



ENVIRONMENTAL SCAN

BIO-ENERGY INDUSTRIES

California

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CENTER OF EXCELLENCE

Central Region

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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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Centers of Excellence, Economic and Workforce Development Program

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BASED ON RESEARCH OF CALIFORNIA EMPLOYERS, THE ESTIMATED COMBINED GROWTH OF SEVEN OCCUPATIONS IN THE BIO-ENERGY SECTOR OVER THE NEXT 3 YEARS IS 350 NEW JOBS.

Executive Summary

The Centers of Excellence (COE) studied the bio-energy sector in California to better understand the current and projected demand for bio-energy occupations and the workforce needs of bio-energy employers. For the purposes of this study, bio-energy companies were defined as companies delivering bio-energy services as their primary focus; public or private utilities hiring workers specifically for bio-energy activities; or companies supporting bio-energy services.

The bio-energy sector contains five major industry segments including:

- agriculture, forestry, fishing, and hunting;
- manufacturing;
- professional, scientific, and technical services;
- public administration;
- utilities.

The COE collected information from over 200 employers statewide, providing data that is highlighted throughout this report. Seven bio-energy occupations with relevance to community colleges were the focus of the research. Occupations included in this report are: 1) methane gas generation system technician or operators; 2) bio-energy engineering technician; 3) bio-energy manager or supervisor; 4) Biofuels processing technician; 5) bio-energy instrument and controls technician or operator; 6) biomass plant technician; 7) bio-energy research assistant or analyst.

Methane gas generation system technician or operators have the largest projected growth with 140 new jobs in the next three years. Collectively, the seven occupations studied are projected to add 350 new jobs in California over the next three years. Research indicates that the majority of employers experience difficulty finding qualified candidates in bio-energy occupations. Employers reported the highest level of difficulty hiring bio-energy research assistants and analysts (91% difficulty), biofuels processing technicians (90% difficulty), and bio-energy instrument and controls technicians/operators (90% difficulty).

Based on research conducted for this report, few community college training programs for bio-energy occupations are needed in California, and a modest increase in employment is projected over the next three years. Furthermore, the bio-energy sector has a relatively small number of total jobs overall.

Employers indicate they are most comfortable with community college training for three of the seven occupations: (1) biofuels processing technicians, (2) bio-energy instrument and controls technicians and operators, (3) methane/landfill gas generation system technicians and operators. These three occupations account for 210 of the 350 projected new jobs.

California Community Colleges are well positioned to build a pipeline of skilled workers, create and expand industry partnerships, and meet existing workforce needs in the bio-energy sector and future needs if they arise. Based on research conducted for this report, the following action steps are recommended to promote the development of the bio-energy sector:

- Review the following considerations for the development of bio-energy programs:
 - geographic proximity to employers;
 - employment need;
 - leverage existing programs.
- Monitor state and federal policy and legislation that may support the growth and development of bio-energy in California

Introduction

The California Community Colleges Chancellor's Office has charged the Economic and Workforce Development Program (EWD) with identifying industries and occupations with unmet employee development needs. The Centers of Excellence (COE) are one initiative within EWD. Appendix A contains further information on the initiative and how to use the report.

Bio-energy is a sector consisting of energy and fuel developed using agricultural products, and is an attractive energy source for several reasons. First, it is a truly renewable source of energy. Bio-energy also provides the opportunity for local, regional, and national energy self-sufficiency.

The intent of this report is to provide community colleges with data and insight into the short- and long-term occupational outlook for the bio-energy sector. This report also provides recommendations for community colleges interested in exploring opportunities that may exist within localized labor markets to develop and implement training programs for the bio-energy sector.

Industry Overview

The United States imports roughly 60% of the petroleum used annually. Because the US economy relies on petroleum products and oil imports, any disruption in oil supplies can result in significant economic and social impacts. Furthermore, traditional oil production will peak in the near future, requiring a diversification of the nation's fuel and energy portfolio to include unconventional fossil resources and bio-energy sources¹. Energy derived from biomass offers an alternative to traditional fuel and energy sources that supports national and state renewable energy targets and environmental sustainability.

Defining the Bio-Energy Sector

The bio-energy sector is comprised of several existing industries. In 2009, the COE conducted a study to scope the green economy in California². The report provided industry-validated sectors of the green economy using the existing North American Industry Classification System (NAICS). Using the classifications provided in the report, bio-energy is defined using five existing industry sectors: 1) Agriculture, forestry, fishing, and hunting; 2) Manufacturing; 3) Professional, scientific, and technical services; 4) Public administration; 5) Utilities. Once the bio-energy industry is defined, activities within the sector fall into biomass or biofuels. Some companies provide both biomass and biofuels, while others focus on one area.



Biomass

Biomass is a renewable energy source, made from living (or recently living) organisms such as wood, waste, (hydrogen) gas, and alcohol fuels³. However, the most conventional way in which biomass is used still relies on direct incineration. Forest residues such as dead trees, branches and tree stumps, yard clippings, wood chips and garbage are often used for this. Biomass also includes plant or animal matter used for production of fibers or chemicals and may also include biodegradable wastes that can be burnt

¹ Source: Breaking the Biological Barriers to Cellulosic Ethanol (2006), U.S. Department of Energy

² Source: "Understanding the Green Economy in California", www.coecc.net

³ Source: Biomass Energy Center, http://www.plantpower.eu/index.php?option=com_content&view=article&id=3&Itemid=4

as fuel. Biomass does not include organic materials like fossil fuels that have been transformed by geological processes into substances such as coal or petroleum.

Biomass energy is derived from five distinct energy sources: garbage, wood, waste, landfill gases, and alcohol fuels. Wood energy is derived both from direct use of harvested wood as a fuel and from wood waste streams. The largest source of energy from wood is pulping liquor, a waste product from processes of the pulp, paper and paperboard industry. Waste energy is the second-largest source of biomass energy. The main contributors of waste energy are municipal solid waste (MSW), manufacturing waste, and landfill gas.



Biofuels

Biofuels are a wide range of fuels which are in some way derived from biomass. The term covers solid biomass, liquid fuels and various biogases⁴. Biofuels are gaining increased public and scientific attention, driven by factors such as oil price spikes, the need for increased energy security, and concern over greenhouse gas emissions from fossil fuels.

Bioethanol is an alcohol made by fermenting the sugar components of plant materials and it is made mostly from sugar and starch crops. With advanced technology being developed, cellulosic biomass, such as trees and grasses, are also used as feedstock for ethanol production. Ethanol can be used as a fuel for vehicles in its pure form, but it is usually used as a gasoline additive to increase octane and improve vehicle emissions.

Biodiesel is made from vegetable oils, animal fats or recycled greases. Biodiesel can be used as a fuel for vehicles in its pure form, but it is usually used as a diesel additive to reduce levels of particulates, carbon monoxide, and hydrocarbons from diesel-powered vehicles.

For the purposes of this study, bio-energy companies were defined as those:

- delivering bio-energy services as their primary focus; or
- public or private utilities hiring workers specifically for bio-energy activities; or
- companies supporting bio-energy services.

To calculate bio-energy workforce projections and determine employer needs, 7 specific occupations were selected for this research study. Occupations selected meet the following criteria:

- the occupation is primarily found in one of the identified industry sectors;
- the occupation meets the definition of bio-energy as described above;
- each occupation can provide a decent wage for employees;
- community colleges can address the workforce needs through degree or certificate programs.

Table 1 on the following page lists the seven occupations studied for this report.

⁴ Source: Science Direct, http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6V1T-4WBR6MN-4&_user=1510497&_coverDate=11%2F30%2F2009&_rdoc=1&_fmt=high&_orig=search&_origin=search&_sort=d&_docanchor=&view=c&_acct=C000053379&_version=1&_urlVersion=0&_userid=1510497&md5=1084721a35e97512e25aea6f57fd5519&searchtype=a

Table 1: Bio-Energy Occupations

Bio-Energy Occupations Studied	
Methane gas generation system technician or operator	Bio-energy instrument & controls technician or operator
Bio-energy engineering technician	Biomass plant technician
Bio-energy manager/supervisor	Bio-energy research assistant/analyst
Biofuels processing technician	

Bio-Energy in the United States

Biomass resources are varied, ranging from agricultural crops and residues to forest resources and energy crops. They are available in every region of the United States. In 2004, the ethanol industry alone supported creation of 147,000 jobs in all sectors of the economy, boosted U.S. household income by \$4.4 billion through increased economic activity and new jobs, and added \$1.3 billion in federal tax revenue and \$1.2 billion in state and local tax revenues. Such biomass-based industries will help provide new markets and product diversification to farmers, ensuring economic vitality for years to come. Moreover, new value products from forest and agriculture industry residuals will open new market opportunities for these industries, for example, conversion of biomass — including forest residues, agricultural residues and spent pulping liquor (black liquor) — into ethanol and syngas⁵; and conversion of syngas, carbonaceous solids and oils into fuels, power, chemicals (such as hydrogen, hydrogen carriers, and butanol) and other high-value materials.

Currently, biomass accounts for approximately 4% of the total U.S. energy consumption but has the potential to contribute much more. Biomass resources are diverse and are found in every state in the United States. Feedstocks from the agriculture and forestry industries can be converted into liquid fuels, power, chemicals and other higher-value materials. According to a 2005 report by U.S. Department of Agriculture (USDA) and U.S. Department of Energy (DOE), there is approximately 1.3 billion tons of biomass available in the United States for conversion to fuels, power and products. Biomass is used to produce heat and power for industrial purposes, to produce electric power for sale to the electrical grid, and to produce bio-based fuels such as ethanol and biodiesel.

Bio-Energy in California

California is a national leader in the production of biomass power. In 2005, more than 4 million dry tons (MDT) of solid biomass was used by 28 biomass power plants to generate more than 600 megawatts (MW) of renewable energy. Another 360 MW was generated using landfill gas and biogas from sewage treatment, food processing waste, and animal waste digestion. Combined, these resources meet 2% of present total electric demand in the state and can produce as much electricity per year as about 2,500 MW of wind power. California also leads the nation in ethanol consumption, consuming more than 900 million gallons in 2004. This accounts for almost 25% of all ethanol produced in the United States in 2004. California however produces less than 5% of the ethanol it consumes. California also consumes approximately 5 million gallons of biodiesel, a renewable diesel substitute made annually from vegetable oils or animal fat. California's current use of bio-energy represents a small fraction of what is technically feasible. It is estimated that California has approximately 30 MDT of technically recoverable solid biomass resources each year – *enough to power more than 3 million homes or produce enough biofuel to run more than 2 million automobiles at today's efficiencies*. These resources are derived mainly from residues associated with agriculture, forestry, and municipal waste, representing a value-added use of materials that would otherwise be considered waste.

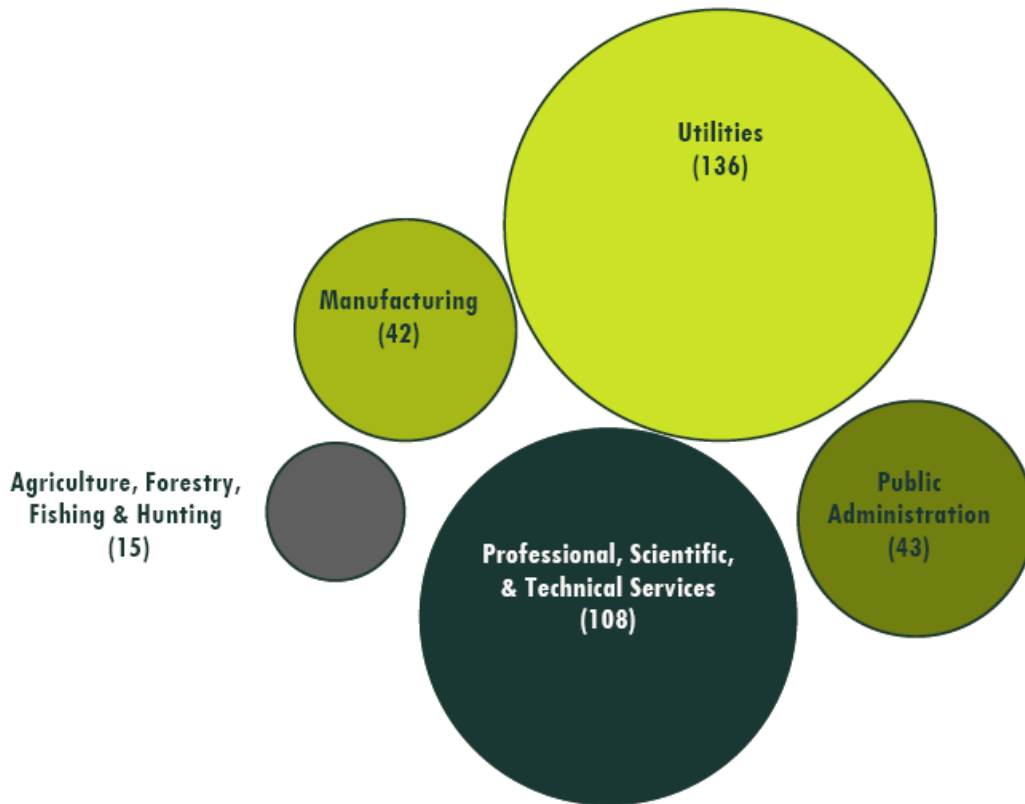
⁵ Syngas is the thermo chemical conversion of biomass into a synthesis gas that can be run through a turbine for the production of electricity, used to replace natural gas or converted into biofuels (Biomass Magazine, <http://biomassmagazine.com/articles/1399/syngas-101/>)

Biomass is the prominent bio-energy source in the state. California is the largest producer of biomass in the United States, with 45% of biomass plants located in the state⁶. At its peak in 1994, California produced just over 2% of the state’s electricity consumption using biomass. However, electricity deregulation in California poses a threat to the continued existence of the industry because of its narrow focus on price at the expense of value. Producing bio-energy is a costly process with no incentives and legislation to support the industry (Appendix B contains a description of existing policies). As a result, many facilities are not operational. Of 43 biomass plants in operation in 1994, only 29 are currently producing electricity. Ten are available to resume operations with the right incentives⁷.

