



Clean Technology Workforce Challenges and Opportunities

Presented to the
Los Angeles/Orange County Regional Consortium &
Los Angeles Trade-Technical College



February 2008

Partial Funding Provided by
the Los Angeles Department
of Water and Power



TABLE OF CONTENTS

List of Figures.....	ii
List of Tables.....	ii
Executive Summary	1
Introduction	1
Key Findings	2
Conclusions.....	5
The Opportunity of Clean Technology	5
Community College Programs for Clean Technology Technicians.....	5
Industry Definition	7
Growth in Clean Technology.....	10
Investing in Clean Technology.....	11
Energy Prices Create New Opportunities	14
Government Commitment to Clean Technology.....	15
Profile of Clean Technology Employers.....	16
Workforce Issues and Challenges	19
Developing a Rapidly Evolving Workforce.....	19
Employer Challenges: Recruitment, Retention, and Keeping Current Workers Properly Trained	20
Hiring Profile of Clean Technology Employers.....	22
Occupational Skills Profile of Clean Technology Employers.....	24
Technology and Skills for Clean Technology.....	24
Occupational Skills and Training Requirements	25
Workforce Opportunities	27
Interest in Potential Community College Programs	27
Occupational Assessment.....	28
Occupational Summary.....	30
Methodology.....	37
Appendix A: Topline Results	A-1
Appendix B: Education and Training Models: Best Practices in the United States and Internationally.....	B-1
Energy Management and Sustainability: Lane Community College, Eugene Oregon	B-1
Environmental Technology: Cape Cod Community College, West Barnstable Massachusetts.....	B-3
Center for Renewable Energy Systems Technology: Loughborough University, Leicestershire United Kingdom.....	B-4

LIST OF FIGURES

Figure 1 Green Economy and Workforce Opportunities in the Region	8
Figure 2 California's Clean Technology Investment in 2007 by Industry (\$'s in Million) .	11
Figure 3 Proportional Clean Technology Investment by Industry (2007)	12
Figure 4 California's Clean Technology Investment by Region (2007)	13
Figure 5 Nominal Historical Gasoline and Crude Oil Prices (1998 – 2007)	14
Figure 6 Current Number of Permanent Employees.....	16
Figure 7 Current and Future Manufacturing Expectations of Clean Technology Employers	17
Figure 8 Industry Identification by Firm (Multiple Industries Allowed)	18
Figure 9 Workforce Challenges for Clean Technology Employers	20
Figure 10 Expected Change in the Composition of Employees in the Next 12 to 24 Months	21
Figure 11 Job Creation by Firm Size.....	22
Figure 12 Hiring Individuals in the Next 12 to 24 Months that Do <i>Not</i> Have an Advanced Degree	23
Figure 13 Technology and Skill Sets Important to Clean Technology Employers	24
Figure 14 General Skill Deficiencies Among Recent Hires	25
Figure 15 Most Important Technical Skills Among those Without an Advanced Degree	26
Figure 16 Employer Interest in Potential Community College Programs	27
Figure 17 Occupational Hiring Expectations in the Next 12 to 24 Months	29

LIST OF TABLES

Table 1 Survey Methodology	37
----------------------------------	----

EXECUTIVE SUMMARY

INTRODUCTION

In November 2007, the Los Angeles / Orange County Regional Consortium hired BW Research to conduct a workforce demand study of employers in the clean technology cluster, also referred to as clean energy and the environment. Additional funding for this project was provided by the Regional Economic Development Institute at the Los Angeles Trade-Technical College with support from Los Angeles Department of Water and Power and Community Development Department.

This emerging cluster represents an area of opportunity where the community colleges can provide training opportunities to serve the emerging workforce as well as develop education programs to prepare students for careers in renewable energy, sustainable development, and opportunities in the innovative green technologies.

The primary research objectives of the study were to:

- Describe the clean technology cluster and its current and potential impact upon the region's economy;
- Assess current and emerging clean technology workforce needs within the Los Angeles and Orange County region, as well as some of the trends within the State of California;
- Develop profiles of employers, hiring and occupational skills within clean technology; and
- Identify potential solutions to workforce challenges that can be addressed by the community colleges.

Data compiled for this report were drawn from external sources, including information from California's Employment Development Department, Energy Information Administration, the Bureau of Labor Statistics, and the Cleantech Network. Two phases of primary research were conducted, including qualitative executive interviews with employers, industry leaders and educators in clean technology and a quantitative telephone survey of 82 clean technology employers in California with a strategic over-sample of firms in the Los Angeles and Orange County region.

The focus of this report is on the clean technology cluster in California and when possible, specifically on the Los Angeles and Orange County region. This report will examine what is driving growth in the cluster, the workforce needs of clean technology, and how community colleges can play a more active role in supporting the growth of clean technology.

KEY FINDINGS

Research findings indicate that the clean technology cluster in the Los Angeles and Orange County region is expecting to see substantial increases in employment in the upcoming years and will also begin to see significant changes in the composition of its workforce. Some of the key indications of a growing and changing workforce include:

- According to our employer survey, three out of every four clean technology employers will increase their number of permanent employees and increase total employment in the cluster by about 25 percent in the next 12 months;
- Over half of clean technology employers indicated they would have at least some change (40%) if not substantial change (26%) in the composition of their workforce in the next 12 to 24 months;
- Approximately 60 percent of employers indicated they were having at least some difficulty, if not great difficulty, recruiting qualified applicants, either entry-level employees with appropriate education and training or non-entry-level employees with adequate experience and skills.

The growing demand for a trained and able workforce all point to the need for the community colleges to develop training and education programs within clean energy and the environment to meet these challenges.

Industry Analysis

In an emerging industry like Clean Technology, venture capital investment is seen as an important indicator for economic and workforce development. It also can be used as a direct estimate for the number of new jobs that can be created in a given region within a given sector.

- Over 300 million dollars have been invested in clean technology companies in Los Angeles and Orange County in 2007;
- “In 2006, 36% of venture capital investment in energy technology invested in the U.S. went to firms located in California¹”;
- In clean technology, California accounted for approximately half (49%) of all venture capital investment in the United States in the first half of 2007².

Investing in clean technology is not the only important driver of the growth in clean technology; both the increased costs of traditional fossil fuels as well as the passage of legislation targeting global warming and increased energy efficiency are providing requirements and incentives that support the development of clean technology.

- Crude oil and gasoline prices have provided strong incentives to find alternative forms of energy as well as developing greater efficiency from traditional energy users. In the last 10 years, the average price of gasoline has nearly tripled along with the average price per barrel of crude oil.

¹ Source: California Green Innovation Index, 2008 Inaugural Issue, page 43 (Nth Power)

² Source: California Green Innovation Index, 2008 Inaugural Issue, page 44 (Cleantech Network, LLC)

- In the last few years, Sacramento has offered multiple pieces of legislation that are committed to improving the environment, combating global warming, and changing business as usual in the state's economy.

Workforce Challenges

- Employers reported the most difficulty “Recruiting enough non entry-level employees with adequate skills and experience” (63% difficulty) and “Recruiting enough entry-level employees with appropriate training and education” (56% difficulty).
- Almost two-thirds of clean technology employers (65%) expect to see at least some change in the composition of their workforce and just over a quarter expect to see substantial change in the composition of their workforce in the next 12 to 24 months.

Workforce Opportunities & Hiring Profile

- The clean technology cluster expects to increase total employment by 27 percent in the next 12 months.
- New job opportunities in clean technology are relatively evenly split between small firms (10 or less employees), medium-sized firms (11 to 99 employees), and large firms (100 or more employees).
- However, job opportunities in clean technology for those individuals that do not require an advanced college degree are more likely to be found among firms that are planning to manufacture products, but are not currently doing so, firms that have 100 or more employees and firms that have two or more locations.
- Over 60 percent of clean technology employers expressed either “Great interest” or “Some interest” in a two-year associate's degree program designed for clean technology and renewable energy technicians.

Occupational Skills Profile

Results of the survey revealed the technologies that clean technology employers felt were most important in their business.

- Renewable energy was ranked as the most important technology of those that were tested. Three out of every four employers said it was at least somewhat important, and over half indicated it was very important.
- The second most important technology tested in the survey was advanced manufacturing, with again three out of four clean technology employers indicating it is at least somewhat important for their business.
- Software development and information technology was ranked as the third most important technology for clean technology employers, with two out of every three employers indicating it was at least somewhat important for their business.

- Almost half of clean technology employers indicated that working knowledge of GMP (Good Manufacturing Practices) principles was one of the most important skill sets for future hires without an advanced degree. The other three technical skill sets that received over a quarter of respondents indicating it was one of the most important technical skills included electrical knowledge and soldering skills (42.6%), working knowledge of renewable energy (38.9%), and knowledge of regulatory issues (33.3%).
- One of the recurring patterns in the survey results was the importance of manufacturing within clean technology, particularly among the employers that are most likely to hire individuals that are coming out of a community college program. It is also important to note that regulatory issues would be an important skill, even among those without an advanced degree.

Occupational Assessment

- Over half of clean technology employers that expect to hire individuals that do not have an advanced college degree plan on hiring the following occupations in the next 12 to 24 months:
 - Assembler (including electronic and electrical);
 - Customer service representative;
 - Manufacturing technician;
 - Operations and maintenance technician or engineer;
 - Research and development assistant or technician;
 - Quality control technician.

CONCLUSIONS

THE OPPORTUNITY OF CLEAN TECHNOLOGY

The growth and expansion of clean technology offers an opportunity that is seldom found in economic or workforce development, the chance to support dynamic economic growth, while improving the environment and re-invigorating employment opportunities for individuals that have struggled in the knowledge-based economy.

- **Economic Growth:** Clean technology employers exist in an innovative, profit driven environment. Venture capitalists have invested billions in this industry, and employers have indicated they expect to increase employment substantially both important indicators of dynamic economic growth.
- **Environmental Sustainability:** The cluster as a whole is focused on developing effective solutions to the environmental challenges of the day using the latest innovative technologies. The underlying objective of most firms in this industry is to attain greater sustainability in how we produce and provide goods and services.
- **Equitable Opportunities:** The growth of other high-technology clusters has not necessarily created new jobs for all facets of the workplace, often times those individuals that do not have a bachelor's degree or higher are left out of the economic dividends generated from emerging clusters. Clean technology and its promise of advanced manufacturing and assembly occupations can provide economic opportunity for a broad array of educational backgrounds.

Given the potential benefits of a growing clean technology industry, it is not hard to understand why regional policy makers and economists have been strongly advocating for the support and development of the clean technology industry in and around their communities. Community colleges can play a critical role in supporting this industry by training and educating the workforce that will support the clean technology cluster as employers transition from research and development to producing and manufacturing clean technology products and services.

COMMUNITY COLLEGE PROGRAMS FOR CLEAN TECHNOLOGY TECHNICIANS

Over half of clean technology employers indicated they were interested in degree or certificate programs in clean technology provided by a community college and over 40 percent indicated interest in on-site customized training programs for current employees provided by the community colleges. Employers recognize that the composition of their workforce is changing and they will need to find more skilled technicians as the industry moves from research to the production and assembly of goods and services. The question becomes what types of programs the community colleges should offer for students who want to find employment in clean technology?

Results of the survey reveal three areas that could be the focus of associate's degree programs in clean technology based on employer needs:

- **Energy:** This program would include both energy efficiency and renewable energy and could follow a model similar to what has been developed at Lane Community College (See Appendix B for more details). This program would develop renewable energy technicians as well as those individuals that are interested in energy auditing and consulting.
- **Environmental Technology:** This program would focus on environmental analysis and compliance issues and could follow a model similar to what has been developed at Cape Cod Community College (See Appendix B for more details). This program would focus on developing compliance and regulatory technicians as well as research and development assistants who are working in the environmental or clean technology field.
- **Clean Manufacturing:** This program would combine an understanding of environmental compliance and sustainability, energy efficiency, and advanced manufacturing. GMP (Good Manufacturing Practices) principles, an understanding of electrical and soldering skills, as well as basic tool skills would all be important components in the curriculum. The program would focus on developing quality control technicians, high level assemblers, and manufacturing technicians.

This does not rule out shorter more condensed certificate programs or more general training that provides the foundation for bachelor's and graduate degrees. However, any program that is developed should be done in collaboration with advisory employers currently in the clean technology industry.

INDUSTRY DEFINITION

To better understand the workforce opportunities in clean technology, we will first take a step back and look at the key opportunities in Southern California for the entire green economy.

For this study, the **green economy** can be seen as the products and services that are being developed and produced to lower greenhouse gas (GHG) emissions, improve air and water quality, provide more sustainable development alternatives, or provide cleaner and more efficient energy options.

