Pest Control Adviser and Operator (Licensed)
		010400	Viticulture, Enology, and Wine Business
		010930	Nursery Technology
		011200	Agriculture Business, Sales and Service
	17-2021 Agricultural engineers	019900	Other Agriculture and Natural Resources
	17-2051 Civil Engineers	092400	Engineering Technology, General
	19-1013 Soil and plant scientists	010100	Agriculture Technology and Sciences, Gen
	19-1020 Biologists	049900	Other Biological Sciences
	19-4011.01 Agricultural technicians	019900	Other Agriculture and Natural Resources
	19-4021 Biological technicians	043000	Biotechnology and Biomedical Technology
	19-4031 Chemical technicians	095400	Chemical Technology
	45.1011.07 First-line supervisors/managers of	019900	Other Agriculture and Natural Resources
	45-2011 Agricultural inspectors	010200	Animal Science
010300		Plant Science	

**Crosswalk between Related Green Occupations and College Programs (TOP codes)**

<b>Green Economy area/sector</b>	<b>Green Occupations with SOC code*</b>	<b>Related TOP Code</b>	<b>TOP Program Title</b>
<b>Transportation/ Alternative Fuel</b>	15-1030 Computer software engineers	070700	Computer Software Development
	17-2071 Electrical engineers	092400	Engineering Technology, General
	17-2072 Electronics engineers	092400	Engineering Technology, General
	17-3023 Electrical & electronics engineering technicians	093400	Electronics and Electric Technology
	17-3025 Environmental engineering technicians	099900	Other Engineering & Related Industrial Tech
	17-3027 Mechanical engineering technicians	094500	Industrial Systems Technology and Maintenance
	17-3031.02 Mapping Technician	095730	Surveying
	47-2111 Electricians	095220	Electrical
	49-2096 Electronic equip. installers, repairers, motor veh.	094800	Automotive Technology
	49-3020 Automotive technicians and repairers	094800	Automotive Technology
	49-3031 Bus & truck mechanics & diesel engine specialists	094700	Diesel Technology
	51-2031 Engine and other machine assemblers	094720	Heavy Equipment Maintenance
	51-2041 Structural metal fabricators and fitters	095640	Sheet Metal and Structural Metal
	51-2092 Team assemblers	099900	Other Engineering & Related Industrial Tech
	51-4121 Welders, cutters, solderers, and brazers	095650	Welding Technology
51-4122 Welding, soldering, and brazing machine	095650	Welding Technology	

**Crosswalk between Related Green Occupations and College Programs (TOP codes)**

<b>Green Economy area/sector</b>	<b>Green Occupations with SOC code*</b>	<b>Related TOP Code</b>	<b>TOP Program Title</b>	
<b>Water, Wastewater &amp; Waste Management</b>	13-1041.01 Environmental compliance inspectors	039900	Environmental Sciences and Technologies, Other	
	17-2081 Environmental engineers	099900	Other Engineering & Related Industrial Tech	
	17-2141 Mechanical engineers	092400	Engineering Technology, General	
	17-3025 Environmental engineering technicians	099900	Other Engineering & Related Industrial Tech	
	17-3027 Mechanical engineering technicians	094500	Industrial Systems Technology and Maintenance	
	19-1031 Conservation scientists		011400	Forestry
			011500	Natural Resources
			011520	Wildlife and Fisheries
	19-2041 Env. scientists and specialists, including health	039900	Environmental Sciences and Technologies, Other	
	29-9011 Occupational health and safety specialists	095670	Industrial and Occupational Safety and Health	
	43-5041 Meter readers, utilities	099900	Other Engineering & Related Industrial Tech	
	47-2152 Plumbers, pipefitters, and steamfitters	095230	Plumbing, Pipefitting and Steamfitting	
	47-3015 Helpers-pipelayers, plumbers, pipefitters...	095230	Plumbing, Pipefitting and Steamfitting	
	47-4041 Hazardous materials removal workers	030300	Environmental Technology	
	49-2092 Electric motor, power tool and related repairers	093400	Electronics and Electric Technology	
	49-9012 Control and valve installers and repairers,	099900	Other Engineering & Related Industrial Tech	
	49-9041 Industrial machinery mechanics (hydroelectric)	095630	Machining and Machine Tools	
	49-9042 Maintenance and repair workers, general	095700	Civil and Construction Management Technology	
	49-9043 Maintenance workers, machinery	095630	Machining and Machine Tools	
	49-9098 Helpers-installation, maintenance, and repair	099900	Other Engineering & Related Industrial Tech	
	51-4041 Machinists	095630	Machining and Machine Tools	
	51-8021 Stationary engineers and boiler operators	099900	Other Engineering & Related Industrial Tech	
	51-8031 Water and liquid waste treatment plant and	095800	Water and Wastewater Technology	
	51-9061 Inspectors, testers, sorters and weighers	095680	Industrial Quality Control	
	53-7081 Refuse and recyclable material collectors	099900	Other Engineering & Related Industrial Tech	