Types of Bio-Energy Employers in California

In California, it is estimated that approximately 350 companies employ bio-energy workers in one or more of the seven occupations studied. Of these companies, 246 (70% of employers) provided information related to bio-energy occupations. The majority of employers provide services in the utilities or professional services sectors, as illustrated in Figure 1 below⁸.

Figure 1: California Bio-Energy Employers by Sector



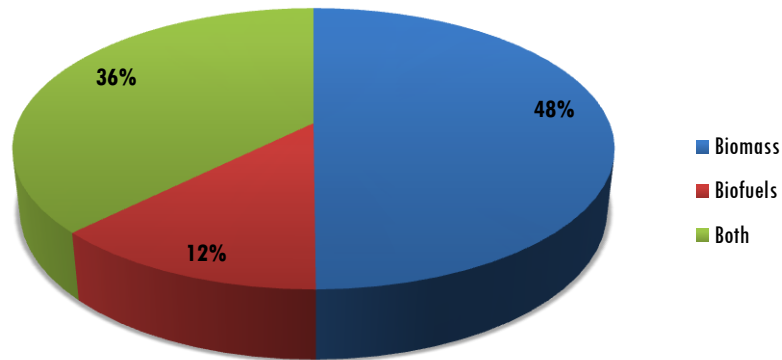
⁶ Source: U.S. Biomass Plants, U.S. Department of Energy

⁷ Source: Breaking the Biological Barriers to Cellulosic Ethanol (2006), U.S. Department of Energy

⁸ Employers were able to select more than 1 sector

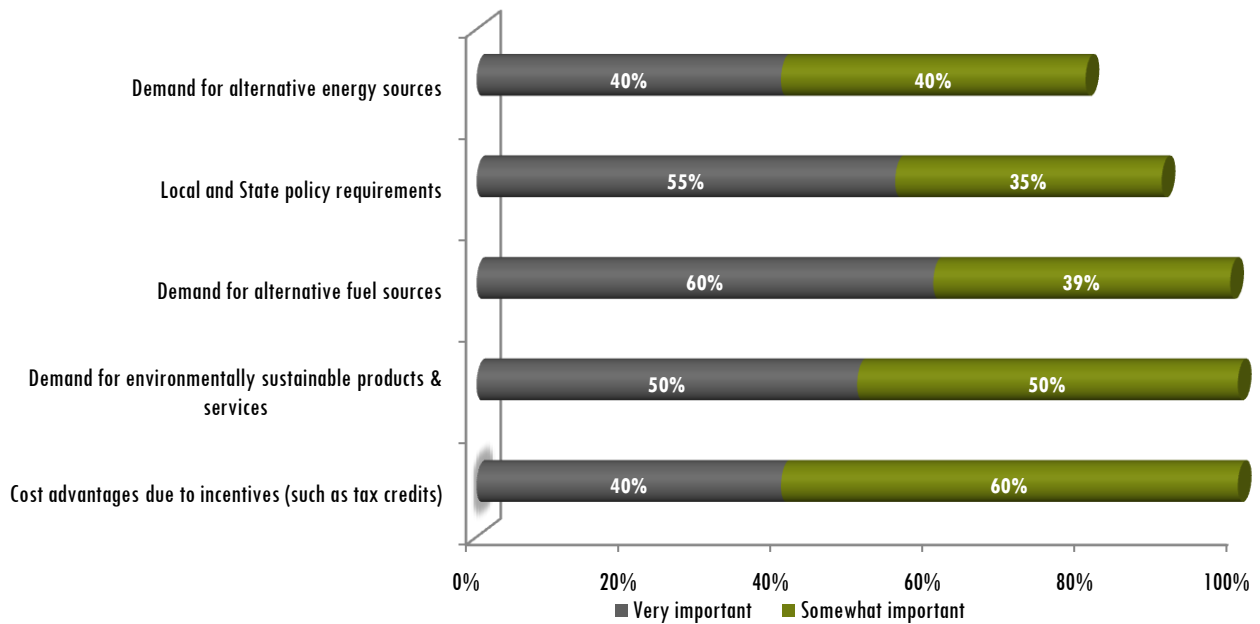
Employers were also asked to indicate what form of bio-energy their respective companies provide services for. Nearly half (48%) indicated they provide services in the biomass sector. Only 12% of companies provide services in the biofuels sector, and just over one-third (36%) provide both biomass and biofuel services.

Figure 2: Bio-energy Company Distribution by Type of Service



According to employers, there are several factors driving the development of the bio-energy sector in California, as illustrated in Figure 3 below.

Figure 3: Factors Driving Growth in the Bio-energy Sector



One hundred percent of respondents indicated the following factors are the most impactful on the industry:

- Demand for alternative fuel sources
- Demand for environmentally sustainable products and services
- Cost advantages due to incentives (such as tax credits)

Occupational Overview

Occupations included in the research had to be classified in the bio-energy sector and training for the occupations had to be within the scope of community colleges’ education offerings. Occupations were identified through a review of existing literature and executive interviews with industry representatives. The seven occupations studied and projected employment is listed on the following page. Occupational profiles for each of the occupations are located in Appendix C.

The bio-energy sector is comprised of occupations that can be categorized into five industry sectors: utilities, agriculture, manufacturing, public administration, and professional services. Table 2 below indicates how occupations included in this report correspond with the sectors. Several occupations are located across multiple industry sectors.

Table 2: Bio-energy Industry Sectors and Occupation Titles

Industry Sector	Occupation
Utilities	Bio-energy manager/supervisor Biomass plant technician Bio-energy instrument and controls technician/operator Methane/landfill gas generation system technician/operator Biofuels processing technician
Agriculture	Methane/landfill gas generation system technician/operator
Manufacturing	Bio-energy engineering technician Bio-energy instrument and controls technician/operator Biofuels processing technician
Public Administration	Methane/landfill gas generation system technician/operator Bio-energy research assistant/analyst
Professional, scientific, & technical services	Bio-energy engineering technician Bio-energy research assistant/analyst

The majority of jobs within the bio-energy cluster are located within the utility sector, with agriculture and public administration contributing the least amount of jobs supporting bio-energy activities. Collectively, the number of total jobs within the bio-energy industry is relatively small and based on interviews, surveys, and a review of secondary research, the industry has little to no growth projected in the near future. Employers did indicate that if the industry received legislative and policy support similar to the wind and solar industries, the bio-energy industry could grow quickly. Many bio-energy companies exist and are either running with minimal staffing or sitting idle because of the high costs and lack of policy support associated with the sector.

The current combined employment for the occupations studied could be as high as 3,045 jobs. The figure is a projection of employment based on employer surveys and an estimate of the total number of firms in the bio-energy sector. Several factors may influence how accurate employment levels are to the employment estimates included in this report. The estimated occupational employment totals and projections assume the sample of firms who responded to the survey is representative of the population of firms in terms of occupational staffing and job outlook.

Projected Growth for Bio-Energy Occupations

Based on research conducted for this report, the estimated combined growth of the seven bio-energy occupations over the next three years is 350 new jobs for California’s economy. The overall projected growth for the occupations studied is fairly low, with an average of 116 new jobs projected each year. The occupation with the largest number of new jobs projected is methane/landfill gas generation system technicians and operators (140 new jobs in the next three years). Employers do not expect employment projections to increase until there is a significant increase in the demand for bio-energy products and

services or until legislative policy and regulations support the growth of the industry. Table 3 below highlights current and projected employment for the occupations studied.

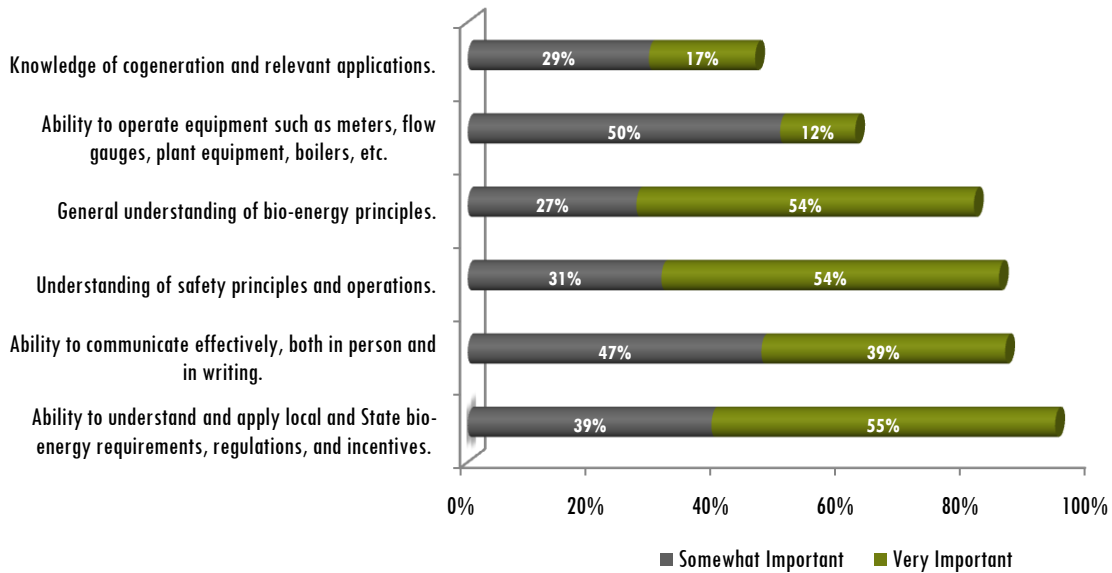
Table 3: Bio-energy Employment Projections

Bio-Energy Occupation	2010 Employment Estimate (Ca)	12-mo Projected Growth	Growth Rate	3-year Projected Growth	Growth Rate
Bio-energy manager/supervisor	105	0	0%	0	0%
Biomass plant technician	455	0	0%	35	8%
Bio-energy engineering technician	525	0	0%	0	0%
Bio-energy Instrument & controls technician/operator	595	0	0%	35	6%
Methane/Landfill gas generation system technician/operator	420	70	17%	140	33%
Bio-energy research assistant/analyst	70	35	50%	105	150%
Biofuels processing technician	875	0	0%	35	4%
Totals	3,045	105	3%	350	11%

Occupational Skill and Knowledge Requirements

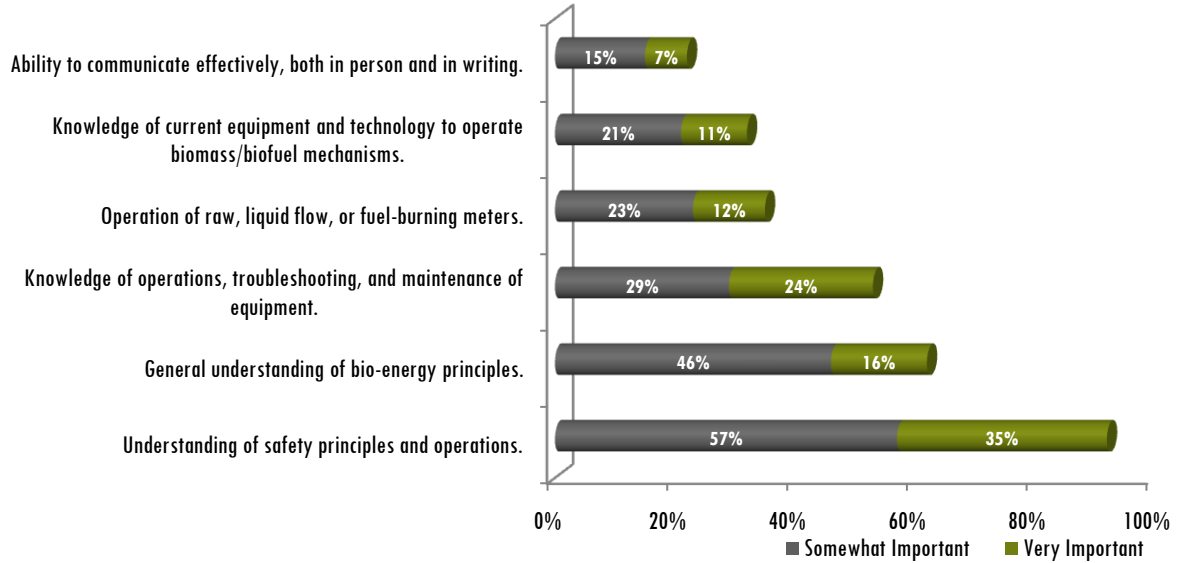
Employers were asked to identify the top skills and areas of knowledge for each of the seven occupations.