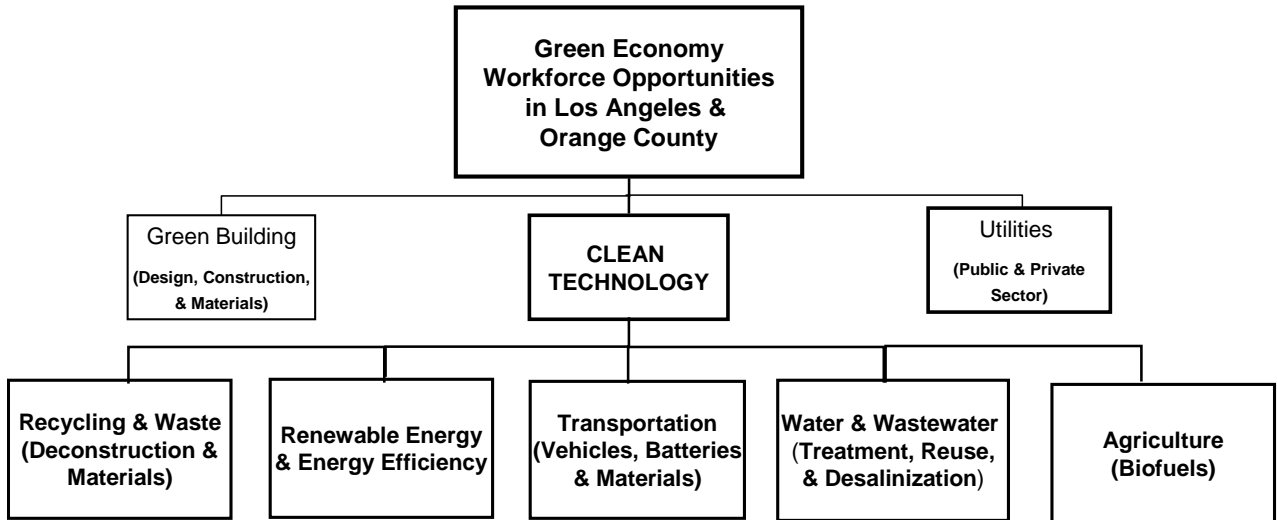
In Southern California, the most immediate and significant workforce opportunities in the green economy can be found in three key clusters. They include

Green Building: Green building or green construction can be defined as an organized effort to design, construct and maintain buildings and facilities using a process and materials which promote environmental sustainability. Green building firms are found in all sectors of construction, including commercial and industrial facilities, residential buildings, and among specialty trade contractors. The workforce impact will not only be felt in the construction industry, but also among those firms that are involved in green design (architects and planners) as well as firms that develop and produce green building materials.

Utilities: As cities like Los Angeles commit to leading the country in the green economy, public and private institutions that provide energy, water, and wastewater services prepare for significant changes to how they do business. Utilities are expanding their renewable energy portfolio and will need technicians and engineers to install, operate, and maintain wind turbines and solar panels.

Clean Technology: Represents innovative firms and research institutions that are using technology to develop market-based solutions for the environmental challenges of the day. These firms are using the latest technology to find economically viable solutions to our environmental challenges.

Figure 1 Green Economy and Workforce Opportunities in the Region



Unlike a traditional industry cluster that is defined by specific supply chains and industry classifications, clean technology (like the greater green economy) is defined by products and services that solve the environmental challenges associated with global warming and increased greenhouse gas emissions, poor air and water quality, and/or development that is unsustainable. Clean technology employers are also primarily in the private sector and focused on earning profits and a high rate of return for investors while providing superior performance at a competitive cost.

Below is a summary of the main industries where clean technology is focused. An example of a clean technology employer has been included in each of the industries to provide a more complete understanding of the type of employers that exist within each of these industries.

Renewable Energy & Energy Efficiency: In terms of investment dollars or notoriety in the media, renewable energy, whether it is associated with solar power, wind energy or even geothermal energy generation is the largest industry in the clean technology portfolio. This is true for the entire State of California, but also true for the Los Angeles and Orange County region where it accounts for over half of the venture capital investments in clean technology. This sector also includes those firms that are looking to create energy efficiency products and services as well as developing innovative products for energy storage (e.g., hydrogen fuel cells) and the energy infrastructure.

Renewable Energy Employer: *Miasole* is located in Santa Clara, in Silicon Valley, and manufactures a thin-film photovoltaic cell. It consists of an ultra-thin layer of photoactive material on a stainless steel foil only 50 microns thick. It can easily be used in photovoltaic PV modules or incorporated into building materials like membrane roofing. For more information on this firm go to www.miasole.com.

Transportation: The next generation of automobiles and public transportation options are being designed and developed by many of the transportation firms

that can be found in Los Angeles and Orange County. Firms in this industry are developing automobiles that that can achieve over 100 miles to the gallon, while maintaining cost competitiveness with traditional vehicles.

Transportation Employer: Venture Vehicles, Inc. is an innovative, environmentally-friendly personal transportation company based in Los Angeles, California. The company's first vehicle is a revolutionary, two-passenger, three-wheeled, tilting (articulating) vehicle, powered by a highly fuel efficient hybrid propulsion system that will deliver over 100 mpg, at over 100 mph, and extremely quick zero to 60 acceleration. Yet, it is designed and engineered to be priced affordably. For more information on the firm go to www.flytheroad.com.

Recycling & Waste: This industry within clean technology is focused on the entire lifecycle of products and waste treatment. Most firms within this industry are developing new materials from different waste streams both organic and inorganic. One example is the focus on developing new plastics from recycled plastics using environmentally sensitive processes.

Recycling & Waste Employer: Earthanol is headquartered in Irvine and is focused on developing new fuels from organic waste streams. Using innovative technologies, the firm is developing a series of successful projects within each targeted waste resource area. For more information on this firm go to www.earthanol.com.

Water & Wastewater: This industry within clean technology is focused on developing new products that can be used in water treatment, water reuse programs, and desalination. New membranes are being developed using nanotechnology to develop filtration systems that are environmentally sound and provide superior filtering performance to more conventional methods.

Water Employer: NanoH2O is located in Los Angeles and leverages the benefits of nanotechnology to create advanced membrane materials for the desalination and water reuse industries. NanoH2O's next generation energy-efficient membranes dramatically improve the baseline economics of desalination and water reuse. NanoH2O is committed to developing a new generation of advanced membrane technology to maintain an economically viable and sustainable freshwater supply. For more information on this firm go to www.nanoh2o.net.

Agriculture: This industry within clean technology is developing new products and processes to grow and develop bio-based materials for both human consumption and for use as bio-fuels. Examples include micro-irrigation systems, non-toxic cleaners, and natural pesticides.

Agriculture Employer: Ceres is headquartered in Thousand Oaks and is using advanced plant breeding and biotechnology to develop dedicated energy crops as raw materials for a new generation of biofuels made from plant stems, stalks and leaves — often called cellulosic biofuels. For more information on the firm go to www.ceres.net.

GROWTH IN CLEAN TECHNOLOGY

The growth and economic opportunities in clean technology are being pushed forward by the economic, political, and social realities of the day. Residents, voters, and consumers are demanding goods and services that reduce greenhouse gas emissions, provide more sustainable consumption options, and/or improve air and water quality. Clean technology is focused on using innovative technologies to find solutions to these environmental demands in a market-driven economy. Three key drivers and future indicators of clean technology include;

- The quantity and availability of **venture capital** investments being introduced into the clean technology cluster. Venture capital investments provide a strong indication of the market-based commitment to clean technology based on the expectations of future profits and a high rate of return on their investment.
- The **scarcity and increased costs of natural resources**, including fossil fuels and water, have created stronger financial incentives to find clean energy alternatives and new ways of treating and reusing water.
- California's elected leaders in Sacramento have passed **legislation** that has committed the state to a leadership role in the green economy. The legislation has created both incentives and requirements for the creation and/or development of infrastructure that would serve the green economy and the products and services provided by the clean technology cluster.

These drivers of clean technology are also pushing forward the entire green economy. Policy makers and business leaders increasingly see the development of the green economy, and clean technology in particular, as the key component in their economic development strategy. Regions throughout the country and even throughout the globe are moving quickly to establish themselves as leaders in the green economy, not just because of the environmental benefits they think it will bring to their respective communities, but because of the opportunities for jobs and economic prosperity.

INVESTING IN CLEAN TECHNOLOGY

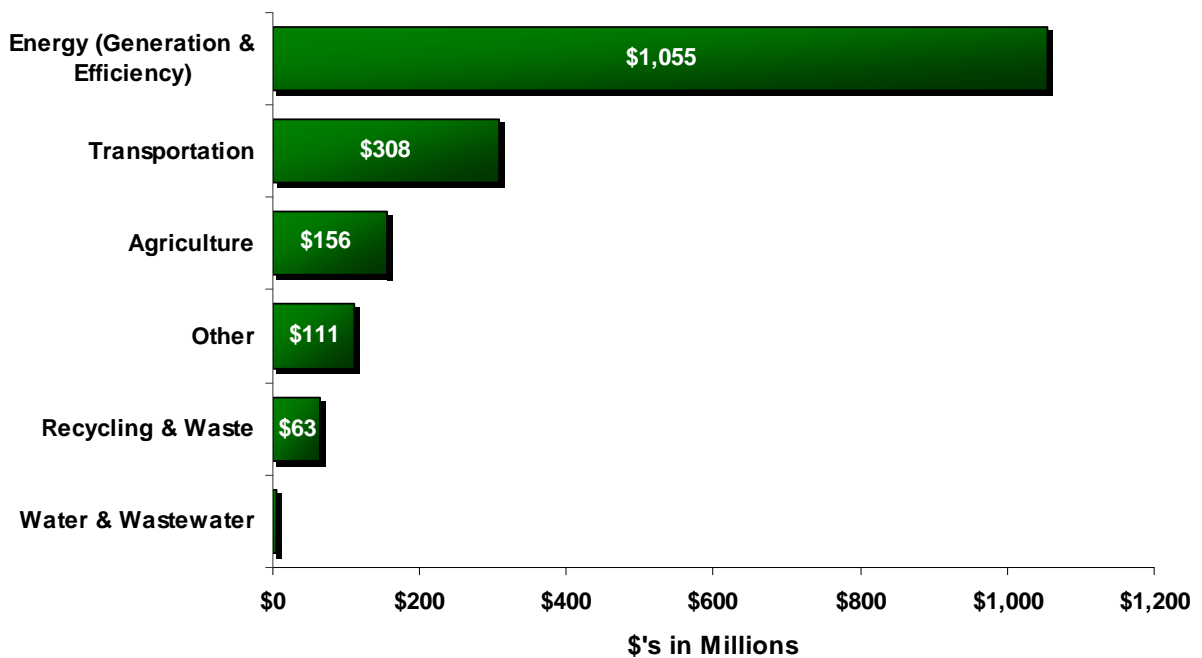
Investing in clean technology is not only an important indicator of the economic health and potential growth of the clean technology cluster, but also a key metric in quantifying the number of jobs that will be directly created in the clean technology cluster from these investments.

A clean technology investment pundit, Nicholas Parker³ believes that for every 100 million dollars of venture capital invested in clean technology, 2,500 jobs are created within the cluster.

According to Mr. Parker, California should see over 40,000 new jobs in clean technology in 2008, thanks to over 1.5 billion dollars of venture capital invested in the state's clean technology firms in 2007. For the same time period, Los Angeles and Orange County will see over 8,200 new jobs based on the 355 million dollars that were invested as venture capital in the region's clean technology firms.

The figure below illustrates how much venture capital funding has gone into the different clean technology sectors in California in 2007. The clear leader, the energy sector, which includes energy generation, efficiency and storage accounts for almost two-thirds of all the venture capital investment in California's clean technology cluster. Transportation received the second largest portion of the state's clean technology venture capital in 2007, with approximately 20 percent. Agriculture received the third highest proportion of venture capital investing, but most firms that garnered the venture capital could also be placed in transportation as they were looking to grow bio-fuels.