Crosswalk between Related Green Occupations and College Programs (TOP codes)			
Green Economy area/sector	Green Occupations with SOC code*	Related TOP Code	TOP Program Title
Environmental Compliance and Sustainability Planning	11-3071.01 Transportation managers	050100	Business and Commerce, General
		050500	Business Administration
		050600	Business Management
		051000	Logistics and Materials Transportation
		210200	Public Administration
		302000	Aviation and Airport Management and Services
		302010	Aviation and Airport Management
	13-1041.01 Environmental compliance inspectors	039900	Environmental Sciences and Technologies, Other
	15-2041 Statisticians	170100	Mathematics, General
	17-2081 Environmental engineers	099900	Other Engineering & Related Industrial Tech
	17-2111.01 Industrial safety and health engineers	099900	Other Engineering & Related Industrial Tech
	17-2151 Mining & geological engineers, incl. mining	099900	Other Engineering & Related Industrial Tech
	17-3025 Environmental engineering technicians	099900	Other Engineering & Related Industrial Tech
	19-1031.01 Soil and water conservationists	011400	Forestry
		011500	Natural Resources
		011520	Wildlife and Fisheries
	19-2041 Env. scientists and specialists, including health	039900	Environmental Sciences and Technologies, Other
	19-3011 Economists	220400	Economics
	19-3051 Urban and regional planner	099900	Other Engineering & Related Industrial Tech
	19-4021 Biological technicians	043000	Biotechnology and Biomedical Technology
	19-4031 Chemical technicians	095400	Chemical Technology
	19-4061.01 City and regional planning aides	099900	Other Engineering & Related Industrial Tech
	19-4091 Environmental science and protection technicians, including health	093470	Electron Microscopy
		192000	Ocean Technology
	19-4093 Forest and conservation technicians	011400	Forestry
		011500	Natural Resources
	25-9021 Farm and home management advisors	010200	Animal Science
		130580	Child Development Administration and Mgt
		130110	Consumer Services
		130100	Family and Consumer Sciences, General
		130300	Fashion

<b>Crosswalk between Related Green Occupations and College Programs (TOP codes)</b>			
<b>Green Economy area/sector</b>	<b>Green Occupations with SOC code*</b>	<b>Related TOP Code</b>	<b>TOP Program Title</b>
<b>Environmental Compliance and Sustainability Planning, continued</b>		130570	Foster and Kinship Care
		130900	Gerontology
		139900	Other Family and Consumer Sciences
		130560	Parenting and Family Education
		010300	Plant Science
	29-9011 Occupational health and safety specialists	095670	Industrial and Occupational Safety and Health
	29-9012 Occupational health and safety technicians	095670	Industrial and Occupational Safety and Health
	53-6041 Traffic technicians	099900	Other Engineering & Related Industrial Tech