Figure 4: Bio-Energy Manager/Supervisor Skill and Knowledge Requirements



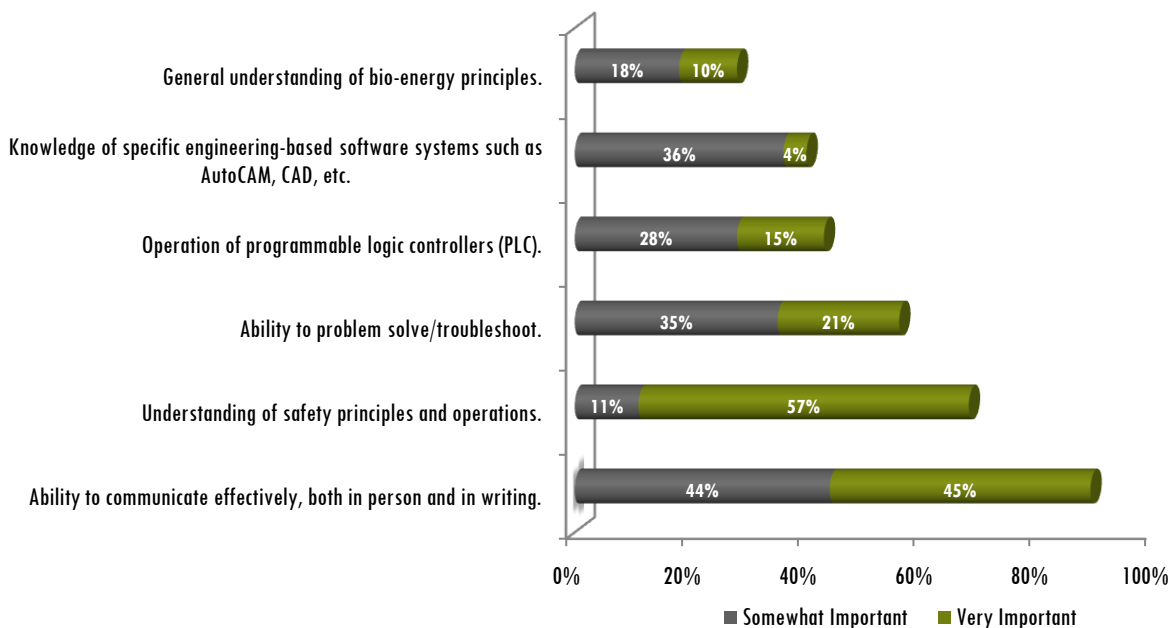
Bio-energy employers indicate a high level of importance for an employee’s ability to understand local and state bio-energy requirements, regulations and incentives (94%). More than 80% of respondents also indicated communication, safety, and a general understanding of bio-energy principles is important. Employers indicated the more ‘technical’ aspects of bio-energy (knowledge of cogeneration, operation of equipment) were less important.

Figure 5: Biomass Plant Technician Skill and Knowledge Requirements



Employers indicate that an understanding of safety principles and operations is the most important skill for biomass plant technicians to possess (92%). Many of the other knowledge and skill requirements for biomass plant technicians were identified with a much lower degree of importance. During employer interviews, several employers indicated that many of the skills are taught to employees when they are hired, so employers do not see them as highly important skills potential employees need to possess.

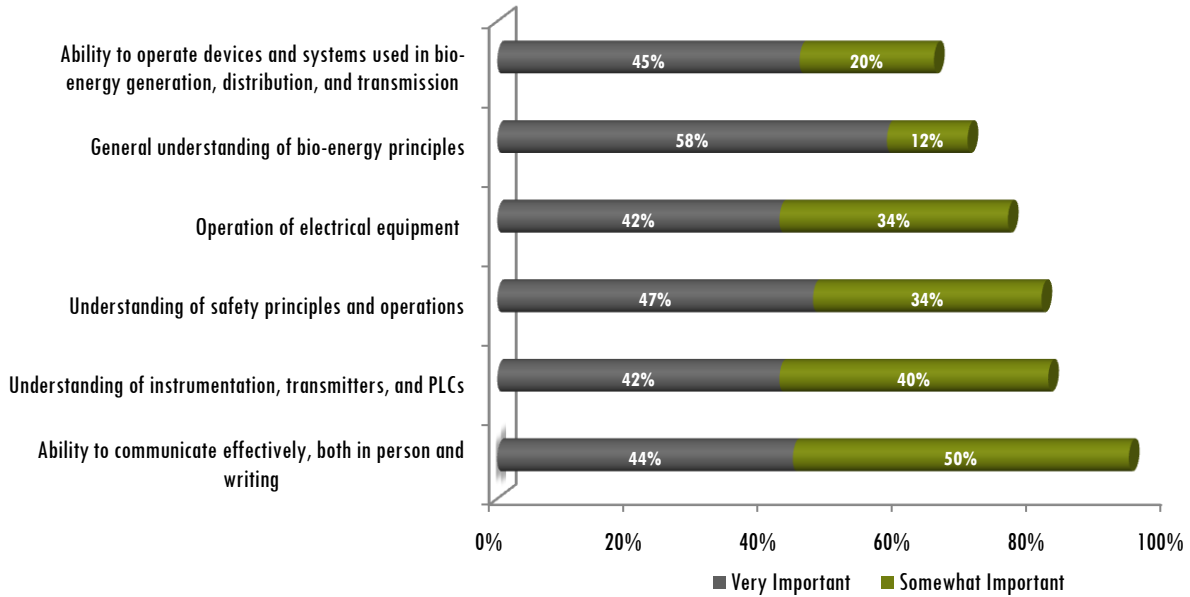
Figure 6: Bio-Energy Engineering Technician Skill and Knowledge Requirements



Important skill and knowledge requirements for bio-engineering technicians are similar to biomass plant technicians. 89% of employers identified the ability to communicate effectively as an important skill requirement; however, only 42% or less felt the technical skills were less important. During employer interviews, several employers did indicate that they were not aware of any engineering technician

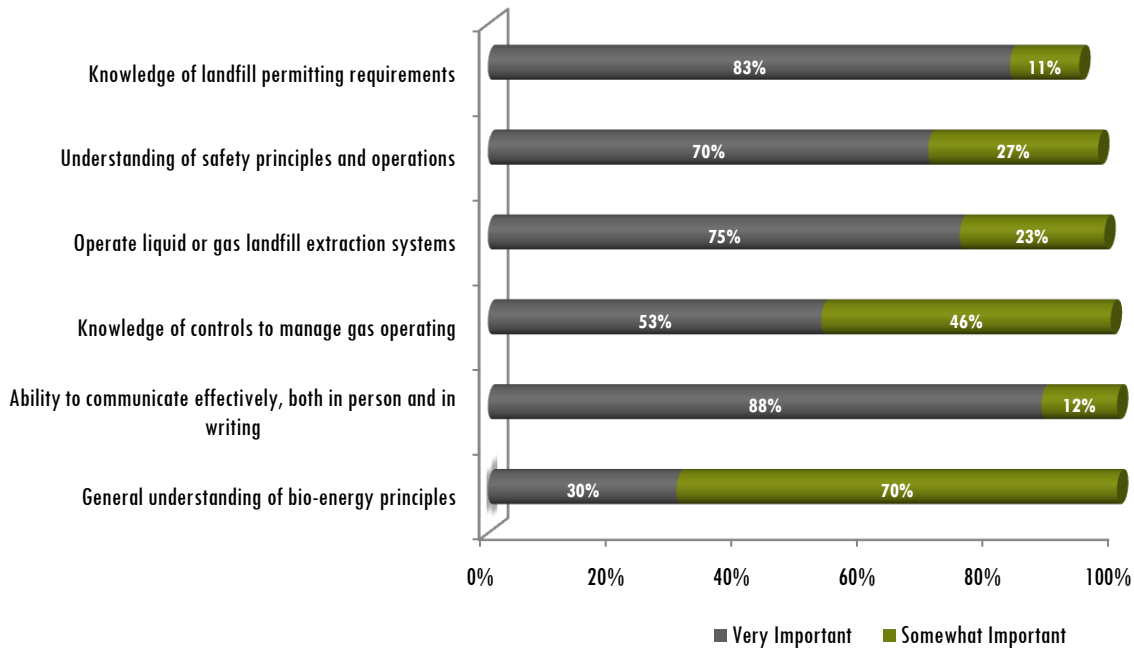
programs specifically for bio-energy sectors and would be very interested in hiring for those positions if trained workers were available.

Figure 7: Bio-Energy Instrument and Controls Technician Skill and Knowledge Requirements



The most important identified knowledge and skill requirement for bio-energy instrument and controls technicians and operators is communication skills, with 94% of employers identifying this skill. Additionally, employers indicate an understanding of instrumentation, transmitters, and PLC's and an understanding of safety principles and operations is important (81% and 82%, respectively).

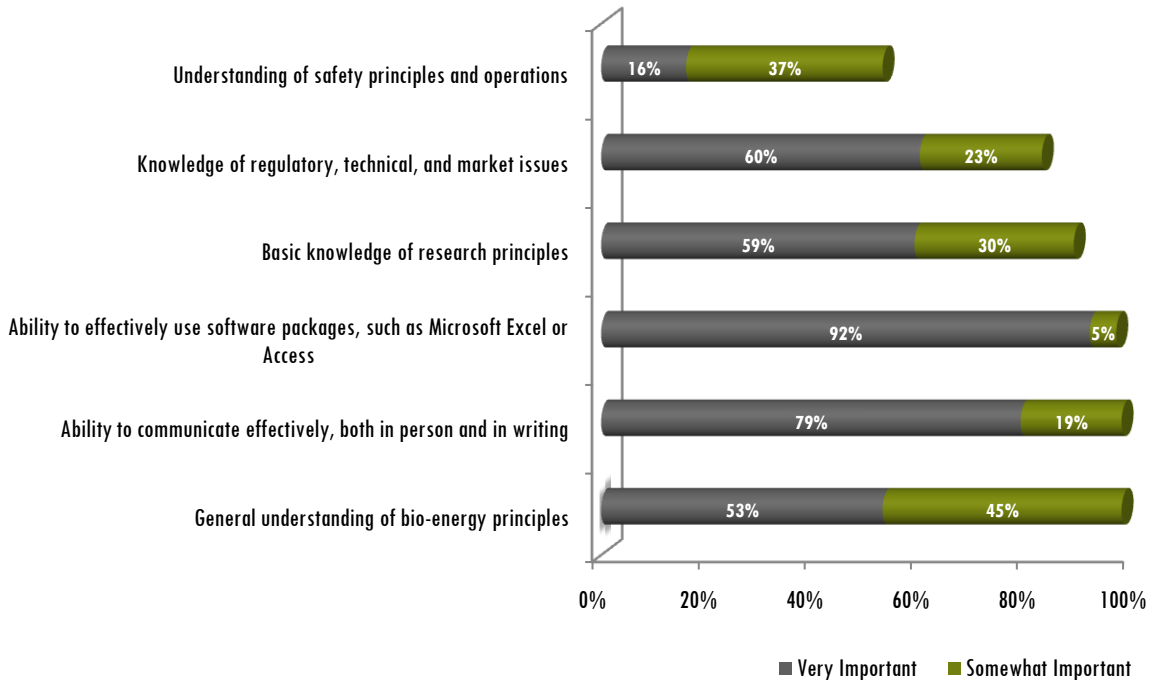
Figure 8: Methane/Landfill Gas Collection System Technician Skill and Knowledge Requirements