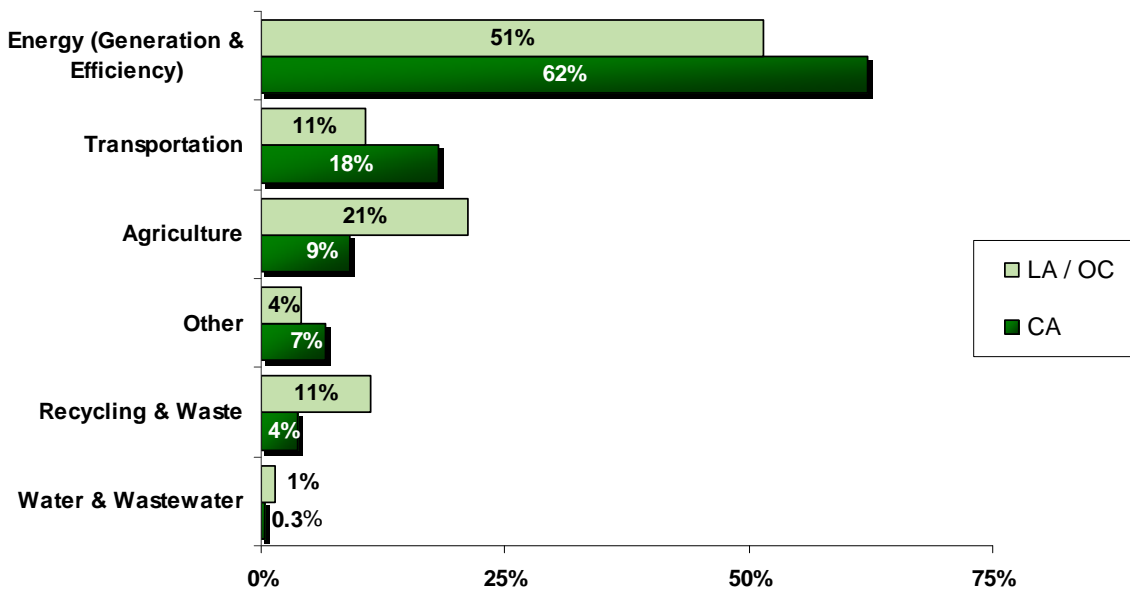
Figure 2 California's Clean Technology Investment in 2007 by Industry (\$'s in Million)



³ CEO of the Cleantech Network, the world's premier clean technology investment platform.

The figure below compares the clean technology venture capital investments in 2007 by industry in California versus the Los Angeles and Orange County region. The figure shows that the region is getting a relatively larger portion of venture capital investment in agriculture and recycling and waste compared to the entire state. The region is also receiving somewhat less proportionally in the energy and transportation industry. It should be noted that the region's agriculture investment was driven by one large venture capital investment (\$75 million) to a firm that is focused on developing new bio-fuels for transportation.

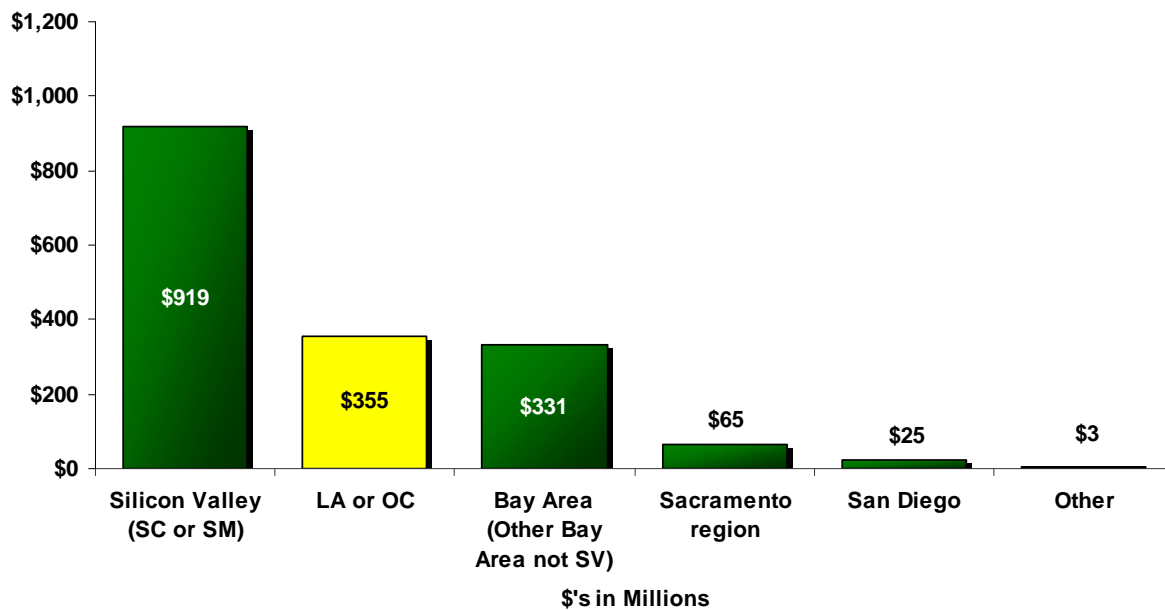
Figure 3 Proportional Clean Technology Investment by Industry (2007)



The figure below shows the regional distribution of clean technology venture capital investments in 2007. Silicon Valley (defined for this study as Santa Clara and San Mateo counties) is the clear leader in clean technology investing, as it received well over half of all of California's venture capital in the cluster. The Los Angeles and Orange County region received over \$350 million in 2007, the second highest region, just ahead of the Bay Area (except for Silicon Valley) which received just over \$330 million. Overall in California, it should be noted that venture capital in clean technology is highly concentrated in the three regions that were identified.

In 2007, over 90 percent of venture capital investments in clean technology in California were invested in a firm that was located or headquartered in one of three regions; Silicon Valley (Santa Clara & San Mateo), Los Angeles and Orange County, or the Bay Area (except for Silicon Valley).

Figure 4 California's Clean Technology Investment by Region (2007)

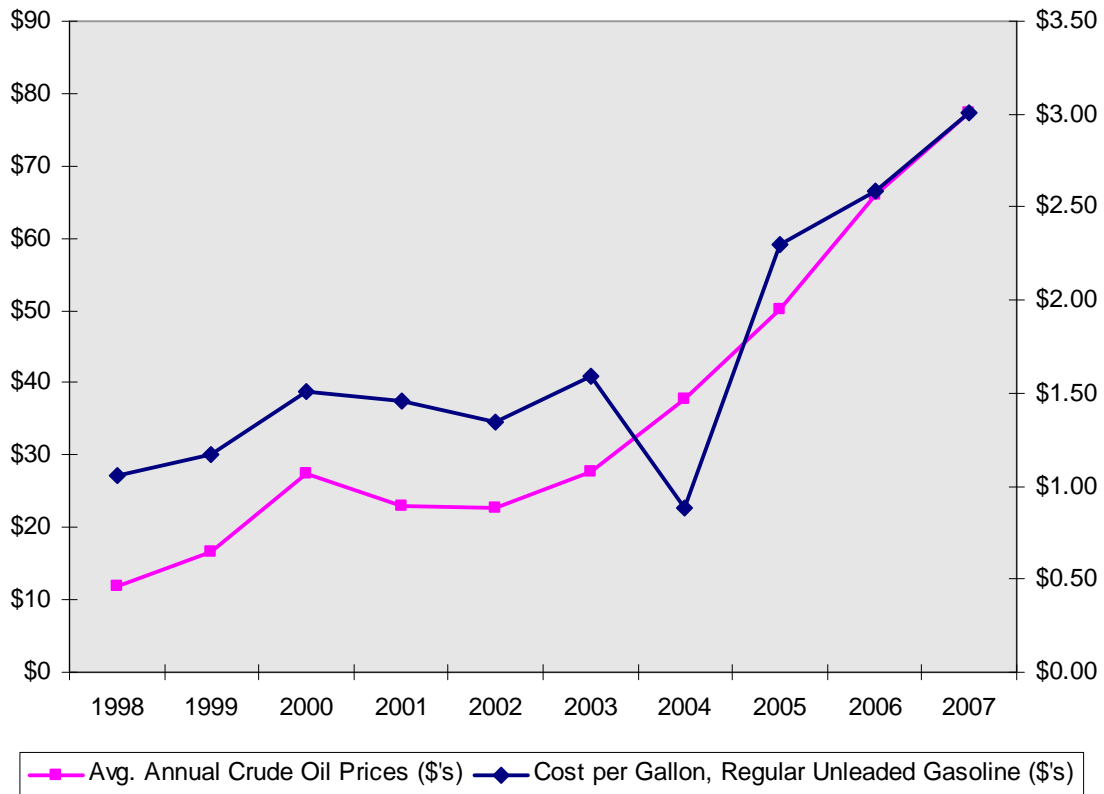


ENERGY PRICES CREATE NEW OPPORTUNITIES

One of the initial concepts taught in economics is the idea that as costs for specific inputs increase, the relative price of potential input substitutes becomes lower, even if the nominal price of that substitute input does not change. Renewable energy and energy efficiency, the largest component of the clean technology cluster (as shown in the previous section), face an environment where the costs for traditional fossil fuel inputs have gone up considerably in the last 10 years and renewable energy substitutes for fossil fuels have become increasingly cost competitive. Even if there were not a single bit of data to support global warming or environmental damage from burning fossil fuels, given the change in prices of fossil fuels over the last 10 years it is hard to imagine any market system not investing some resources in new energy options that are not based on a resource that is becoming so costly.

The figure below shows the stark increases in both what consumers pay at the fuel pump (cost per gallon, regular unleaded) and what producers pay for a barrel of crude oil. These increased prices in fossil fuels not only spawn investment in energy generation and efficiency, but also new transportation vehicles that run on electricity or do more with less gas (100+ miles per gallon), or agricultural technology that grows the next types of fuel that run our vehicles (bio-fuels).

Figure 5 Nominal Historical Gasoline and Crude Oil Prices (1998 – 2007)⁴



⁴ Source: Energy Information Administration and www.inflationdata.com

GOVERNMENT COMMITMENT TO CLEAN TECHNOLOGY

Recently, leadership on the country's and planet's environmental quandaries has not been found at the national level, unlike California which has taken a legislative lead on environmental issues such as global warming and deteriorating air quality. In the last few years, Sacramento has offered multiple pieces of legislation that are committed to improving the environment, combating global warming, and changing business as usual in the state's economy. Some of the more important pieces of legislation include;

- **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. This is considered by many to be the hallmark legislation that provides clear goals and requirements for lowering greenhouse gas emissions and changing business as usual in the world's eighth⁵ largest economy.
- **SB 1: The Million Solar Roofs Bill** – Provides funding, incentives, and mandates to increase solar panels throughout the state and complement the million solar roofs plan.
- **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 technology⁶.

These legislative examples illustrate California's commitment to reducing greenhouse gases and improving our environment. To meet the goals and mandates set forth in this legislative package, technology will need to make significant advances in energy generation, transportation, and the other key sectors within clean technology.

⁵ Source: United States, Department of Commerce, based on 2005 data.

⁶ Source: California Progress Report, August 29, 2007 by John Boesel and Karen Douglas.

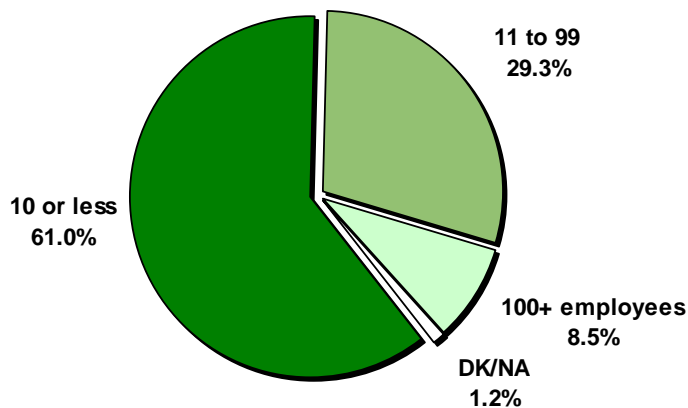
PROFILE OF CLEAN TECHNOLOGY EMPLOYERS

Unlike other industry clusters, where employers exist along a given supply chain, clean technology employers are more likely to be found in a wider group of industries from transportation to agriculture to energy storage. Clean technology is still emerging and likely to face significant changes in the years ahead. With that said, the following section is meant to provide a general profile of some of the current characteristics of clean technology employers.

Clean technology employers tend to fall into one of two groups, either smaller (less than 50 employees) bottom up firms that are developing a new technology to bring to the marketplace or they are a larger firm that provides other products and/or services and have moved into this arena because of the opportunity for profits. Los Angeles and Orange County have both of these types of clean technology firms. The following charts and figures describe the clean technology firms that participated in this study's survey.

As shown by the figure below, over half (61%) of clean technology firms in California have 10 or less employees, approximately 29 percent have 11 to 99 employees, and just under 10 percent of firms have at least 100 employees.