Employers of methane/landfill gas technicians indicate that all the identified skill and knowledge requirements had a high level of importance. One hundred percent of employers identified a general

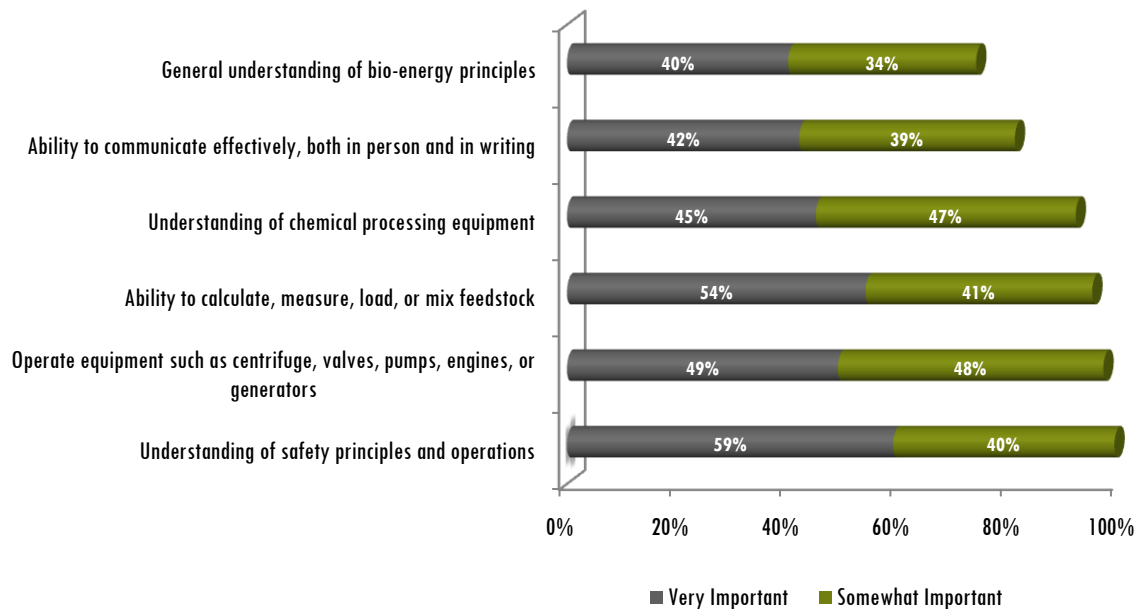
understanding of bio-energy principles and the ability to communicate in person and in writing as important.

Figure 9: Bio-Energy Research Assistant/Analyst Skill and Knowledge Requirements



Ninety-eight percent of employers indicate a general understanding of bio-energy principles and the ability to communicate effectively are the most important knowledge and skill requirements for bio-energy research assistants. Additionally, employers identified an ability to use software platforms, knowledge of research principles, and an understanding of regulatory and market issues as significantly important.

Figure 10: Biofuels Processing Technician Skill and Knowledge Requirements

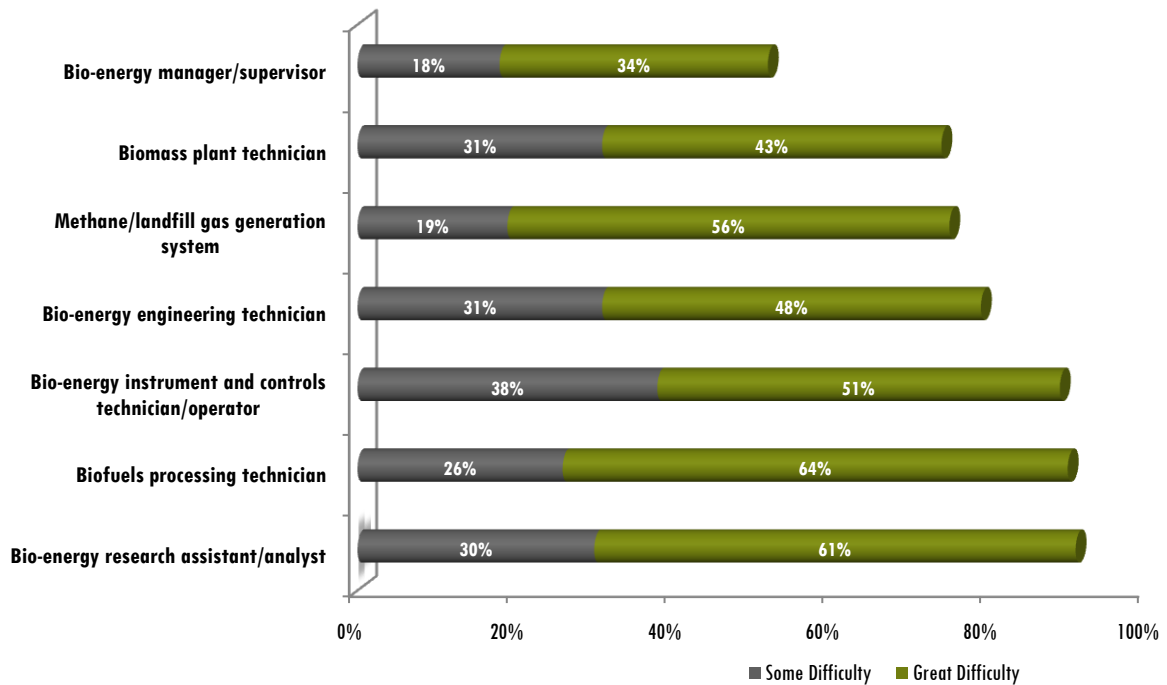


Employers identified an understanding of safety principles and operations as the most important knowledge and skill requirement for biofuels processing technicians (99%). With the exception of an understanding of bio-energy principles (only 74% identified), employers indicate all the identified knowledge and skill requirements are important for biofuels processing technicians.

Employer Needs and Challenges

Bio-energy employers in California indicate a high level of difficulty attracting trained and experienced personnel. The level of difficulty creates a challenge for employers to hire replacement positions as well as any new jobs that may develop.

Figure 11: Difficulty Hiring for Each Occupation

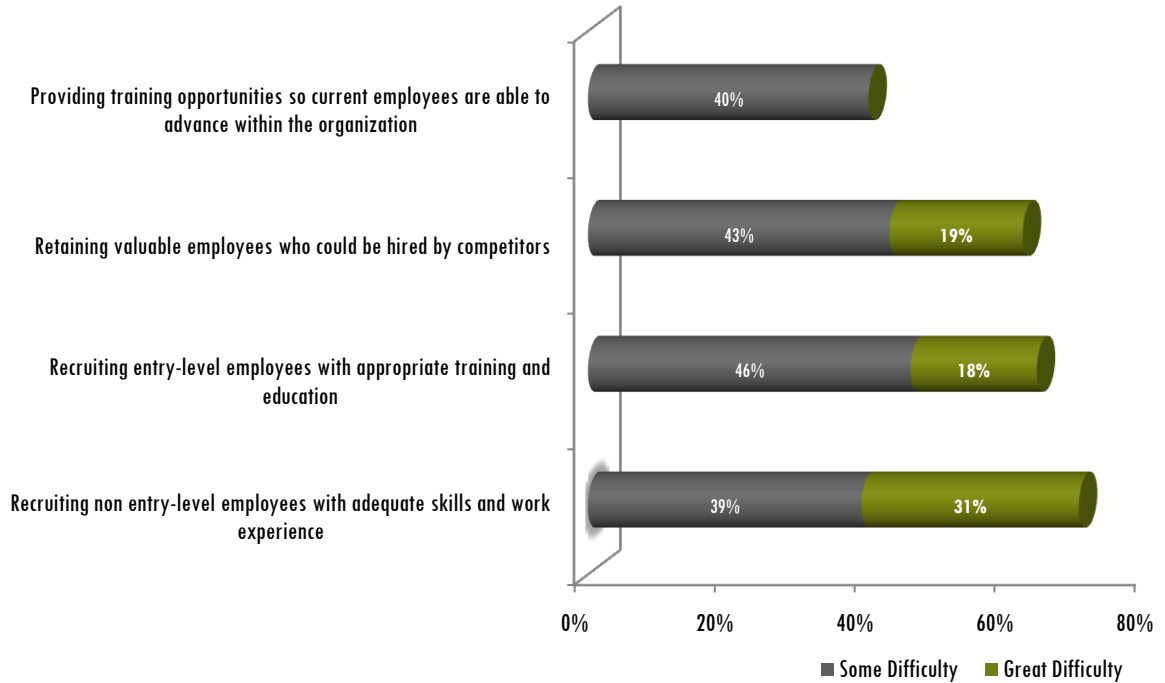


The majority of employers report difficulty hiring for all seven occupations as shown in Figure 11 above. The level of difficulty finding qualified applicants increases the overall demand for these positions and could support the need for quality training programs. In particular:

- 91% of employers reported difficulty finding qualified bio-energy research assistants/analysts;
- 40% of employers experience great difficulty finding bio-energy instrument and controls technicians/operators;
- more than half of employers have some degree of difficulty hiring for any of the occupations researched in this report.

In the bio-energy sector, the relationship between difficulty in hiring and projected growth for each of the eight occupations is noteworthy. For example, bio-energy research assistants/analysts are the occupation with the highest projected growth rate (150%), with 91% of employers also reporting difficulty in hiring for the position. Biofuels processing technicians are the largest occupation identified (875 jobs), with 90% of employers reporting difficulty hiring for the position. Additionally, employers indicate the two biggest workforce challenges are recruiting entry level employees with appropriate training and education (64% difficulty) and recruiting non entry-level employees with adequate skills and work experience (70% difficulty). Figure 12 below highlights employer-identified workforce challenges in the bio-energy sector.

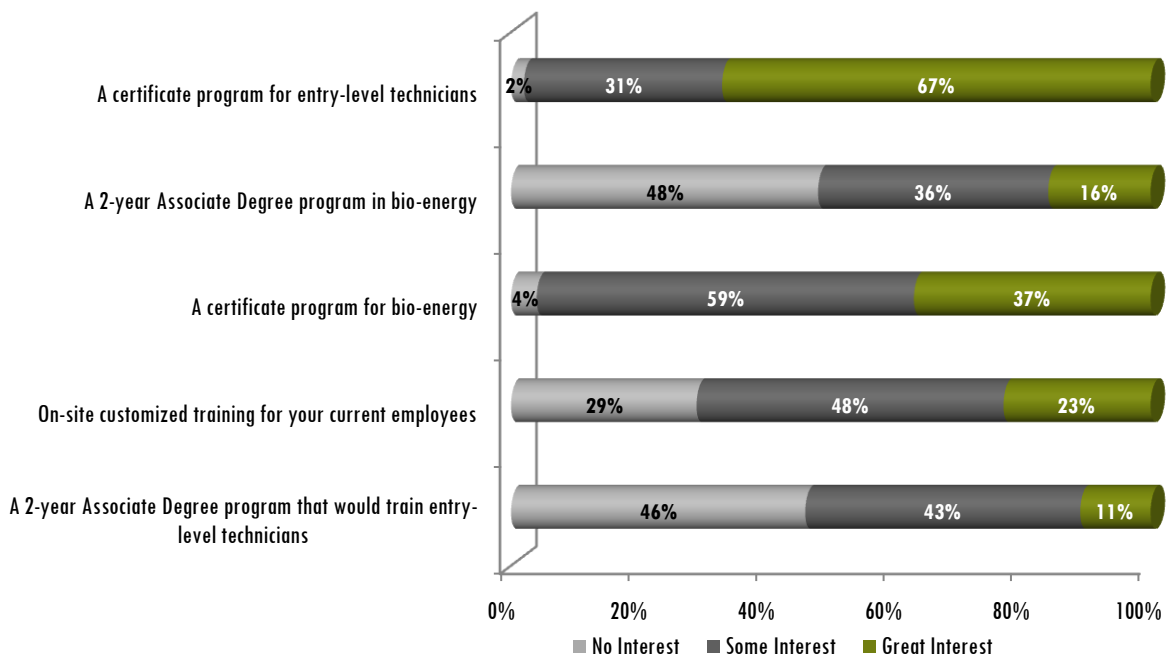
Figure 12: Employer Challenges



Education and Experience Preferences

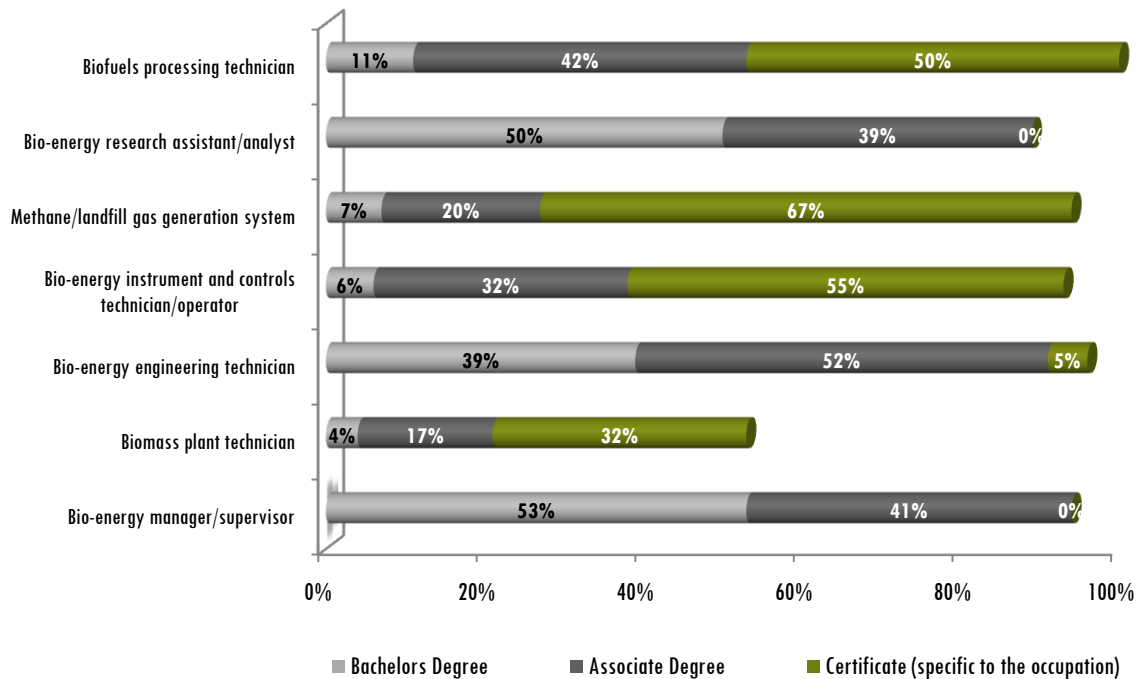
When asked to describe their organizations level of interest regarding educational and training programs that could be developed by community colleges for the bio-energy workforce, the majority of responses indicated some or great interest in certificate programs for entry-level technicians and a certificate program for bio-energy. The majority of respondents and current job listings do not indicate a strong desire for a 2-year Associate’s degree. Employers did express the need for the potential employee to have on-the-job experience or the desire to provide on-site customized training.

Figure 13: Employer Education and Experience Preferences



When potential bio-energy employers were asked to list the preferred educational level by occupation, the following occupations were listed as primarily needing a certificate or Associates Degree: biofuels processing technicians, methane/landfill gas generation system, bio-energy instrument and controls technician/operator, and biomass plant technicians. At least half of the employers surveyed prefer a Bachelor’s Degree for bio-energy research assistant/analyst and bio-energy manager/supervisor.

Figure 14: Preferred Education Level for Bio-Energy Occupations



Potential for Bio-Energy Training

Only college programs or courses related to the seven bio-energy occupations studied in this scan are included in this section. Programs that do not prepare students for the occupations, or programs that are transfer oriented, were not included.

Bio-energy is a newly emerging sector and as a result specific training programs (certificate or AA/AS) have not been developed. A review of the California Community College Chancellor’s Office (CCCCO) Inventory of Approved Programs was conducted to identify any existing programs with the potential to train an emerging bio-energy workforce.



The CCCCCO’s Inventory of Approved Programs does not currently contain for-credit programs identified as or associated specifically with bio-energy. The eleven programs listed in the table below are existing programs in the CCCCCO’s Inventory of Programs with the most potential to train workers in the identified bio-energy occupations, based on the Taxonomy of Programs (TOP) and their related codes. The number of programs within each college region is also identified. Appendix D contains a list of the specific colleges within each region that currently offer the programs identified in this report.

Table 4: Potential Community College Programs Related to Bio-energy Occupations with TOP Code

Top Code	Program Title	Program Description ⁹	Number of Programs by Region		
0101.00	Agriculture Technology and Sciences, General	Economic and business principles used in the organization, operation, and management of farm and agriculture businesses.	Far North- 3 North- 2 Central- 5 Total - 14	Los Angeles- 1 Inland Empire- 1 Silicon Valley- 1	San Diego/Imperial- 1
0115.00	Natural Resources	Theories, principles, laws, and regulations, and the application of skills to the use, management, and conservation of renewable natural resources, including wildlife and fisheries.	Far North- 4 North- 1 Central- 3 Total – 12	Los Angeles- 1 Silicon Valley- 1 Inland Empire- 1	South Central Coast- 1
0199.00	Other Agriculture and Natural Resources	Emerging technologies not included in all other Agriculture Technology and Sciences or Natural Resources TOP Codes.	South Central Coast-1 Total – 1		
0302.00	Environmental Studies	Study of environment-related issues, including policy and legislation, social, legal, and economic aspects, and scientific principles of the ecosystem and environmental conservation.	Far North- 1 North- 3 Silicon Valley- 2 Total – 9	Los Angeles- 1 Orange- 1 South Central Coast- 1	
0303.00	Environmental Technology	Environmental management, monitoring, assessment, and restoration, including environmental pollution control system and the management of hazardous materials and hazardous waste, and related government regulations.	Central- 2 Los Angeles- 2 Orange- 2 Total - 11	San Diego/Imperial- 2 South Central Coast- 2	San Francisco Bay- 2
0946.10	Energy Systems Technology	Theory and methods of energy conservation applied to heating, cooling, and related systems, including the measurement and assessment of energy consumption, diagnosis and prescription. Includes alternative energy systems.	Far North- 1 Los Angeles- 1 Total – 3	San Francisco Bay- 1	
0948.40	Alternative Fuels and Advanced Transportation Technology	Conversion to, installation of, and maintenance of electric vehicles, liquefied petroleum gas, compressed natural gas, hybrid fuel technologies, and related systems.	Los Angeles- 1 Total – 1		
0953.00	Drafting Technology	Planning, preparation, and interpretation of various engineering sketches for design and drafting duties, for circuits, machines, structures, weldments, or architectural plans. Includes the application of advanced computer software and hardware (Computer Assisted Drafting and Computer Assisted Design) to the creation of graphic representation.	Far North- 2 North- 2 Central- 9 Orange- 7 Total-46	Los Angeles- 9 Inland Empire- 4 San Francisco Bay- 3 Silicon Valley- 3	San Diego/Imperial- 4 South Central Coast- 3
0955.00	Laboratory Science Technology	Practical analytical applications of inorganic chemistry, organic chemistry biochemistry, and other physical and biological sciences in laboratory, testing, and quality control settings in industry and science.	Central- 2 Los Angeles- 2 Orange- 2 Total-10	San Diego/Imperial- 2 San Francisco Bay- 1 Silicon Valley- 1	
0956.00	Manufacturing and Industrial Technology	Engineering principles and technical skills for the manufacture of products and related industrial processes. Includes shaping and forming operations, materials handling, instrumentation and controls, and quality control. Includes Computer Aided Manufacturing and robotics. Also includes optimization theory, industrial and manufacturing planning, and related management skills.	Far North- 1 North- 1 Central- 4 Total-20	South Central Coast- 1 Los Angeles- 4 Silicon Valley- 2 Orange- 2	Inland Empire- 2 San Francisco Bay- 1
0999.00	Other Engineering and Industrial Technologies	Emerging technologies not included in all other Engineering and Industrial Technologies.	Central- 1 Los Angeles- 1 Total-5	Orange- 3	

⁹ Program descriptions for each program taken from the California Community Colleges TOP Codes, 6th Edition

Table 5 below lists the eight bio-energy occupations and matches them to existing training programs that could be potentially used to train for the identified occupation based on job descriptions, required education and training, and employer demanded knowledge, skills, and abilities. The programs could be modified with additional curriculum to meet the requirements of bio-energy occupations.

Table 5: Emerging Bio-Energy Occupations and Potential Training Programs

Occupation	Potential Training Program
Bio-energy Manager/Supervisor	Alternative Fuels and Advanced Transportation Technology; Drafting Technology; Manufacturing and Industrial Technology; Natural Resources; Other Engineering and Industrial Technologies
Biomass Plant Technician	Alternative Fuels and Advanced Transportation Technology; Drafting Technology; Environmental Technology; Manufacturing and Industrial Technology; Other Engineering and Industrial Technologies
Bio-energy Engineering Technician	Alternative Fuels and Advanced Transportation Technology; Drafting Technology; Environmental Technology; Manufacturing and Industrial Technology; Other Engineering and Industrial Technologies
Bio-energy Instrument & Controls Technician/Operator	Energy Systems Technology; Drafting Technology; Environmental Technology; Manufacturing and Industrial Technology; Other Engineering and Industrial Technologies
Methane/Landfill Gas Collection System Operators/Technicians	Agriculture Technology and Sciences, General; Alternative Fuels and Advanced Transportation Technology; Environmental Technology; Manufacturing and Industrial Technology; Other Engineering and Industrial Technologies
Bio-energy Research Assistant/Analyst	Environmental Studies; Laboratory Science Technology; Other Engineering and Industrial Technologies
Biofuels Processing Technician	Alternative Fuels and Advanced Transportation Technology; Environmental Technology; Drafting Technology; Manufacturing and Industrial Technology; Natural Resources; Other Engineering and Industrial Technologies

College Program Example

Biomass Operations Certificate, Des Moines Community College

The Biomass Operations Technology certificate is designed to train individuals to become operators in a biomass production facility. At the completion of the program, the students should be able to understand the basic operation of a biomass plant, as well as the chemical flow, instrumentation, environmental and safety issues, lab sampling techniques and other complex plant operations. The Biomass Operations Technology program is part of the college's Industrial Electro-mechanical Technology Program.

Course outline¹⁰

Course #	Course Name	Credits
BPT 102	Intro to Biomass Process Tech	2
BPT 111	Biomass Equipment and Systems	3
BPT 112	Biomass Tech Health/Safety	3
BPT 125	Piping and Instrument Diagrams	2
BPT 128	Operator Biomass Lab Process	3
RRO 101	Railcar Safety	2
BMA 167	Steam Plant Operations	2
Total credits required to complete this certificate		17

¹⁰ Source: <https://go.dmac.edu/programs/iemt/Pages/biomasscert.aspx>

Community Support and Resources

There are opportunities for California Community Colleges to receive support or resource contributions with industry and community organizations to meet workforce needs of employers who hire bio-energy workers. Because bio-energy is an emerging industry impacted by state and national policies and initiatives, most of the support and resources are in the form of available information and reports. The following table summarizes potential support or resource contribution from six state and four national organizations that can be leveraged if community college's in California are planning to develop bio-energy training programs.

Table 6: Community Resources

Organization	Service Area	Support or Resource Contribution
Advanced Transportation Technology and Energy Initiative (ATTE), California Community Colleges www.attecolleges.org	Statewide	Provide students, technicians, faculty, public and other initiative centers with the education, training and resources they need to effectively learn, teach and work with advanced transportation
Bio-energy Feedstock Information Network www.bioenergy.ornl.gov	Nationwide	Maintains and distributes information from resources such as the US Department of Energy, Oak Ridge National Laboratory, Idaho National Laboratory, and the National Renewable Energy Laboratory.
Biomass Energy Research Association (BERA) www.bera1.org	Nationwide	Association that warehouses information pertaining to biomass energy, biomass plants, renewable energy, environmental issues, energy conservation, as well as other green information.
California Air Resources Board www.arc.ca.gov	Statewide	Part of the California Environmental Protection Agency and can be utilized for purposes pertaining to air quality and pollution standards and practices.
California Energy Commission www.energy.ca.gov	Statewide	The California Energy Commission can be utilized for information pertaining to its responsibilities such as: licensing thermal power plants 50 megawatts or higher, setting and enforcing the state's appliance and building efficiency standards, researching, developing, and demonstrating programs, providing market support to existing, new, and emerging renewable technologies, providing incentives, and reducing the states petroleum dependency by developing and implementing the state's Alternative and Renewable Fuel and Vehicle Technology Program.
California Public Utilities Commission (CPUC) www.cpuc.gov	Statewide	Regulates privately owned electric, natural gas, telecommunications, water, railroad, rail transit, and passenger transportation companies. CPUC also regulates utility services and can be used for information related to initiatives and policies.
U.S Department of Energy-EERE Biomass Program www.eere.energy.gov	Nationwide	Works with industry, educational proponents, and national laboratory partners on a balanced portfolio of research in biomass feedstocks and conversion technologies.
Environmental Training Centers, California Community Colleges www.EnvTraining.org	Statewide (Economic & Workforce Development Program)	Technical assistance, curriculum development, training on energy auditing, regulatory compliance, and energy management/conservation
Renewable Energy Policies Project (REPP) www.repp.org	Nationwide	Conducts research and writes reports on green industry such as renewable energy manufacturing. In 2006, REPP conducted a Renewable Energy Manufacturing Industry Report for California. This report shows how a national renewable energy development would potentially benefit California's economy and is available on via REPP's website. REPP can also provide the location of firms on the county level and can provide a list of statewide active firms.
Workforce Investment Boards (WIBS) www.cwib.ca.gov	Statewide	Access to job seekers, training funds, and employment resources

It is estimated that California has approximately 30 MDT of technically recoverable solid biomass resources each year – enough to power more than 3 million homes or produce enough biofuel to run more than 2 million automobiles at today's efficiencies.