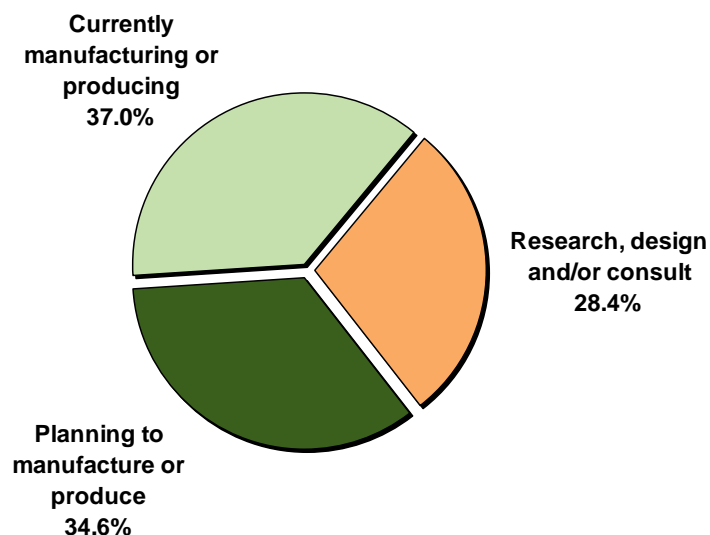
Figure 6 Current Number of Permanent Employees



Clean technology firms are relatively evenly split between where they currently are and where they want to be in the future. The figure below delineates clean technology firms into one of three profiles, based on the products and services they are currently providing and those they hope to provide in the future. The following is a short description of each profile;

- **Currently Manufacturing or Producing:** Almost 40 percent of clean technology firms are currently assembling or manufacturing products that are being brought to the marketplace. These firms are relatively early in their manufacturing process as many expect to add new products and increase capacity in the near future.
- **Planning to Manufacture or Produce:** Just over a third of clean technology firms are currently developing a product or products that they plan to manufacture or assemble in the future. These firms typically have less employees and have generally strong growth expectations.
- **Research, Design and/or Consult:** Almost 30 percent of clean technology firms are currently involved in research, designing, and/or consulting but have no current plans to assemble or manufacture any products.

Figure 7 Current and Future Manufacturing Expectations of Clean Technology Employers⁷

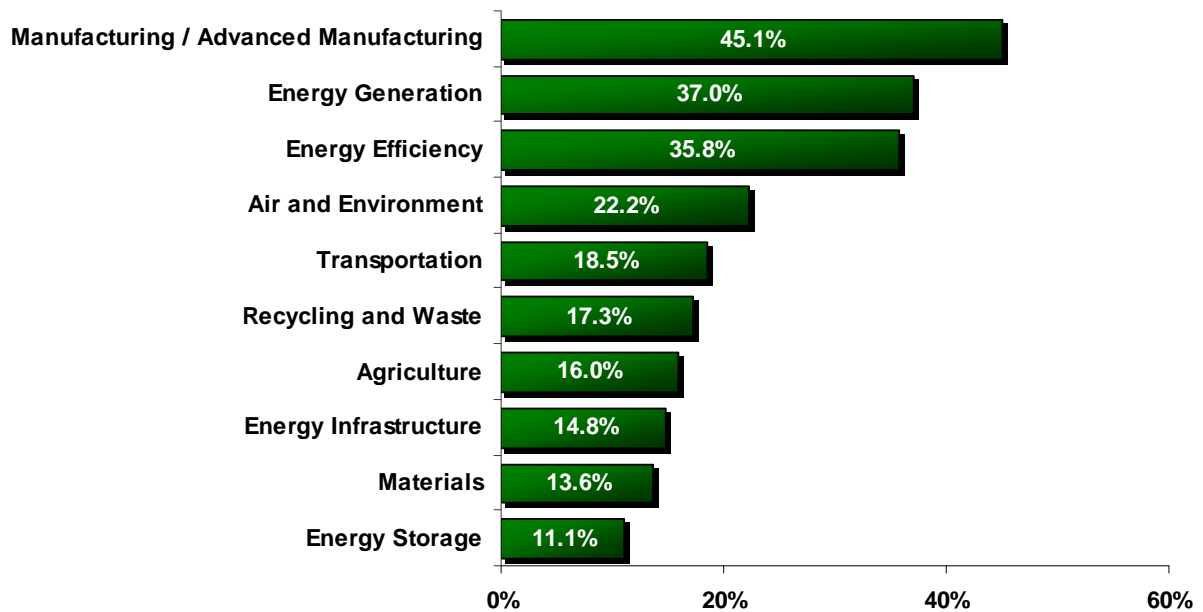


⁷ Please note that these figures are not consistent with the topline in Appendix A as each respondent was placed into a single profile based on the combination of their responses to Question 6, rather than being considered in multiple groups as shown in the survey results.

The figure below shows all of the industries that clean technology firms identify themselves as currently working in. Almost half of clean technology firms indicated they were either currently working in manufacturing or advanced manufacturing. Energy was also heavily cited by clean technology employers, as firms indicated they were in energy generation (37%), energy efficiency (36%), energy infrastructure (15%) and energy storage (11%). Some of the other industries mentioned included air and environment (22%), transportation (19%), recycling and waste (17%), agriculture (16%), and materials (14%).

Please note that respondents were allowed to choose more than one industry, so the figure below will add up to more than 100 percent.

Figure 8 Industry Identification by Firm (Multiple Industries Allowed)



WORKFORCE ISSUES AND CHALLENGES

DEVELOPING A RAPIDLY EVOLVING WORKFORCE

Clean technology offers the hope of both a cleaner and improved environment and economic prosperity; it also offers the hope of well-paying, sustainable jobs for a growing portion of the public. For many the promise of clean technology is the opportunity to create a new wave well-paying jobs in production and manufacturing. These positions would require some training and education which could be met by the community colleges, but would not require advanced college degrees. The growth in clean technology occupations such as renewable energy technician and quality control technician provide an important indicator of how the cluster is evolving and the type of workforce that will be needed in the future.

With all of the strong indications of economic growth, the clean technology cluster faces questions on whether it can meet that promise of sustainable jobs for a growing portion of the public, these questions include;

1. Will clean technology employers take the next step and begin assembling and manufacturing on a larger scale and change the composition of their workforce from one that is almost entirely focused on research and design to one that is concentrated on the production and assembly of green products and services?
2. If clean technology is able to make the transition to actually produce more goods and services, will the production and assembly positions stay within the country, California and within the Los Angeles and Orange County region?

These questions can not be completely answered today, but they should be considered as we evaluate the current and future needs of the clean technology cluster and consider the possible workforce scenarios for the future.

Case Study⁸ – Workforce Expectations in Silicon Valley for the Solar

Industry: A white paper produced by SolarTech in June 2007. SolarTech is an industry collaborative committed to creating “a solar center of excellence in Silicon Valley”. The purpose of the white paper was to identify and evaluate technological and marketplace challenges associated with the goal of reducing the installed costs of photovoltaic (PV) systems. The paper identified education and training programs as a key objective for the solar industry in developing a skilled and productive workforce that can support the growth of the solar industry. According to the paper “solar employers are experiencing increasing difficulty in meeting the growing demand for solar workers.”

Assessment of the Solar Industry in Silicon Valley: Currently, there are approximately 1,500 workers employed in the solar industry in Silicon Valley. SolarTech estimates annual employment growth at 35 to 40 percent a year, with 10,000 to 20,000 solar workers in Silicon Valley in the next 10 years. SolarTech estimates that 60 percent of the jobs will be in manufacturing and employment, 20 percent in sales and marketing, and 20 percent in engineering.

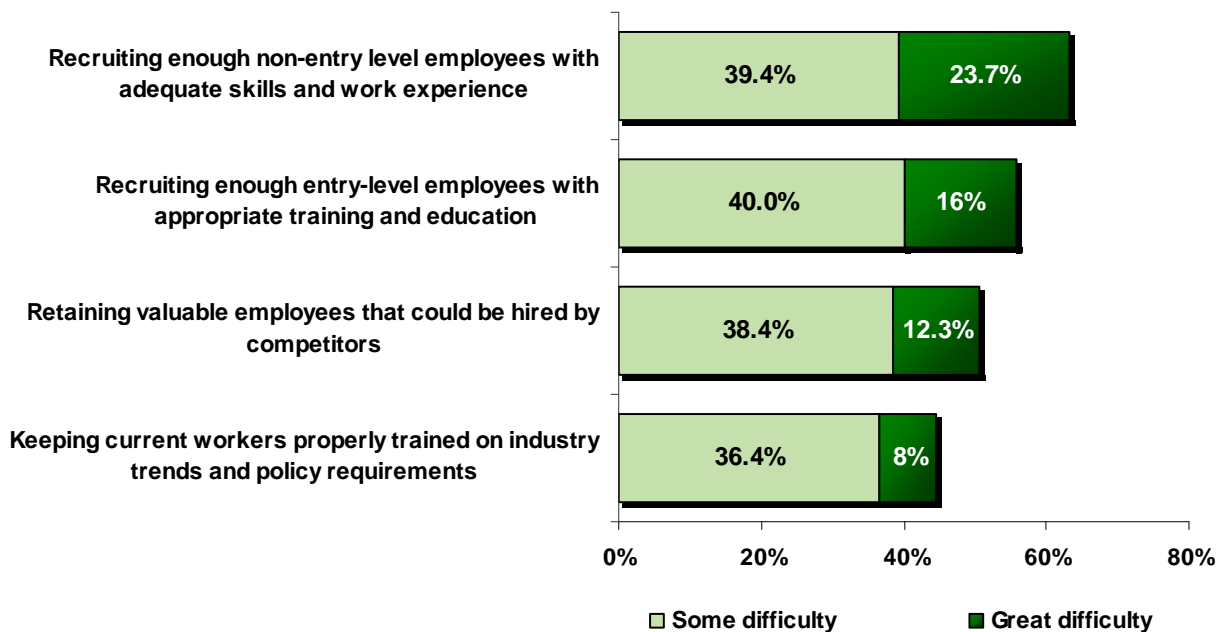
⁸ For the complete SolarTech white paper go to www.solartech.org/STWP.pdf.

EMPLOYER CHALLENGES: RECRUITMENT, RETENTION, AND KEEPING CURRENT WORKERS PROPERLY TRAINED

The figure below reveals the difficulty clean technology employers indicated towards general workforce issues. Specifically, results of the survey showed that employers had the most difficulty with “Recruiting enough non entry-level employees with adequate skills and experience” (63% difficulty) and “Recruiting enough entry-level employees with appropriate training and education” (56% difficulty).

Recruiting, particularly non-entry level employees, is the greatest difficulty for clean technology employers of the workforce challenges that were examined.

Figure 9 Workforce Challenges for Clean Technology Employers⁹



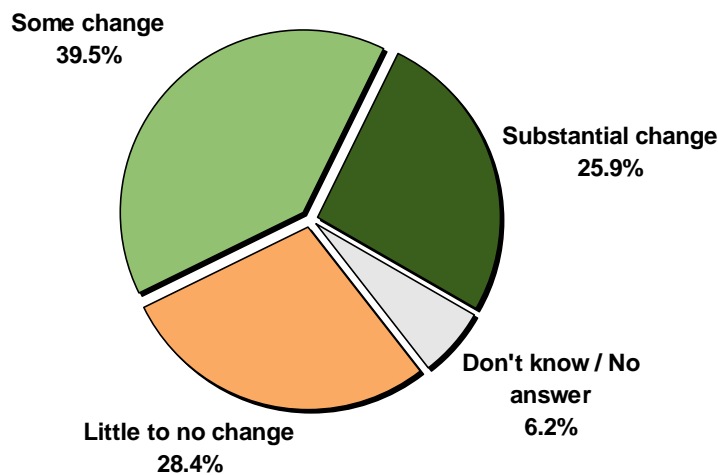
⁹ Percentages were derived after removing Don't Know and No Answer from the overall results

The current assessment of workforce challenges in clean technology is a valuable initial indicator of what workforce obstacles these employers are facing today, but like many emerging industries, their human capital needs are changing.

Clean technology employers were asked how much change they expected to see in the skills, education, and abilities of their firm's employees in the next 12 to 24 months.

Almost two-thirds of clean technology employers (65%) expect to see at least some change in the composition of their workforce and just over a quarter expect to see substantial change in the composition of their workforce in the next 12 to 24 months.

Figure 10 Expected Change in the Composition of Employees in the Next 12 to 24 Months

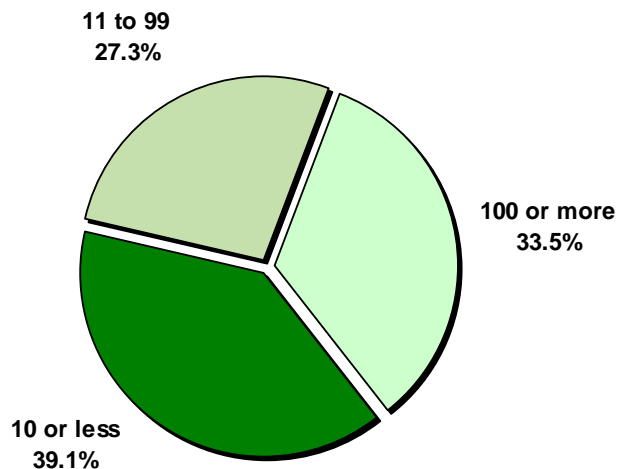


HIRING PROFILE OF CLEAN TECHNOLOGY EMPLOYERS

Clean technology employers expect to hire considerably more employees in the next 12 months and beyond. Three out of every four employers (78%) indicated they would increase their amount of permanent employees over the next 12 months, the remaining 22 percent of employers stated their permanent employees would remain at the current amount. The firms that are expecting to hire new employees are looking to bring on a substantial number of new permanent employees in the next 12 months, with the total clean technology workforce expected to increase by over one quarter (27 percent) according to current employers.

The figure below illustrates where new permanent employment will be found in clean technology by the size of employers. While smaller employers (10 or less employees) typically have higher proportional growth rates, the overall majority of new permanent employment is not necessarily found with smaller employers. For clean technology, new employment is found among all sizes of employers. However, smaller employers (10 or less employees) and larger employers (100 or more employees) are expected to account for more than seven out of every 10 new jobs created in clean technology.

Figure 11 Job Creation by Firm Size

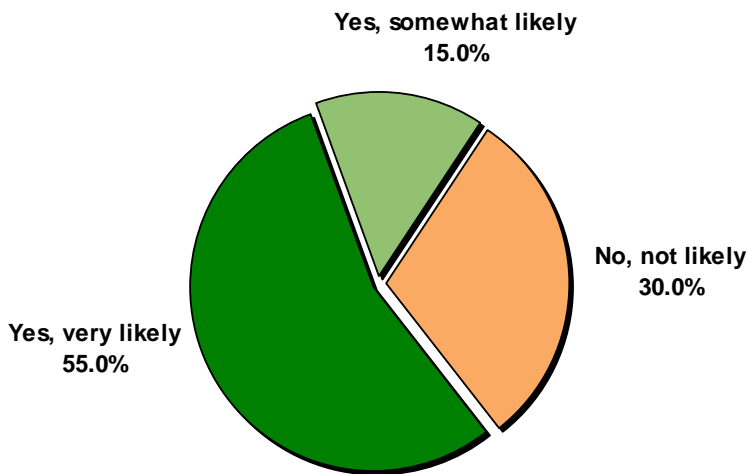


For emerging technologies that are focused on research and development, the initial phase of hiring is typically focused on individuals with advanced college degrees who are focused on using the latest technologies to solve cutting-edge problems. The question becomes, will clean technology firms begin to broaden their search for the next employee?

Clean technology employers were asked if they expected to hire individuals in the next 12 to 24 months that did not require an advanced college degree¹⁰. Over half of clean technology employers said this was very likely and another 15 percent indicated they were somewhat likely to hire individuals that do not have an advanced college degree. Some of the clean technology firms that were more likely to hire individuals without an advanced college degree in the next 12 to 24 months included:

- Firms that are planning to manufacture products, but are not currently doing so (66.6% very likely);
- Firms that have 100 or more employees (66.6% very likely);
- Firms that have two or more locations (84.0% very likely).

Figure 12 Hiring Individuals in the Next 12 to 24 Months that Do Not Have an Advanced Degree



¹⁰ Telephone interviewers were instructed to define advanced college degree as a master's degree or higher. The Internet version of the survey included the same definition if it was clicked upon.

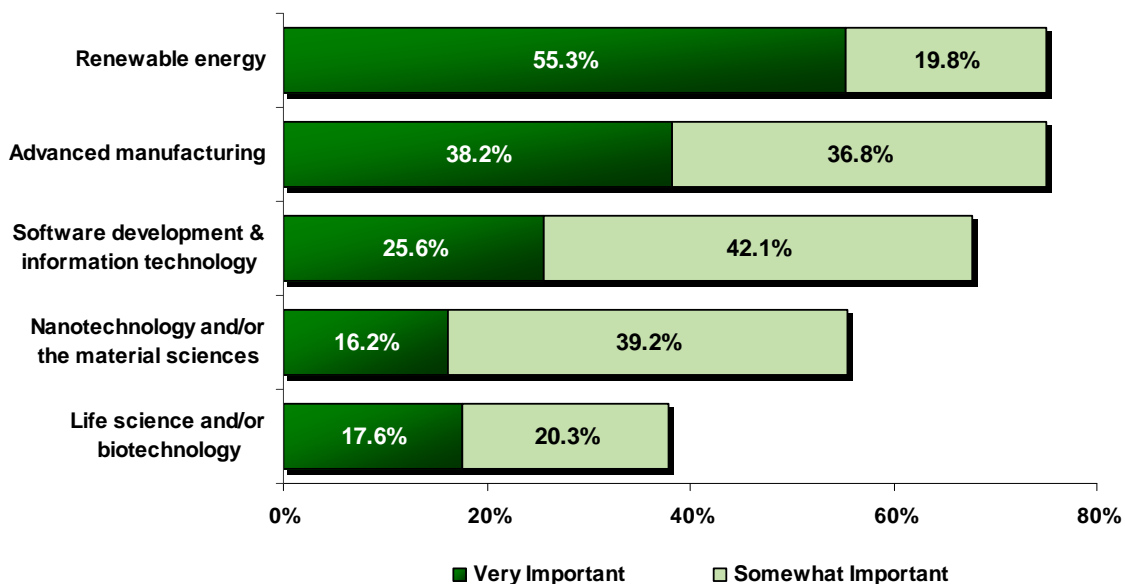
OCCUPATIONAL SKILLS PROFILE OF CLEAN TECHNOLOGY EMPLOYERS

TECHNOLOGY AND SKILLS FOR CLEAN TECHNOLOGY

Like other emerging applied technologies, such as nanotechnology, clean technology needs a flexible, inter-disciplinary workforce whose skill sets are found in many different areas. The broad nature of the cluster means it will need to hire individuals who have skills sets that are tied to energy generation and distribution, construction, the material sciences, environmental sciences, and information technology. While it is unlikely that an individual will have applied expertise in each of these areas, it is important to understand which of these broader skill sets are most important to employers in clean technology.

Renewable energy was ranked as the most important technology of those that were tested - three out of every four employers said it was at least somewhat important and over half indicated it was very important. The second most important technology tested in the survey was advanced manufacturing, with again three out of four clean technology employers indicating it is at least somewhat important for their business. Software development and information technology was ranked as the third most important technology for clean technology employers, with two out of every three employers indicating it was at least somewhat important for their business. Over half of clean technology employers indicated nanotechnology and/or the material sciences were at least somewhat important to their business. Of the technologies examined, only life sciences and/or biotechnology received less than half of clean technology indicating it was at least somewhat important.

Figure 13 Technology and Skill Sets Important to Clean Technology Employers¹¹



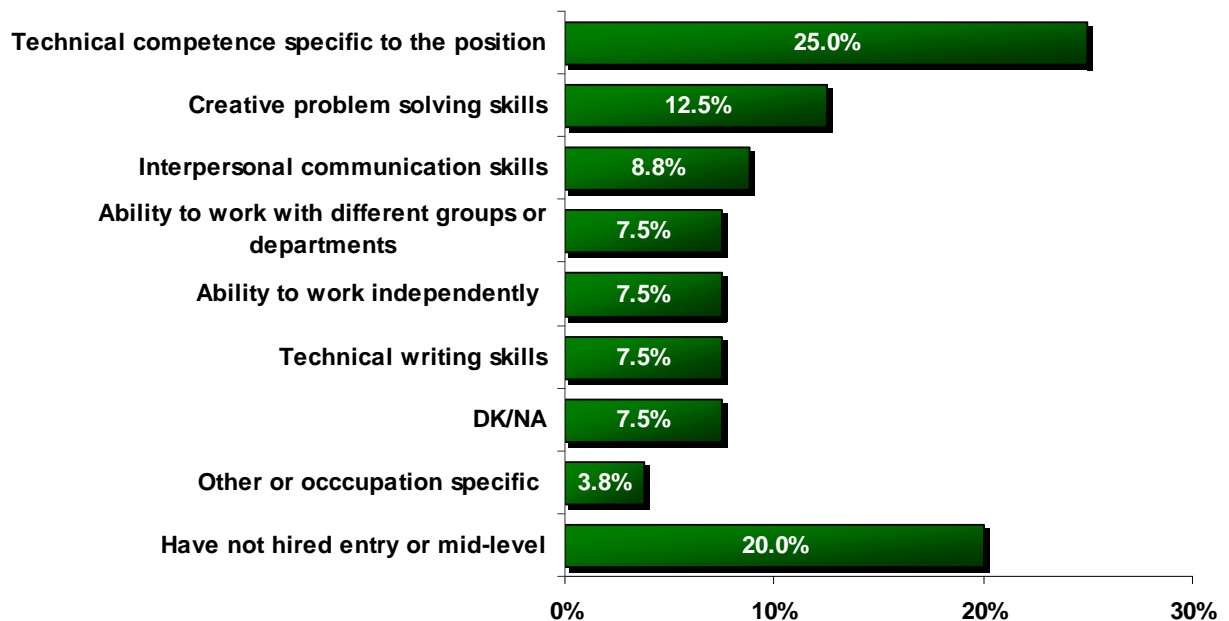
¹¹ Percentages were derived after removing Don't Know and No Answer from the overall results.

OCCUPATIONAL SKILLS AND TRAINING REQUIREMENTS

Clean technology employers were also asked to reflect on recent hires at their organization. Employers indicated that new hires tend to be most deficient in technical skills specific to the position (25.0%), creative problem-solving skills (12.5%), and interpersonal communication skills (8.8%).

One of the key overall findings from this question is that, except for technical competence specific to the position, clean technology employers are not indicating any substantial deficiencies among their recent hires and even 25 percent for a general deficiency such as technical competence specific to the position is not terribly high. It is also worth noting that one out of every five clean technology employers has not hired an entry or mid-level position.

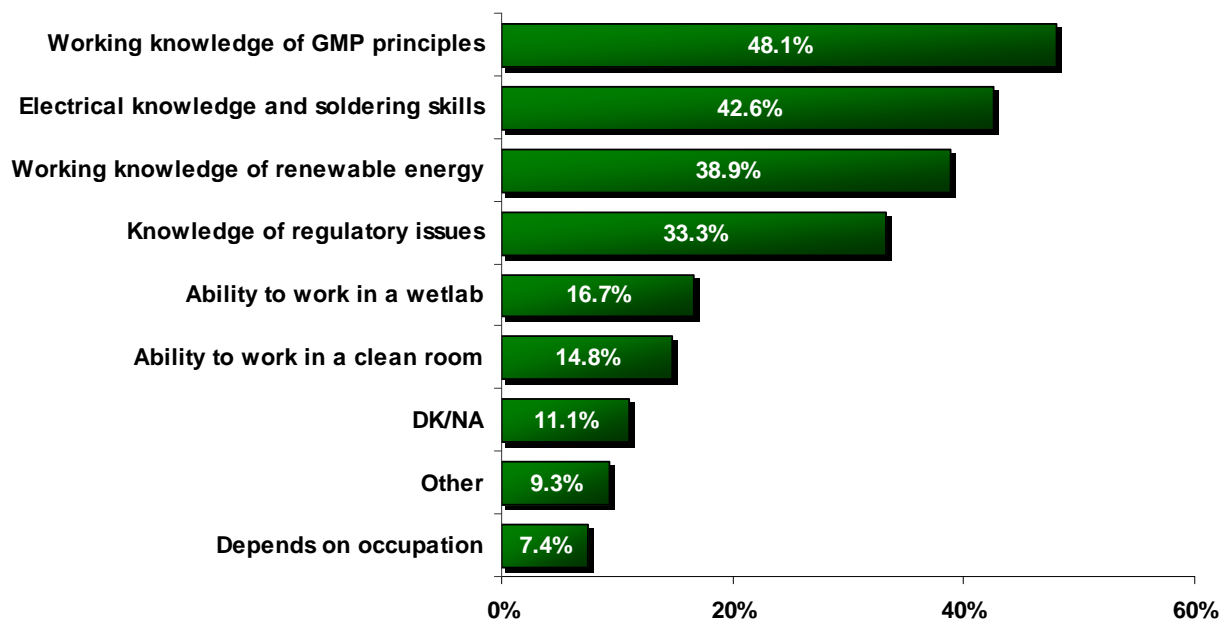
Figure 14 General Skill Deficiencies Among Recent Hires



Clean technology employers were asked earlier in the survey if they expected to hire individuals in the next 12 to 24 months that did not require an advanced college degree. The 70 percent of employers that indicated they expected to hire someone were asked a few follow-up questions about the technical skill sets that were most important for these occupations. Specifically, clean technology employers were asked to indicate which technical skills would be most important for any future hires without an advanced degree. Almost half of clean technology employers indicated that working knowledge of GMP (Good Manufacturing Practices) principles was one of the most important skill sets for future hires without an advanced degree. The other three technical skill sets that received over a quarter of respondents indicating it was one of the most important technical skills included electrical knowledge and soldering skills (42.6%), working knowledge of renewable energy (38.9%), and knowledge of regulatory issues (33.3%).