Conclusion

Research conducted for this report indicates a modest increase in employment over the next three years, with a small number of jobs overall within the bio-energy sector. Employers did indicate a level of difficulty hiring qualified workers for the occupations studied.

Although there are community colleges throughout California with programs existing or in development to train in some biofuels occupations (mainly alternative fuel technicians), there are few existing programs for the occupations studied in this report. However, there is an adequate base of existing approved programs throughout California with the potential to incorporate bio-energy into the programs.

According to research results, employers indicate they were most comfortable with community college training for three occupations: (1) biofuels processing technicians, (2) bio-energy instrument and controls technicians and operators, (3) methane/landfill gas generation system technicians and operators. Collectively, these three occupations account for 1,890 jobs in 2010 and are projected to increase by 210 jobs in the next three years. Additionally, nearly 85% of employers reported difficulty hiring for these three occupations.



Recommendations

California Community Colleges are well positioned to build a pipeline of skilled workers, create and expand industry partnerships, and meet existing workforce needs in the bio-energy sector and future needs if they arise. Based on research conducted for this report, the following action steps are recommended to promote the development of the bio-energy sector.

1. Colleges contemplating implementation or development of bio-energy training programs should review the following considerations for program development.

Keeping in mind the limited number of overall jobs within the bio-energy sector, few training programs are needed to meet current and future employment demands. In order for a college to determine if it is reasonable to provide training in this sector, there are three main considerations: A) is the college located in an area where bio-energy is prevalent; B) is there a need for trained workers in the area; C) can the college use existing program to develop bio-energy programs? A further option for colleges to consider is the opportunity for contract education for incumbent workers.

A. Geographic proximity to bio-energy employers

Bio-energy facilities are located in distinct regions of California. Biomass facilities are clustered in 22 counties in with the majority of facilities located in the Central Valley and Far North regions. Methane digesters and ethanol producers are located primarily in the Central Valley, while

biodiesel producers are located in the southern LA and eastern Bay regions. There are 43 landfill gas plants located throughout California, with a majority located in Southern California. Appendix E contains a listing of the distribution of bio-energy facility types by county. The distribution of bio-energy facilities creates an opportunity for colleges in the Far North, Central, and Inland Empire to create partnerships, access faculty for training programs, and address regional labor market demands.

B. Employment need

Individual colleges should assess the employment need in their service area based on employer data in this report and through additional outreach and information gathering from local employers. Colleges should consider the number of jobs in the area, future need, financial resources needed for program development and recruitment of faculty to teach classes for bio-energy occupations.

C. Leverage existing programs

If a college can confidently substantiate a need for training within the bio-energy sector, then consideration should be given to whether any existing programs can be leveraged in establishing a bio-energy related training program. By tapping existing program infrastructure in both curriculum and technology, colleges can greatly reduce start-up expenses and the time to delivery. Additionally, colleges may consider using a short term program to meet existing employer needs that can be discontinued or suspended if needed.

2. Monitor state and federal policy and legislation that may support the growth and development of the bio-energy sector in California.

The future growth of the bio-energy workforce is largely contingent upon support from policy and legislation in the forms of financial incentives, tax credits, and regulations supporting the industry. If this type of support occurs, the bio-energy sector could see a rapid growth and the need for a qualified workforce would also grow. Colleges can monitor these policy development as well as build partnerships with local employers to remain poised for response should there be an increased need for trained workers in the sector.

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Appendix A: How to Use this Report

This report is designed to provide current industry data to:

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

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

About the Centers of Excellence

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

The Centers of Excellence Initiative is funded in part by the Chancellor’s Office, California Community Colleges, Economic and Workforce Development Program. The total grant amount represents funding for multiple projects and written reports through the Central Region 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.

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: California's Key Legislative and Policy Initiatives

Bio-energy, as an industry, is heavily impacted by legislation and policies pertaining to renewable industry and other green issues both at the state and national level. Some of the state legislation that may impact bio-energy includes:

- AB 32: The Global Warming Solutions Act of 2006- this legislation mandates the state of California to reduce its greenhouse gas emissions back below 1990 levels by 2020.
- AB 118: Low Carbon Transportation and Energy Efficiency- this measure will generate more than \$100 million in funding for new technologies, vehicles, and fuels that reduce greenhouse gas emissions. Approximately half the funding for AB 118 would go toward incentives for putting significantly lower carbon fuels and vehicles on the road. The other half would be allocated for the development of the next generation of clean and energy efficient transportation technologies such as renewable and low carbon fuels, electronic, hybrid, and fuel cell technology.
- AB 1007: California's Renewable Portfolio Standard (RPS)- this measure has been called one of the most ambitious renewable energy standards in the country. The RPS program requires investor-owned utilities, electric-service providers, and community choice aggregators to increase procurement from eligible renewable energy resources by at least 1% of their retail sales annually, until they reach 20% by 2010 and 30% by 2020 and that includes landfill gas, municipal solid waste, anaerobic digestion, and biodiesel.

One piece of legislation responsible for initiating interest in the bio-energy movement was AB 939-*The Integrated Waste Management Act (IWMA)*. IWMA was designed to implement source reduction, recycling and composting, and environmentally safe transportation and land disposal (meaning the diversion of solid waste from landfill or transformation facilities). AB 939 is an example of the vital role local, state, and national policy and legislation plays in the bio-energy sector. Once AB 939 was implemented, compliance became mandatory and organizations were forced to respond.¹¹ An explanation of AB 939 is provided below.

- AB 939: *The Integrated Waste Management Act*--Established the "California Integrated Waste Management Act (IWMA) of 1989." Repealed the majority of Title 7.3 of the Government Code, regulating solid waste management, and codified the new Act in the Public Resources Code. Also repealed provisions of the Health and Safety Code, related to garbage and refuse disposal, and codified them in the Public Resources Code. Established an integrated waste management hierarchy to guide the Board and local agencies in implementation, in order of priority: (1) source reduction, (2) recycling and composting, and (3) environmentally safe transformation and land disposal. Included the following major provisions:
 - *California Integrated Waste Management Board*--Replaced the part-time Solid Waste Management Board with a six-member California Integrated Waste Management Board (CIWMB). Required the new Board to include: one member appointed by the Governor with private sector experience in the solid waste industry; one member appointed by the Governor who has served as an elected or appointed official of a non-profit environmental protection organization, whose principle purpose is to promote recycling and the protection of air and water quality; two members appointed by the Governor who shall represent the public; one member appointed by the Senate Committee on Rules who shall represent the public; and one member appointed by the Speaker of the Assembly who shall represent the public.

¹¹ Explanation of AB 939 and AB 9389 were taken from the *California Protection Agency* website: <http://www.calepa.ca.gov>

- *Integrated Waste Management Planning*--Replaced the County Solid Waste Management Plan (CoSWMP) with an Integrated Waste Management Plan (IWMP). Required each county to establish a task force to coordinate the development of city Source Reduction and Recycling Elements (SRREs) and a countywide siting element . Required each city, by 7/1/91, to prepare, adopt and submit a SRRE to the county which includes the following components: waste characterization; source reduction; recycling; composting; solid waste facility capacity; education and public information; funding; special waste (asbestos, sewage sludge, etc.); and household hazardous waste. Also required each county, by 1/1/91, to prepare a SRRE for its unincorporated area, with the same components described above, and a countywide siting element, specifying areas for transformation or disposal sites to provide capacity for solid waste generated in the jurisdiction which cannot be reduced or recycled for a 15 year period. Required each county to prepare, adopt, and submit to the Board an Integrated Waste Management Plan (IWMP), which includes all of the elements described above, according to the following schedule: by 1/1/92 for counties with less than 5 years landfill capacity; by 1/1/93 for counties with 5 to 8 years landfill capacity; by 1/1/94 for counties with more than 8 years landfill capacity.
- *Waste Diversion Mandates*--Required each city or county plan to include an implementation schedule which shows: diversion of 25 percent of all solid waste from landfill or transformation facilities by January 1, 1995 through source reduction, recycling, and composting activities; and, diversion of 50 percent of all solid waste by January 1, 2000 through source reduction, recycling, and composting activities. Excluded agricultural wastes, inert wastes and other wastes not normally disposed of at landfills. Authorized any plan submitted after 1/1/95 to include up to 10 percent transformation in achieving its 50 percent diversion goal, provided front-end removal of recyclable materials and other specified conditions are met. Authorized the Board to exempt a city or county from these goals or to reduce the requirements if the city or county demonstrates that attainment of the goals is not feasible due to the small geographic size of the jurisdiction and the small quantity of waste generated. Authorized the Board to establish an alternative goal to the 50 percent requirement, after 1/1/95, if the Board finds that the local agency is effectively implementing all source reduction, recycling, and composting measures to the maximum extent feasible. Also authorized the Board to reduce the goals for any city or county which, prior to 1/1/89, disposed of 75 percent or more of its solid waste by transformation, provided that attainment of the 25 percent or 50 percent waste diversion goals would impair existing contracts, or would interfere with repayment of debt incurred to finance a transformation project.
- *Board Review of IWMPs and Plan Implementation*--Required the Board to approve or disapprove a city element or a county plan within 120 days of receipt. Required the Board to issue a notice of deficiency with specific recommendations for corrections, if an element or plan is disapproved, providing 120 days in which the city or county must correct the document and resubmit it to the Board. Required the Board to conduct a public hearing on any element or plan which still fails to meet the requirements after the revision, and authorized the Board to impose administrative civil penalties of up to \$10,000 per day for failure to submit an adequate plan. Also required the Board to review the implementation of each SRRE at least once every two years. Authorized the Board, if it finds, after a public hearing, that the city or county has failed to implement its element, to issue an order of compliance with a specific schedule. Also authorized the Board to impose administrative civil penalties of up to \$10,000 per day for continued failure to comply. Required each city to review its element and each county its plan at least once every five years to correct deficiencies, comply with the waste diversion requirements, and revise documents as necessary.

- *Permitting and Enforcement*--Established a comprehensive statewide system of permitting, inspections, enforcement, and maintenance for solid waste facilities. Required the Board to adopt minimum standards for solid waste handling and disposal to protect air, water, and land from pollution. Required the Board, by 1/1/94, to establish minimum standards requiring operators of solid waste facilities to provide assurance of financial ability to respond to possible damage claims. Required the Board, by 8/1/91, to prepare and adopt certification regulations specifying requirements that a local agency shall meet before being designated as a Local Enforcement Agency (LEA). Required the Board, in conjunction with an inspection conducted by an LEA, to conduct at least one inspection per year of each solid waste facility in the state.
- *Financing*--Authorized local jurisdictions to impose fees based on the types or amounts of solid waste generated to be used to pay actual costs incurred in preparing, adopting and implementing integrated waste management plans, as well as in setting and collecting the local fees. Also provided that state planning, implementation and operating costs be funded by a fee collected by every operator of a solid waste landfill and paid quarterly to the Board of Equalization, based on all solid waste disposed of at each disposal site, after 1/1/90. Set the fee initially at 50 cents per ton through 6/30/90; at an amount sufficient to generate the 1990-91 funding, but not to exceed 75 cents per ton from 7/1/90 through 6/30/91; and, from 7/1/91, at an amount sufficient to generate funding for each fiscal year, but not to exceed one dollar per ton. (*Chapter 1095*)

Another piece of legislation responsible for past growth of the bio-energy sector is AB 3989. An explanation of AB 3989 is provided below:

- **AB 3989: Resource Recovery Projects /Waste-to-Energy**-Required an LEA, prior to the issuance of a permit for a project which burns municipal solid waste or refuse-derived fuel, to require the project applicant to consider in its contracts, or other commitments for municipal solid waste, methods to remove recyclable materials prior to incineration.
AB 3989 prohibited an air district from issuing or renewing a permit for the construction of, renewing a permit for the operation of, or issuing a determination of compliance for, a project which burns municipal waste or refuse-derived fuel unless the project will not prevent or interfere with the attainment or maintenance of state and federal ambient air quality standards, will comply with applicable emission limitations and toxic air control measures of the district, the district performs health risk assessment and submits it for review to the ARB and the Department of Health Services, and determines that no significant increase in illness or mortality is anticipated as a result of air pollution from the project, and periodic monitoring of emission is performed. Exempted any project which exclusively burns digester gas produced exclusively from manure or other animal solid or semisolid waste, or methane gas from a disposal site, or forest, agricultural, wood, or other biomass products. Required resource recovery projects to complete an EIR. Also required the State Energy Resources Conservation and Development Commission to include in its written decision approving any waste-to-energy technology site and related facility, specific condition requirements that the facility be monitored to ensure compliance with state and federal ambient air quality standards, compliance with emission limitations, and toxic air control measures of the district and periodic monitoring for compliance.