One of the reoccurring patterns we see in the results to this question is the importance of manufacturing within clean technology, particularly among the employers that are most likely to hire individuals that are coming out of a community college program. It is also important to note that regulatory issues would be an important skill, even among those that do not require an advanced degree.

Figure 15 Most Important Technical Skills Among those Without an Advanced Degree



WORKFORCE OPPORTUNITIES

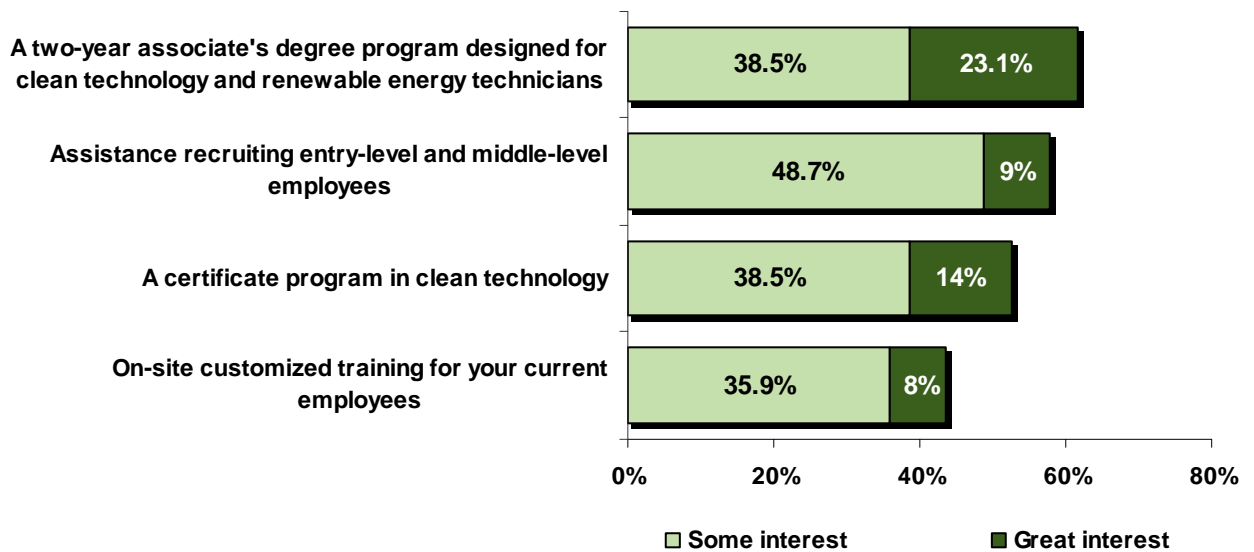
INTEREST IN POTENTIAL COMMUNITY COLLEGE PROGRAMS

Employers expressed the most overall interest in a program with the Los Angeles and Orange County community colleges that would provide a two-year associate's degree program designed for clean technology and renewable energy technicians (61.6%).

The majority of clean technology employers also expressed either great or some interest in assistance recruiting entry-level and middle-level employees (57.7% indicated at least some interest) or offering a certificate program in clean technology (52.6% indicated at least some interest). Comparatively, employers were less interested in an on-site customized training program for current employees.

Over 60 percent of clean technology employers expressed either "Great interest" or "Some interest" in a two-year associate's degree program designed for clean technology and renewable energy technicians.

Figure 16 Employer Interest in Potential Community College Programs



OCCUPATIONAL ASSESSMENT

The primary research component of this study focused on seven occupations within clean technology. The list of occupations is focused on positions that could easily be served by education and training programs provided by community colleges as well as those positions that do not typically require an advanced college degree.

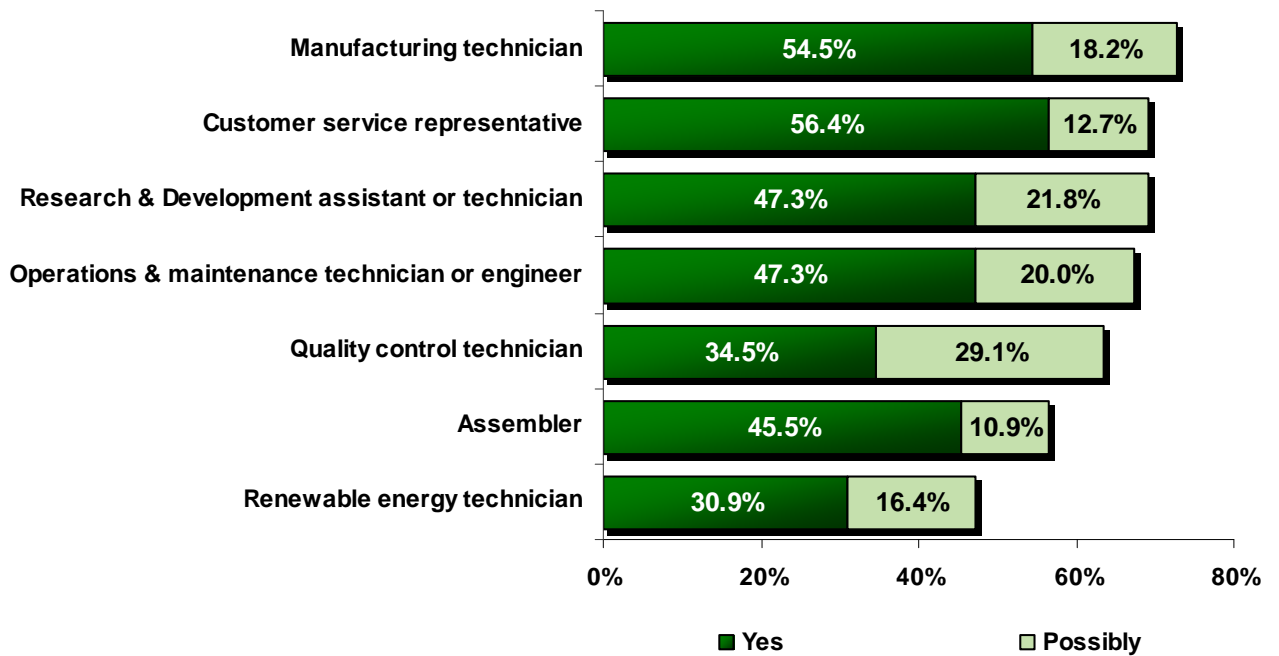
The occupations chosen as the focus of the study were:

- Assembler (including electronic and electrical);
- Customer service representative;
- Manufacturing technician;
- Operations and maintenance technician or engineer;
- Renewable energy technician;
- Research and development assistant or technician;
- Quality control technician.

Like the question related to technical skills, only those clean technology employers who indicated they expected to hire individuals in the next 12 to 24 months that did not require an advanced college degree were asked the following occupational question. The 70 percent of clean technology employers that did qualify were asked if they expected to hire each of the seven occupations examined within this study over the next 12 to 24 months. The figure below shows that for all of the occupations examined in this study, except for renewable energy technicians which were just below 50 percent, at least half of employers will consider (yes plus possibly) hiring each of these occupations in the next 12 to 24 months.

Manufacturing technician had the highest percentage of employers indicating they would hire or possibly hire someone in this position in the next 12 to 24 months (72.7%), followed closely by customer service representative (69.1%) and research development assistant or technician (69.1%).

Figure 17 Occupational Hiring Expectations in the Next 12 to 24 Months



OCCUPATIONAL SUMMARY

The clean technology cluster and its occupations are still emerging with changing responsibilities and evolving skill sets. This section of the report synthesizes the labor market information that is available for standardized occupations that are similar to the positions found in clean technology.

Manufacturing Technician

Similar standardized occupations (SOC Code): Industrial Engineering Technician (17-3026).

The work of manufacturing technicians is focused on applying engineering theory and principles to problems of industrial layout or manufacturing production, usually under the direction of engineering staff¹².

The critical skill sets include mechanical aptitude using high technology tools and competency in mathematics, production processes, and engineering and basic familiarity with computers.

Education:

Most manufacturing technicians require training in vocational schools, related on-the-job experience, or an associate's degree. Some may require a bachelor's degree.

Across industries:

- Manufacturing technicians are found in many industries that require advanced manufacturing and research and development. In the Los Angeles and Orange County region, a substantial proportion are found in medical devices, applied science as well as research and development, and the aerospace industry.
- Within The Los Angeles and Orange County region, the median annual wage for manufacturing technician/industrial engineering technician ranges from \$37,848 to \$74,004 depending on the industry.

In Clean Technology¹³:

- This occupation is more likely to be considered for employment by firms with 11 or more employees.
- This occupation is more likely to be considered by firms that are currently or planning to engage in manufacturing, and less likely to be hired by those firms that are focused on research, design, and consulting.
- Clean technology sectors that are more likely to hire manufacturing technicians include those firms that are involved in energy generation, transportation, water and wastewater, and advanced manufacturing.

¹² Most of the occupation descriptions in this section were summarized or excerpted from Bureau of Labor Statistics, U.S. Department of Labor, Occupational Outlook Handbook, 2008-09 Edition and O*net Online.

¹³ Clean technology assessment by occupation is qualitative in nature and is not statistically reliable in representing the entire clean technology cluster.

Research & Development Assistant or Technician

Similar standardized occupations (SOC Code): Biological Technician (19-4021), Chemical Technician (19-4031) and Environmental Science and Protection Technician (19-4091).

Research and development assistants or technicians apply the principles and theories of science and mathematics to solve problems in research and development and to help invent and improve products and processes. Unlike scientists, these positions are more practically oriented. Technicians set up, operate, and maintain laboratory instruments, monitor experiments, make observations, calculate and record results, and often develop conclusions.

The critical skill sets include scientific aptitude using high technology tools and competency in mathematics, biology, chemistry, and environmental sciences, and strong familiarity with computers.

Education:

Most research and development assistants or technicians require a bachelor's degree, but some do not.

Across industries:

- Research and development assistants or technicians are found in the private sector, public sector, and academia. In the Los Angeles and Orange County region, a substantial proportion are found in scientific research and development services, pharmaceutical manufacturing as well as architecture and engineering services.
- Within The Los Angeles and Orange County region, the median annual wage for scientific technicians ranges from \$29,001 to \$74,706 depending on the industry.

In Clean Technology:

- This occupation is considered for employment in the future by firms of all sizes, both large and small.
- This occupation is more likely to be considered by firms that are planning to engage in manufacturing, but are not currently doing so.
- Clean technology sectors that are more likely to hire research and development assistants or technicians include those firms that are involved in energy efficiency, water and wastewater, and agriculture.

Quality Control Technician

Similar standardized occupations (SOC Code): Inspectors, Testers and Graders (51-9061).

The work of quality control technicians is focused on monitoring or auditing quality standards for virtually all domestically manufactured products, including textiles, clothing, glassware, motor vehicles, electronic components, computers, and structural steel. Depending on their skill level, inspectors may also set up and test equipment, calibrate precision instruments, repair defective products, or record data.

The critical skill sets include scientific aptitude using high technology tools and competency in mathematics, biology, chemistry, and environmental sciences, and strong familiarity with computers.

Education:

These occupations usually require a high school diploma and may require some vocational training or job-related course work. In some cases, an associate's or bachelor's degree could be needed.

Across industries:

- Quality control technicians are found in just about every type of manufacturing from computers and high technology equipment to food processing. In the Los Angeles and Orange County region, a substantial proportion are found in semiconductor manufacturing, medical devices, textiles, and apparel manufacturing, and the aerospace industry.
- Within The Los Angeles and Orange County region, the median annual wage for inspectors, testers and graders/quality control technician ranges from \$19,693 to \$63,347 depending on the industry.

In Clean Technology:

- This occupation is considered by firms of all sizes, but more so by larger firms (100+ employees).
- This occupation is more likely to be considered by firms that are currently or planning to engage in manufacturing, and less likely to be hired by those firms that are focused on research, design, and consulting.
- Clean technology sectors that are more likely to hire quality control technicians include those firms that are involved in recycling and waste, advanced manufacturing, and agriculture.

Assembler

Similar standardized occupations (SOC Code): Electrical and Electronic Equipment Assemblers (51-2022), Engine and Other Machine Assemblers (51-2031) and Electromechanical Equipment Assemblers (51-2023).

The work of assemblers is focused on assembling and fabricating finished products and the pieces that go into them. The products they assemble using tools, machines, and their hands range from entire airplanes to intricate timing devices. They fabricate and assemble household appliances, automobiles and automobile engines and parts, computers, electronic devices, and more.