Appendix C: Occupational Profiles

Occupation: Bio-energy Manager/Supervisor

Bio-energy managers or supervisors manage operations at biofuels power generation facilities; they collect and process information on plant performance, diagnose problems, and design corrective procedures. The following describes in detail some of the specific tasks that may be required of bio-energy managers or supervisors¹²:

- Manage operations at biofuels power generation facilities, including production, shipping, maintenance, or quality assurance activities.
- Adjust temperature, pressure, vacuum, level, flow rate, or transfer of biofuels to maintain processes at required levels.
- Approve proposals for the acquisition, replacement, or repair of biofuels processing equipment or the implementation of new production processes.
- Conduct cost, material, and efficiency studies for biofuels production plants or operations.
- Monitor meters, flow gauges, or other real-time data to ensure proper operation of biofuels production equipment, implementing corrective measures as needed.
- Prepare and manage biofuels plant or unit budgets.
- Review logs, datasheets, or reports to ensure adequate production levels or to identify abnormalities with biofuels production equipment or processes.
- Shut down and restart biofuels plant or equipment in emergency situations or for equipment maintenance, repairs, or replacements.
- Supervise production employees in the manufacturing of biofuels, such as biodiesel or ethanol.
- Confer with technical and supervisory personnel to report or resolve conditions affecting biofuels plant safety, operational efficiency, and product quality.
- Draw samples of biofuels products or secondary by-products for quality control testing.
- Monitor transportation and storage of flammable or other potentially dangerous feedstocks or products to ensure adherence to safety guidelines.
- Provide direction to employees to ensure compliance with biofuels plant safety, environmental, or operational standards and regulations.
- Provide training to subordinate or new employees to improve biofuels plant safety or increase the production of biofuels.

Occupational Wage and Employment Trends: Bio-energy managers/supervisors are usually part of the manufacturing industry (80% employed in this sector) and in 2009 this occupation had a national median wage of \$40.90 hourly, \$85,080 annually. The median hourly wage in 2009 for California was \$43.47 hourly and \$90,400 annually. In 2008 there were 156,000 bio-energy managers/supervisors nationally. The national projected growth over the next eight years is between **-3% to -9%**, which is a loss of approximately 54,700 jobs.

Education and Training: The most common educational or training level for bio-energy managers/supervisors is work experience in a related occupation.

Required Knowledge, Skills, and Abilities:

Knowledge	Skills	Abilities
Production and processing	Coordination	Problem sensitivity
Mechanical	Critical thinking	Deductive reasoning

¹² O*Net OnLine, "Details Report for: 11-3051.03- Biofuels Production Managers"

Mathematics	Monitoring	Oral comprehension
Administration and management	Management of personnel resources	Oral expression
Education and training	Time management	Speech clarity

Other Job Titles Associated with Bio-Energy Managers/Supervisors:

- Biofuels Production Managers
- Biomass Production Managers
- Geothermal Production Managers
- Hydroelectric Production Managers
- Industrial Production Managers
- Quality Control Systems Managers

Occupation: Biomass Plant Technicians

Biomass plant technicians control and monitor biomass plant activities and perform maintenance as needed. The following describes in detail some of the specific tasks that may be required of biomass plant technicians¹³:

- Measure and monitor raw biomass feedstock, including wood, waste, or refuse materials.
- Operate valves, pumps, engines, or generators to control and adjust production of biofuels or biomass-fueled power.
- Perform routine maintenance or make minor repairs to mechanical, electrical, or electronic-equipment in biomass plants.
- Assess quality of biomass feedstock.
- Calculate, measure, load, or mix biomass feedstock for power generation.
- Calibrate liquid flow devices or meters, including fuel, chemical, and water meters.
- Inspect biomass power plant or processing equipment, recording or reporting damage and mechanical problems.
- Operate biomass fuel-burning boiler or biomass fuel gasification system equipment in accordance with specifications or instructions.
- Operate equipment to heat biomass, using knowledge of controls, combustion, and firing mechanisms.
- Operate equipment to start, stop, or regulate biomass-fueled generators, generator units, boilers, engines, or auxiliary systems.
- Operate high-pressure steam boiler or water chiller equipment for electrical cogeneration operations.
- Preprocess feedstock to prepare for biochemical or thermochemical production processes.
- Record or report operational data such as readings on meters, instruments, and gauges.
- Clean work areas to ensure compliance with safety regulations.
- Manage parts and supply inventories for biomass plants.
- Read and interpret instruction manuals or technical drawings related to biomass-fueled power or biofuels production equipment or processes.

Occupational Wage and Employment Trends: Biomass plant technicians are primarily found in three sectors: manufacturing (29% employed in this sector), government (26% employed in this sector), and utilities (14% employed in this sector). The national median in 2009 wage was \$23.92 hourly and \$49,760 annually; in California the 2009 median wage was \$27.93 hourly and \$58,100 annually. In

¹³ O*Net OnLine, "Details Report for: 51-8099.03-Biomass Plant Technicians"

2008, there were 13,000 jobs in the biomass plant technician occupation, and in the next ten years there is an expected national **decline** of **3%-9%**.

Education and Training: The most commonly required education and training for a biomass plant technician is long-term on-the-job training.

Required Knowledge, Skills, and Abilities:

Knowledge	Skills	Abilities
Mechanical control system	Written communication	Perceive and analyze problems
Electrical control system	Verbal communication	Work effectively with others
Instrument control system	Basic computer skills	Maintain organization

Other Job Titles Associated with Biomass Plant Technicians:

- Biofuels Processing Technicians
- Hydroelectric Plant Technicians
- Methane/Landfill Gas Generation System Technicians¹⁴

Occupation: Bio-energy Engineering Technician

Bio-energy technicians provide support to research and development groups within the specific employed company and take primary responsibility for the operation and routine maintenance of experimental facilities and equipment. Bio-energy technicians are also responsible for keeping detailed records and maintain a clean and safe working environment while adhering to safety standards. Because bio-energy technicians are a newly emerging occupation, there is very little data available that outlines specific job related responsibilities. Listed below are specific duties outline in an Engineering Technician I job listing with the National Bioenergy Center¹⁵:

- Perform simple routine laboratory tasks.
- Collect, autoclave and dispose of bio-waste (non-hazardous) according to policy.
- Restock laboratory with simple supplies available from the stockroom.
- Conduct work safely and support company policy.
- Provide laboratory assistance or assistance for any other special request when needed.

Occupational Wage and Employment Trends: Environmental engineering technicians are expected to have 30 percent employment growth between 2008 and 2018, much faster than the average for all occupations. More environmental engineering technicians will be needed to comply with environmental regulations and to develop methods of cleaning up existing hazards. A shift in emphasis toward preventing problems rather than controlling those which already exist, as well as increasing public health concerns resulting from population growth, also will spur demand. Median annual wages of wage and salary electrical and electronic engineering technicians were \$53,240 in May 2008. The middle 50 percent earned between \$41,550 and \$64,120. The lowest 10 percent earned less than \$32,490, and the highest 10 percent earned more than \$78,560.

¹⁴ For the purpose of this report, this occupation is listed as a separate occupation.

¹⁵ National Bioenergy Center, Engineering Technician I full-time opening in Golden, CO.

Education and Training:

Required education and experience for bio-energy engineering technicians are relevant Associate's degree or certification program or equivalent relevant education and/or experience.

Required Knowledge, Skills, and Abilities:

Knowledge	Skills	Abilities
Safe work practices	Basic computer skills including Microsoft Office	Function within a matrix organizational structure
Construction	Written communication skills	Multitask
Budgeting	Oral communication skills	Perceive and analyze problems
Mechanical, electrical and instrument control panels	Gas processing and/or gas transportation	
Manufacturing equipment	Landfill gas to energy industry or similar production	

Other Job Titles Associated with Bio-Energy Engineering Technician:

- Engineering Technicians

Occupation: Bio-energy Instrument & Controls Technician/Operator

Because bio-energy instrument & controls technician/operator is a newly emerging occupation, there is very little information available that would allow for an independent occupational profile. For the purpose of this report, information was collected using occupational profiles and job announcements and openings for Operator positions at bio-energy firms across the nation. Bio-energy instrument & controls technicians/operators would typically be responsible for operating the plant and producing quality products while maintaining standard operating procedures. The following list details some of the duties a bio-energy instrument & controls technician/operator may perform on a daily basis:

- Monitor plant operations from a central computer terminal.
- Collect samples and conduct tests and record data.
- Make field adjustments of equipment, perform tank transfers, and all other field operations.
- Respond to alarm conditions with appropriate actions and adjustments.
- Communicate operations status, discrepancies, maintenance requirements and any other issues to a supervisor.
- Record data for operations, work orders, work permits and keep a daily logbook.

Occupational Wage and Employment Trends: Bio-energy instrument & controls technician/operator had a median wage in 2009 of \$29.04 hourly and \$60,400 annually. In 2008, there were 35,000 people employed as bio-energy instrument & controls technicians/operators. Over the next ten years there is little to no projected growth (-2% to 2% change).

Education and Training:

Bio-energy instrument & controls Technician/operator's requires a high school diploma or the equivalent. An Associate's degree in a technical field is preferred.

Required Knowledge, Skills, and Abilities:

Knowledge	Skills	Abilities
Basic chemistry	Troubleshooting	Operate machines and rolling equipment

Basic principles of science	Know how to use distributed control systems and basic statistical process control	
Basic mechanical system operations	Basic computer skills including Microsoft Office	

Other Job Titles Associated with Bio-Energy Instrument & Controls Technician/Operator:

- Operator

Occupation: Methane/Landfill Gas Collection System Operators/Technicians

Methane/landfill gas collection system operators direct daily operations, maintenance, or repair of landfill gas projects, including maintenance of daily logs, determination or service priorities, and compliance with reporting requirements. The following describes in detail some of the specific tasks that may be required of methane/landfill gas collection system operators¹⁶:

- Monitor and control liquid or gas landfill extraction systems.
- Oversee gas collection landfill operations, including leachate and gas management or rail operations.
- Develop or enforce procedures for normal operation, start-up, or shut-down of methane gas collection systems.
- Evaluate landfill gas collection service requirements to meet operational plans and productivity goals.
- Implement landfill operational and emergency procedures.
- Inspect landfill or conduct site audits to ensure adherence to safety and environmental regulations.
- Maintain records for landfill gas collection systems to demonstrate compliance with safety and environmental laws, regulations, or policies.
- Monitor gas collection systems emission data, including biomethane or nitrous oxide levels.
- Monitor landfill permit requirements for updates.
- Operate computerized control panels to manage gas compression operations.
- Optimize gas collection landfill operational costs and productivity consistent with safety and environmental rules and regulations.
- Oversee landfill gas collection system construction, maintenance, and repair activities.
- Prepare and manage landfill gas collection system budgets.
- Prepare soil reports as required by regulatory or permitting agencies.
- Supervise landfill, well field, and other subordinate employees.
- Read meters, gauges, or automatic recording devices at specified intervals to verify gas collection systems operating conditions.
- Coordinate the repair, overhaul, or routine maintenance of diesel engines used in landfill operations.
- Diagnose or troubleshoot gas collection equipment and programmable logic controller (PLC) systems.
- Prepare reports on landfill operations and gas collection system productivity or efficiency.
- Recommend or implement practices to reduce turnaround time for trucks in and out of landfill site.

Occupational Wage and Employment Trends: Methane/Landfill Gas Collection System Operators/Technicians are primarily found in the manufacturing (29% employed), government (26% employed), and utilities (14% employed) sectors. The national wage in 2009 fell between \$23.92-\$40.90 hourly and \$49,800-\$85,100 annually, and in California the average wage fell between \$27.93-\$43.47 hourly and \$58,100- \$90,400 annually. Nationally, this occupation will see a **decline** of **3%-9%** over the next ten years.

¹⁶ O*Net OnLine, “Details Report for: 11-3051.05-Methane/Landfill Gas Collection System Operators”

Education and Training: The most common educational or training level required for Methane/Landfill Gas Collection System Operators/Technicians is work experience in a related occupation.

Required Knowledge, Skills, and Abilities:

Knowledge	Skills	Abilities
Production and processing	Coordination	Problem sensitivity
Mechanical	Critical thinking	Deductive reasoning
Mathematics	Monitoring	Oral comprehension
Administration and management	Management of personnel resources	Oral expression
Education and training	Time management	Speech clarity

Other Job Titles Associated with Methane/Landfill Gas Collection System Operators/Technicians:

- Methane/Landfill Gas Generation System Technician
- Methane/Landfill Gas Generation System Operator
- Industrial Production Managers
- Quality Control Systems Managers

Occupation: Bio-energy Research Assistant/Analyst

Bio-energy research assistant is an emerging occupation with very little current data. For this report, job titles that were reported with bio-energy research assistants were used for compiling data. Agriculture research technologist/technician was the occupation specifically used. The following list describes in detail some of the tasks that may be required of an agriculture research technician¹⁷:

- Receive and prepare laboratory samples for analysis, following proper protocols to ensure that they will be stored, prepared, and disposed of efficiently and effectively.
- Record data pertaining to experimentation and research.
- Prepare data summaries, reports, and analyses that include results, charts, and graphs to document research findings and results.
- Set up laboratory or field equipment, and prepare sites for testing.
- Operate laboratory equipment such as spectrometers, nitrogen determination apparatus, air samples, centrifuges, and potential hydrogen (pH) meters to perform tests.
- Adjust testing equipment, and prepare culture media, following standard procedures.

Occupational Wage and Employment Trends:

Agricultural Technicians (an occupation associated with bio-energy research assistants) had a national median hourly wage of \$16.54 and a national median annual wage of \$34,410. In 2008, there were 22,000 employees in this sector across the United States. The national projected growth over the next eight years for this occupation is between 7%-13% (approximately 9,600 jobs available across the nation).

Education and Training:

Most bio-energy research assistants/analysts require training in vocational schools, related on-the-job experience, or an Associate's degree. This occupation may also require a background in the following: science, technology, engineering, and mathematics (STEM) educational disciplines.

¹⁷ O*Net OnLine, "Details Report for: 19-4011.01-Agriculture Technician"

Required Knowledge, Skills, and Abilities:

Knowledge	Skills	Abilities
Mathematics	Reading comprehension	Near vision
Biology	Critical thinking	Oral comprehension
Computers	Writing	Oral expression
English language	Active listening	Problem sensitivity
	Complex problem solving	Written comprehension
	Coordination	Problem sensitivity
	Speaking	Written comprehension
	Judgment and decision making	Written expression
	Monitoring	Category flexibility
	Active learning	Information ordering
		Deductive reasoning
		Inductive reasoning

Other Job Titles Associated with Bio-Energy Research Assistant/Analyst:

- Research Associate
- Research Assistant
- Seed Analyst
- Agricultural Technician
- Agricultural Research Technician
- Agricultural Research Technologist
- Laboratory Technician
- Research Technician
- Agricultural Laboratory Technician

Occupation: Biofuels Processing Technician

Biofuels processing technicians are responsible for calculating, measuring, loading, mixing, and processing refined feedstock with additives in fermentation or reaction process vessels and monitoring production processes. They are required to perform, and keep records of, plant maintenance, repairs, and safety inspections. The following list highlights some of the daily tasks a biofuels processing technician may be required to perform¹⁸:

- Calculate, measure, load, or mix refined feedstock in biofuels production.
- Operate chemical processing equipment for the production of biofuels.
- Operate equipment, such as centrifuge, to extract biofuels products and secondary by-products or reusable fractions.
- Operate valves, pumps, engines, or generators to control and adjust biofuels production.
- Process refined feedstock with additives in fermentation or reaction process vessels.

¹⁸ O*Net OnLine, "Details Report for: 51-8099.01-Biofuels Processing Technician"

- Assess the quality of biofuels additives for reprocessing.
- Calibrate liquid flow devices and meters including fuel, chemical, and water meters.
- Collect biofuels samples and perform routine laboratory tests or analyses to assess biofuels quality.
- Inspect biofuels plant or processing equipment regularly, recording or reporting damage and mechanical problems.
- Measure and monitor raw biofuels feedstock.

Occupational Wage and Employment Trends: Biofuels processing technicians had a national median hourly wage of \$23.92 and a national median annual wage of \$49,760. In 2008, there were 13,000 employees in this sector across the United States. The national projected decline over the next eight years for this occupation is between -3% to -9%, with a projection of only 2,900 additional jobs available over this time span.

Education and Training:

Biofuels Processing Technicians typically require an Associate’s degree or Certificate. Sometimes long-term on-the-job training can be substituted for education as well as skills transfer from a related field, such as mechanical, electrical, industrial, or manufacturing.

Required Knowledge, Skills, and Abilities:

Knowledge	Skills	Abilities
Complex technical drawings and specifications	Written communication skills	Read and understand complex technical instructions,
	Oral communication skills	Operate computers, including ability to use CMMS, DCS, and HMI software, Microsoft Office and Excel, and inventory control software.
	Ability to use the following tools: samplers or collectors, control valves, distillation pipings or columns or fittings, mixers or agitators, titration equipment.	Work with multiple disciplines

Other Job Titles Associated with Biofuels Processing Technician:

- Processing Technician

Appendix D: Existing Community College Programs

The table below identifies the specific colleges, by region, that currently have the programs identified in Table 4.

Top Code	Program Title	Number of Programs by Region and Specific College
0101.00	Agriculture Technology and Sciences, General	<p>Far North- 3 (Butte College, College of the Redwoods, Shasta College) North- 2 (Sierra College, Yuba College) Silicon Valley- 1 (Santa Rosa Junior College) Central- 5 (Hartnell College, Merced College, San Joaquin Delta College, Reedley College, Modesto Junior College) Los Angeles-1 (Los Angeles Pierce College) Inland Empire- 1 (College of the Desert) San Diego/Imperial- 1 (Imperial Valley College) Total-14</p>
0115.00	Natural Resources	<p>Far North- 4 (Butte College, Mendocino College, Shasta College, College of the Siskiyous) North- 1 (American River College) Silicon Valley- 1 (Santa Rosa Junior College) Central- 3 (Cerro Coso College, San Joaquin Delta College, Columbia College) South Central Coast- 1 (Ventura College) Los Angeles- 1 (Los Angeles Pierce College) Inland Empire- 1 (College of the Desert) Total-12</p>
0199.00	Other Agriculture and Natural Resources	<p>South Central Coast-1 (Cuesta College) Total-1</p>
0302.00	Environmental Studies	<p>Far North- 1 (Feather River College) North- 3 (Cosumnes River College, Sacramento City College, Sierra College) Silicon Valley- 2 (Ohlone College, Santa Rosa Junior College) South Central Coast- 1 (Santa Barbara City College) Los Angeles- 1 (Santa Monica College) Orange- 1 (Saddleback College) Total-9</p>
0303.00	Environmental Technology	<p>San Francisco Bay- 2 (De Anza College, Mission College) Central- 2 (Merced College, Fresno City College) South Central Coast- 2 (Moorpark College, Oxnard College) Los Angeles- 2 (El Camino College, Rio Hondo College) Orange- 1 (Fullerton College) San Diego/Imperial- 2 (Cuyamaca College, Southwestern College) Total-11</p>
0946.10	Energy Systems Technology	<p>Far North- 1 (College of the Siskiyous) San Francisco Bay- 1 (De Anza College) Los Angeles- 1 (Citrus College) Total-3</p>
0948.40	Alternative Fuels and Advanced Transportation Technology	<p>Los Angeles- 1 (Long Beach City College) Total -1</p>
0953.00	Drafting Technology	<p>Far North- 2 (Butte College, Shasta College) North- 2 (American River College, Sacramento City College) San Francisco Bay- 3 (Evergreen Valley College, College of San Mateo, West Valley College) Silicon Valley- 3 (Las Positas College, Contra Costa College, Solano College) Central- 9 (Gavilan College, Hartnell College, Bakersfield College, Cerro Coso College, Merced College, San Joaquin Delta College, Fresno City College, Modesto Junior College) South Central Coast- 3 (Antelope Valley College, Cuesta College, Santa Barbara City College) Los Angeles- 9 (Cerritos College, Citrus College, El Camino College, Mt. San Antonio)</p>

		<p>College, East Los Angeles College, Los Angeles Harbor College, Los Angeles Mission College, Pasadena City College, Rio Hondo College) Orange- 7 (Golden West College, Orange Coast College, Cypress College, Fullerton College, Santa Ana College, Irvine Valley College, Saddleback College) Inland Empire- 4 (College of the Desert, Mt. San Jacinto College, Riverside City College, Victor Valley Community College) San Diego/Imperial- 4 (Mira Costa College, Palomar College, San Diego City College, Southwestern College)</p> <p style="text-align: right;">Total-46</p>
0955.00	Laboratory Science Technology	<p>San Francisco Bay- 1 (Canada College) Silicon Valley- 1 (Las Positas College) Central- 2 (Cerro Coso College, Merced College) Los Angeles- 2 (Mt. San Antonio College, Los Angeles Trade-Tech College) Orange- 2 (Coastline College, Fullerton College) San Diego/Imperial- 2 (San Diego Mesa College, Southwestern College)</p> <p style="text-align: right;">Total-10</p>
0956.00	Manufacturing and Industrial Technology	<p>Far North- 1 (College of the Redwoods) North- 1 (Yuba College) San Francisco Bay- 1 (Mission College) Silicon Valley- 2 (Chabot College, Las Positas College) Central- 4 (Bakersfield College, Cerro Coso College, Fresno City College, Modesto Junior College) South Central Coast- 1 (College of the Canyons) Los Angeles- 4 (Cerritos College, El Camino College, Mt. San Antonio College, Los Angeles Valley College) Orange- 2 (Fullerton College, Santa Ana College) Inland Empire- 2 (Riverside City College, San Bernardino Valley College)</p> <p style="text-align: right;">Total-20</p>
0999.00	Other Engineering and Industrial Technologies	<p>Central- 1 (Taft College) Los Angeles- 1 (Los Angeles Trade-Tech College) Orange- 3 (Coastline College, Golden West College, Orange Coast College)</p> <p style="text-align: right;">Total-5</p>

Appendix E: List of Bio-energy Facilities by County¹⁹

County	Type of Bio-Energy Facility							
	Biomass Power Plant	Methane Digester	Biorefinery	Utility Company ²⁰	Landfill Gas Plant	Bioremediator	Biofuel Distributor	Other (Industry support/specialty)
Alameda	x		x	x	x	x (2)		
Alpine				x				
Butte	x	x		x (2)				x
Calaveras				x (2)				
Colusa	x							
Contra Costa					x (2)	x	x(6)	
El Dorado				x				
Fresno	x (2)	x		x(2)		x	x	
Glenn				x				
Humboldt	x (3)			x				
Imperial	x			x			x(2)	
Kern	x (2)			x(3)				
Lassen	x (4)			x				
Los Angeles				x(6)	x(10)	x(3)	x(7)	X2
Madera	x (2)		x	x				
Marin		x (2)					x	
Mendocino	x						x(2)	
Merced	x	x (2)		x				
Monterey	x				x(2)		x	
Napa					x		x	
Nevada				x(2)				
Orange				x	x(3)	x	x(3)	x(4)
Placer	x (2)			x(4)				
Plumas	x (2)					x		
Riverside	x			x	x	x(3)	x(6)	x(3)
Sacramento		x (3)		x(2)	x		x(3)	x(6)
San Bernardino		x (2)	x	x(2)	x(3)		x(3)	x
San Diego		x		x(3)	x(5)	x(3)	x(2)	
San Francisco				x		x	x(3)	x
San Joaquin	x (2)	x	x	x(3)				x(2)
San Luis Obispo		x					x	x
San Mateo					x		x	
Santa Barbara					x		x	x(2)

¹⁹ Counties that do not have any of the facilities identified in this table were excluded.

²⁰ Nevada Irrigation District serves Nevada, Placer, and Yuba Counties

Bio-Energy Occupations California

Santa Clara				x(3)	x (5)		X (3)	x
Santa Cruz							x	x
Shasta	x (6)			x			x(2)	
Sierra	x							
Siskiyou	x							
Solano				x (4)			x(2)	
Sonoma		x		X	x		x(2)	x
Stanislaus	x (2)		x	x(4)			x(2)	
Sutter				x				
Tulare	x (2)	x (2)	x(3)	x(3)	x			
Tuolumne	x (2)			x				
Ventura						x(2)	x	x(2)
Yolo	x (2)				x		x	x
Yuba				x(2)				
Total # of Facilities	42	17	8	63	41	16	58	30