The job of an assembler or fabricator ranges from very easy to very complicated, requiring a range of knowledge and skills. Skilled assemblers putting together complex machines, for example, begin by reading detailed schematics or blueprints that show how to assemble the machine. After determining how parts should connect, they use hand or power tools to trim, shim, cut, and make other adjustments to fit components together and align properly. Once the parts are properly aligned, they connect them with bolts and screws or by welding or soldering pieces together.

Education:

These occupations usually require a high school diploma and may require some vocational training or job-related course work. In some cases, an associate's or bachelor's degree could be needed.

Across industries:

- Assemblers are found in most manufacturing industries including computers and high technology equipment to HVAC systems. In the Los Angeles and Orange County region, a substantial proportion are found in semiconductor manufacturing, medical devices, and electrical equipment manufacturing.
- Within The Los Angeles and Orange County region, the median annual wage for inspectors, testers and graders/quality control technician ranges from \$17,660 to \$48,300 depending on the industry.

In Clean Technology:

- This occupation is considered for employment in the future by firms of all sizes, both large and small.
- This occupation is more likely to be considered by firms that are currently or planning to engage in manufacturing, and less likely to be hired by those firms that are focused on research, design, and consulting.
- Clean technology sectors that are more likely to hire assemblers include those firms that are involved in energy generation, recycling and waste, energy infrastructure, and materials.

Renewable Energy Technician

Similar standardized occupations (SOC Code): Environmental Science and Protection Technician (19-4091) and Electricians (47-2111).

The work of renewable energy technicians is focused on installing, maintaining and repairing solar cells, wind turbines and other renewable energy applications. This position can include an emphasis on photovoltaic installation and design, solar hot water, and/or wind power installation and maintenance.

Individuals in this occupation typically need to have the skills of a construction worker combined with an in-depth understanding of renewable energy systems including solar, wind and hydro power. Individuals in this occupation often work outside and must be willing to work on top of roofs and other high places. This position also requires some applied mathematics, written and spoken communication skills, the ability to receive and follow directions as well as the ability to work as part of a team.

Education:

This occupation typically requires training in vocational schools, related on-the-job experience, or an associate's degree. Some may require a bachelor's degree.

Across industries:

- Unlike the other occupations examined in this study, the renewable energy technician is typically found in clean technology, the utilities industry, or in the construction industry installing or repairing solar panels or small-scale wind turbines.

In Clean Technology:

- This occupation is considered for employment in the future by firms of all sizes, both large and small.
- This occupation is more likely to be considered by firms that are planning to engage in manufacturing, but are not currently.
- Clean technology sectors that are more likely to hire renewable energy technicians include those firms that are involved in energy generation, recycling and waste, and advanced manufacturing.

Customer Service Representative

Similar standardized occupation (SOC Code): Customer Service Representative (43-4051).

The work of customer service representatives is focused on being the direct point of contact for customers. They are responsible for ensuring that their company's customers receive an adequate level of service or help with their questions and concerns. These customers may be individual consumers or other companies, and their service needs can vary considerably.

All customer service representatives interact with customers to provide information in response to inquiries about products or services and to handle and resolve complaints.

The critical skill sets include ability to communicate complex information and actively listen to clients as well as thorough understanding of products. This occupation also typically requires ability to use different communication technologies and basic familiarity with computers.

Education:

This occupation usually requires a high school diploma and may require some vocational training or job-related course work. In some cases, an associate's or bachelor's degree could be needed.

Across industries:

- Customer service representatives are ubiquitous in our workplace, found in almost every industry from religious organizations to computer design services. In the Los Angeles and Orange County region, a substantial proportion are found in banking, employment services, insurance carriers and consulting.
- Within The Los Angeles and Orange County region, the median annual wage for customer service representatives ranges from \$17,846 to \$60,639 depending on the industry.

In Clean Technology:

- This occupation is considered by firms of all sizes, but more so by small firms (10 or less employees).
- This occupation is more likely to be considered by firms that are planning to engage in manufacturing but are not currently.
- Clean technology sectors that are more likely to hire customer service representatives include those firms that are involved in energy efficiency, advanced manufacturing, energy infrastructure, and materials.

Operations and Maintenance Technician or Engineer

Similar standardized occupations (SOC Code): Maintenance and Repair Workers, General (49-9042) and Machinery Maintenance Workers (49-9043).

The work of operations and maintenance technicians or engineers is focused on operating and maintaining machines, mechanical equipment, and buildings and work on plumbing, electrical, and air-conditioning and heating systems. Typical duties include troubleshooting and fixing faulty electrical switches, repairing air-conditioning motors, and unclogging drains. New buildings sometimes have computer-controlled systems that allow maintenance workers to make adjustments in building settings and monitor for problems from a central location.

The critical skill sets include mechanical aptitude and competency in basic mathematics, engineering, and building and construction, and the ability to work with a large selection of tools.

Education:

This occupation typically requires training in vocational schools, related on-the-job experience, or an associate's degree. Some may require a bachelor's degree.

Across industries:

- Operations and maintenance technicians or engineers, like customer service representatives, can be found in almost every industry of the workforce. In the Los Angeles and Orange County region, a substantial proportion are found in the commercial equipment manufacturing, and the traveler accommodations industry.
- Within The Los Angeles and Orange County region, the median annual wage for maintenance and repair workers/operations and maintenance technicians or engineers ranges from \$17,170 to \$68,810 depending on the industry.

In Clean Technology:

- This occupation is considered by firms of all sizes, but more so by medium and larger sized firms (11+ employees).
- This occupation is more likely to be considered by firms that are currently or planning to engage in manufacturing, and less likely to be hired by those firms that are focused on research, design, and consulting.
- Clean technology sectors that are more likely to hire operations and maintenance technicians or engineers include those firms that are involved in energy generation, water and wastewater, materials and agriculture.

METHODOLOGY

The table below briefly outlines the methodology for this project. Two phases of primary research were conducted as part of this project - qualitative executive interviews with employers, industry leaders, and educators in clean technology and a quantitative telephone survey of 82 clean technology employers in California with a strategic over-sample of firms in the Los Angeles and Orange County region.

Table 1 Survey Methodology

Technique	Telephone & Internet Survey of Clean Technology Employers
Universe	A database of 292 clean technology employers in California was created by identifying industry leaders and firms that have received venture capital funding for clean technology projects (according to Cleantech Network LLC). The database is particularly focused on those firms in Los Angeles and Orange counties but includes firms from all over the state.
Number of Respondents	82 Clean technology employers, with 46 from Southern California and 36 from the Bay Area and Northern California. Considerable emphasis was placed on completing interviews with Southern California firms, particularly those in the Los Angeles and Orange County region.
Field Dates	November 26, 2007 to December 21, 2007

Questionnaire Design

Through an iterative process, BW Research worked closely with the Los Angeles/ Orange County Regional Consortium to develop the questionnaire for the study.

To avoid the problem of systematic position bias - where the order in which a series of questions is asked systematically influences the answers to some of the questions - several of the questions in this survey were randomized such that respondents were not consistently asked the questions in the same order (Questions 9, 10, 13 and 18).

APPENDIX A: TOPLINE RESULTS



Los Angeles/ Orange County
Regional Consortium
December 2007

Clean Technology Employer Survey Preliminary Toplines (n=82)

.....
Introduction:

Hello, my name is _____. May I please speak to a Human Resources Manager or person responsible for staffing at [organization]?

Hello, my name is _____ and I'm calling on behalf of the **California Community Colleges**, who would value your participation in a brief survey that will help address your future organization needs for trained and educated employees with clean and green technology skills and knowledge.

(If needed): The survey should take approximately 10 minutes of your time. By answering this survey, you can help the Community College system develop the appropriate type of training that will prepare the employees you will be looking for in the future.

(If needed): This survey has been commissioned by the Los Angeles and Orange County Community Colleges, which are committed to developing the regional workforce. The survey is being conducted by BW Research, an independent research organization.

(If needed): Your individual responses will **not** be published, only aggregate information will be used in the reporting of the survey results.
.....

Organization-Related Questions (Employer Profile)

I'd like to begin by asking you a few general questions about your organization,

1. Including all full-time and part-time employees, how many **permanent** employees work at your business location?

<u>Total # Employees</u>	<u>Mean</u>	<u>Median</u>
2,572	31.8	7.0

Breakdown

2.4%	No permanent employees
40.2%	5 or less employees
18.3%	6 to 10 employees
14.6%	11 to 24 employees
8.5%	25 to 49 employees
6.1%	50 to 99 employees
8.5%	100 or more employees
1.2%	DK/NA

2. If you currently have [TAKE Q1 #] **permanent** employees at your business location, how many more or less permanent employees to you expect to have at your business location 12 months from now?

78.0% More [record # _____]
 0.0% Less [record # _____]
 22.0% (DO NOT READ) Same number of permanent employees

[If amount differs by 10% or more in either direction, ask:]
 Just to confirm, you currently have _____ permanent employees and you expect to have _____ (more/less) employees, for a total of _____ permanent employees 12 months from now.

Expected Employment: 12 months (Calculated by only examining firms with both current and projected data)

	<u>Current</u>	<u>12 months</u>
n	79	79
Mean	32.3	41.1
Median	7.0	14.0
Total Employees	2,554	3,249
New Employees		695
% Growth		27.2%

3. How many business locations does your firm have?

<u>Total # Locations</u>	<u>Mean</u>	<u>Median</u>
253	3.1	1.0

Breakdown

56.1% 1 location
 25.6% 2 locations
 14.6% 3 to 9 locations
 3.7% 10 or more locations

4. Does your firm have business locations in Los Angeles or Orange County, and if so how many?

<u>Total # Locations in LA/OC</u>	<u>Mean</u>	<u>Median</u>
63	0.8	0.0

Breakdown

52.4% 0 locations in LA/OC
 40.2% 1 location in LA/OC
 3.7% 2 locations in LA/OC
 3.7% 3 or more locations in LA/OC

Next, I would like to ask a few questions about the role your firm has in the clean technology industry. Clean technology, which is also described as green technology or the sustainable business industry, is focused on producing products or providing services that use resources more efficiently and reduce or eliminate pollution that is damaging to the environment.

5. How much of your firm's current or future business revenue is focused on clean technology products or services, the primary part of your business, a secondary but important part of your business, a relatively small part of your business, or not a part of the firm's business revenue plan.

80.5%	The primary focus of the business (50 percent or more)
8.5%	A secondary but important part of the business (25 to 49 percent)
6.1%	A relatively small part of the business (1 to 24 percent)
3.7%	Not a part of the firm's business revenue plan (0 percent)
1.2%	(Don't Read) DK/NA

6. Is your firm planning to or in the process of producing, assembling or manufacturing goods in clean technology, or is your firm solely focused on research and development or consulting services for clean technology? If you fall into more than one of these categories please let us know that to.

[ALLOW MULTIPLE RESPONSES]

48.1%	Planning to produce clean technology goods in the future
38.3%	Currently producing goods in clean technology
33.3%	Research and development in clean technology
18.5%	Consulting services for clean technology
21.0%	Other (Please specify: _____)
1.2%	(Don't Read) DK/NA

7. Which industry or industries best categorizes the type of work you are in?

[ALLOW MULTIPLE RESPONSES]

37.0%	Energy generation
35.8%	Energy efficiency
34.6%	Manufacturing
22.2%	Air and environment
18.5%	Transportation
17.3%	Water/ wastewater
16.0%	Recycling and waste
14.8%	Agriculture
13.6%	Energy infrastructure
13.6%	Materials
12.3%	Advanced manufacturing
11.1%	Energy storage
14.8%	(Don't Read) Other (Please specify: _____)
0.0%	(Don't Read) DK/NA

Now, I would like to ask you about workforce and human resources needs for clean technology.

8. How much change do you expect to see in the skills, education, and abilities, of your firm's employees in the next 12 to 24 months?

- 28.4% Little to no change in the composition of employees
- 39.5% Some change in the composition of employees
- 25.9% Substantial change in the composition of employees
- 6.2% (Don't Read) DK/NA

9. Please tell me how much difficulty your firm faces in addressing the following workforce issues,

Here's the (first/next) one _____ (READ ITEM): Please tell me whether your business has no difficulty, some difficulty, or great difficulty in dealing with this issue?

RANDOMIZE

	<u>No difficulty</u>	<u>Some difficulty</u>	<u>Great difficulty</u>	(DON'T READ DK/NA)
A. Keeping current workers properly trained on industry trends and policy requirements.....	50.6%	33.3%	7.4%	8.6%
B. Recruiting enough entry-level employees with appropriate training and education	38.3%	34.6%	13.6%	13.6%
C. Recruiting enough non-entry level employees with adequate skills and work experience.....	34.6%	37.0%	22.2%	6.2%
D. Retaining valuable employees that could be hired by competitors	44.4%	34.6%	11.1%	9.9%

10. Please tell me how important the following areas of technology are for your business,

Here's the (first/next) one _____ (READ ITEM): Please tell me whether this technology is very important, somewhat important or not at all important in your business?

RANDOMIZE

	<u>Very important</u>	<u>Somewhat important</u>	<u>Not at all important</u>	(DON'T READ DK/NA)
A. Advanced manufacturing	36.3%	35.0%	23.8%	5.0%
B. Renewable energy	52.5%	18.8%	23.8%	5.0%
C. Nanotechnology and/or the material sciences.....	15.0%	36.3%	41.3%	7.5%
D. Software development & information technology	25.0%	41.3%	31.3%	2.5%
E. Life sciences and/or biotechnology.....	16.3%	18.8%	57.5%	7.5%

11. Thinking in general about recent entry-level or mid-level hires at your organization, which of the following skills would you say that recent hires tend to be **most deficient** in?

(IF NEEDED: For this question, I would just like your general perception about skill deficiencies for recent hires across occupations at your organization)

- 25.0% Technical competence specific to the position
- 12.5% Creative problem-solving skills
- 8.8% Interpersonal communication skills
- 7.5% Technical writing skills
- 7.5% Ability to work independently
- 7.5% Ability to work with different groups or departments
- 2.5% Other (Please specify_____)
- 1.3% Depends on occupation
- 20.0% Have not hired entry or mid-level recently
- 7.5% (Don't Read) DK/NA

12. Do you expect to hire individuals in the next 12 to 24 months that do **not** require an advanced college degree (master's degree or higher)?

- 55.0% Yes, very likely
- 15.0% Yes, somewhat likely
- 30.0% No, not likely (SKIP TO Q16)
- 0.0% (Don't Read) DK/NA

13. Thinking about the different types of occupations that you might hire for in the next 12 to 24 months, please think about whether they fall into generalized categories?

As I read each general occupation, please indicate whether you have or expect to hire anyone like this in the next 12 to 24 months.

RANDOMIZE

	<u>Yes</u>	<u>Possibly</u>	<u>No</u>	<u>(DON'T READ) DK/NA</u>
A. Manufacturing technician	54.5%	18.2%	27.3%	0.0%
B. Research & development assistant or technician.....	47.3%	21.8%	30.9%	0.0%
C. Quality control technician.....	34.5%	29.1%	34.5%	1.8%
D. Assembler	45.5%	10.9%	43.6%	0.0%
E. Renewable energy technician.....	30.9%	16.4%	52.7%	0.0%
F. Customer service representative	56.4%	12.7%	29.1%	1.8%
G. Operations and maintenance technician or engineer	47.3%	20.0%	30.9%	1.8%

14. Please identify any occupations that you have or expect to hire for in the future that we have not already discussed and will not require an advanced degree (IF ASKED Master's degree or higher)?

15. Which technical skills or areas of knowledge are most important for any future hires that do not require an advanced degree? [DO NOT READ, ALLOW MORE THAN ONE RESPONSE]

- 48.1% Working knowledge of GMP (Good Manufacturing Practices) principles
- 42.6% Electrical knowledge and soldering skills
- 38.9% Working knowledge of renewable energy
- 33.3% Knowledge of regulatory issues
- 16.7% Knowledge and ability to work in a wetlab
- 14.8% Knowledge and ability to work in a clean room
- 9.3% Other (Please specify: _____)
- 7.4% (Don't Read) Depends on occupation
- 11.1% (Don't Read) DK/NA

Now I have a few questions about clean technology and your workforce.

16. For your business, do you expect new developments in 'clean technology' to play a very important role, somewhat important role, or not at all important role in determining the type of skills and knowledge that you will need to hire for in the future?

- 53.8% Very important
- 28.2% Somewhat important
- 11.5% Not at all important
- 2.6% (Don't Read) Depends
- 3.8% (Don't Read) DK/NA

17. Currently do you hire anyone that needs to have understanding or training in manufacturing?

- 46.2% Yes
- 50.0% No
- 3.8% (Don't Read) DK/NA

Before we finish, I'd like to ask you one general question and verify your contact information.

18. What is your firm's level of interest in the following training and education programs that could be developed at regional community colleges for the clean technology workforce. As I read each possible program, please tell me whether your business would have no interest, some interest, or great interest in the following workforce development programs?

RANDOMIZE	<u>No Interest</u>	<u>Some Interest</u>	<u>Great Interest</u>	<u>(DON'T READ DK/NA)</u>
A. A two-year associate's degree program designed for clean technology and renewable energy technicians.....	33.3%	38.5%	23.1%	5.1%
B. A certificate program in clean technology.....	42.3%	38.5%	14.1%	5.1%
C. On-site customized training for your current employees.....	50.0%	35.9%	7.7%	6.4%
D. Assistance recruiting entry-level and middle-level employees.....	38.5%	48.7%	9.0%	3.8%

Please confirm for us your information

- A. First and Last Name of respondent _____
- B. Position of respondent _____
- C. Phone of respondent _____
- D. Email of respondent _____

Thank you, very much for your time

- E. Name of Company _____
- F. Address of company _____
- G. Date of Interview _____
- H. Name of interviewer _____
- I. Time of Interview _____
- J. City of business location _____
- K. Zip Code _____
- L. PRIMARY SIC/NAICS _____

Region:

- 39.0% Los Angeles or Orange County
- 17.1% San Diego, Ventura, Riverside, or San Bernardino County
- 43.9% Other

APPENDIX B: EDUCATION AND TRAINING MODELS: BEST PRACTICES IN THE UNITED STATES AND INTERNATIONALLY

With strong growth expectations for employment and limited training and education programs, there is a growing demand for effective education programs focused on clean technology occupations. Educators examining programs in the clean technology cluster can build upon the success of a few programs that have been identified in this section of the clean technology study.

This addendum is meant to provide an introduction to some of the training and education programs that have effectively prepared students for positions in the clean technology industry. The description of each college program will include a discussion of the overall goals of the education provided, a description of the curriculum provided, and an assessment of how the program will fit the employment needs of the clean technology industry.

The three programs that are highlighted come from different geographic regions (West Coast of the United States, East Coast of the United States, and in the United Kingdom), focus on different academic degrees, and include programs in both community colleges and a university. While these programs are different in many ways, they share some important similarities; they are typically inter-disciplinary in nature and the curriculum includes applied coursework or internships as well as more traditional academic courses to anchor the programs.

ENERGY MANAGEMENT AND SUSTAINABILITY AT LANE COMMUNITY COLLEGE, EUGENE OREGON

Lane Community College has been a leader in training individuals for work in energy efficiency occupations, which is considered by many to be an important foundation for today's clean technology industry. The director of the program, Roger Ebbage, who is also director of the Northwest Energy Education Institute (NEEI), is committed to teaching energy efficiency as the basis for not only the energy efficiency program, but also as the foundation for other programs taught under the energy management department at Lane.

Lane Community College offered one of the first associate's degree programs in energy efficiency, initially introduced at the community college in 1980. In 2003 the College introduced a program in renewable energy. Currently the College offers a two-year associate's degree of applied science in energy management (focused on energy efficiency) and a renewable energy technician degree. In the near future the energy management department will begin offering other associate's degree programs, including water conservation and collection as well as a degree in sustainability focused on resource conservation management.

Currently, the College accepts 30 new students annually for the energy management program and this program is typically at capacity with a waiting list of individuals who would like to enroll. According to Mr. Ebbage, 75 percent of those students that enter the energy management program at Lane have already received a four-year college degree

and are coming back to get there associate's degree. The students are typically highly motivated and are looking to make a career change.

Curriculum

The two-year associate's of applied science degree in energy management includes courses in mathematics, physics, building and design, and English as well as the courses in energy and electrical engineering.

The more traditional academic courses include:

- Intermediate Algebra
- Fundamentals of Physics
- English Composition: Exposition and Introduction to Argument
- Technical Writing (English).

Some of the energy management courses include:

- Introduction to Sustainability
- Residential/Light Commercial Energy Analysis
- Air Conditioning Systems Analysis
- Energy Investment Analysis
- Energy Accounting.

The renewable energy technician degree program has many of the same requirements as the energy management degree, with a larger focus on building skills and a greater understanding of electrical theory.

Employment in Clean Technology

Graduates from Lane's energy management programs find opportunities in energy consulting positions or in the renewable energy field.

Some of the positions include:

- Renewable Energy Technician
- Operations and Maintenance Technician or Engineer (Energy and/or Utilities)
- Energy Auditor or Consultant.

The associate's degree also requires cooperative education and/or some type of internship. The cooperative education agreements are often made with regional utilities or other potential employers in the region.

ENVIRONMENTAL TECHNOLOGY AT CAPE COD COMMUNITY COLLEGE, WEST BARNSTABLE MASSACHUSETTS

Cape Cod Community College's environmental technology program is viewed as one of the leading programs in clean technology offered in the community college system. The program offers an inter-disciplinary approach to preparing students for employment as a technician in the environmental protection arena or a consultant in the field of sustainability.

The environmental technology program at Cape Cod was developed out of the environmental challenges facing the region in the early 1990's. In 1994, The Massachusetts legislature funded an education and training program that would supply a workforce to deal with these issues. Three higher education institutions: Cape Cod Community College, Massachusetts Maritime Academy and the University of Massachusetts at Dartmouth have collaborated, drawing upon the strengths of the three geographically connected institutions, to develop an education and training ladder that will prepare students for jobs in the environmental industry.¹⁴

Curriculum

The two-year associate's in science degree in environmental technology includes courses in chemistry, communications, engineering, earth science, and English as well as the courses in environmental technology.

The more traditional academic courses include:

- Survey in Chemistry
- Oral Composition (Communications)
- Introduction to Earth Science
- English Composition (I and II).

Some of the environmental technology courses include:

- Environmental Instrumentation
- Environmental Chemistry
- Occupational Health & Safety through Hazardous Waste Management
- Coastal Ecology
- Quantitative Methods for Environmental Analysis.

The environmental technology program includes a number of course electives that focus on specialties including; industrial wastewater treatment, oceanography, geographic information systems, botany, air pollution, and renewable energy.

Besides the associate's degree program, the Community College, in collaboration with the Massachusetts Maritime Academy and the University of Massachusetts at Dartmouth, also offers environmental technology certificates. These certificates are

¹⁴ History taken from <http://www.capecod.edu/web/academics/depts/natsci/env>.

designed to provide students with up-to-date knowledge of the principles and practices that are found in the environmental technology field.

These certificates include:

- Environmental Site Assessment
- Coastal Zone Management
- Geographic Information Systems
- Wastewater Management
- Water Supply.

Employment in Clean Technology

Graduates from Cape Cod's environmental technology programs find opportunities in environmental consulting positions or in the hazardous waste or environmental compliance field.

Some of the positions include:

- Research & Development Assistant or Technician
- Quality Control Technician
- Environmental Compliance Technician or Consultant.

CENTER FOR RENEWABLE ENERGY SYSTEMS TECHNOLOGY AT LOUGHBOROUGH UNIVERSITY, LEICESTERSHIRE UNITED KINGDOM

CREST (Center for Renewable Energy Systems Technology) is established within the Department of Electronic & Electrical Engineering at Loughborough University in the United Kingdom. The center is one of the leading international groups working in the field of renewable energy.

The CREST program is focused on renewable energy research, supporting the development and implementation of renewable energy projects, and providing training and education in both theoretical and practical aspects of renewable energy systems technology. CREST is a leading participant in the UK Energy Research Centre and has committed a significant portion of its resources to research on photovoltaics and wind power. CREST also owns and operates, as part of its training and educational resources, a broad range of renewable energy systems including, wind turbines, generators and photovoltaic equipment and cells, just to name a few.

Curriculum

CREST offers a traditional full-time, as well as a distance learning (on-line), master's of science in renewable energy systems technology. This is a post-graduate degree program with some requirements in mathematics and engineering.

The academic foundation of the coursework is grounded in:

- Electricity – An understanding of the ways in which electrical energy is generated and transported.

- Mechanics – A complete understanding of work, power, energy, and conversion efficiency.
- Fluid Mechanics – An understanding of how wind and water turbines convert energy in a fluid into mechanical energy.
- Mathematics – Use of mathematics to understand the technical basis for evaluation particularly used in the wind and solar modules.

The core courses in the program include:

- Sustainability, Policy and Energy Management
- Solar Power (I & II)
- Wind Power (I & II)
- Biomass (I & II)
- Water Power
- Integration of Renewables.

Besides the master's degree, CREST also provides short courses including a five-day wind power course.

Employment in Clean Technology

Graduates from CREST's renewable energy systems technology post-graduate program find opportunities in the renewable energy industry.

Some of the positions include:

- Research & Development Engineer
- Solar Energy Program Manager
- Wind Power Program Manager
- Energy Auditor or Consultant
- Clean Technology Teacher.