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## Green Jobs and the Ohio Economy: The Workforce Skills and Training Ohio Green Industries Need

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U.S. Department of Labor Employment and Training Administration

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# Green Jobs and the Ohio Economy

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## The Workforce Skills and Training Ohio Green Industries Need

June 30, 2011

Prepared by the

Wright State University  
Center for Urban and Public Affairs

in cooperation with the

U.S. Department of Labor  
Employment and Training Administration



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# The Workforce Skills and Training Ohio Green Industries Need

## Overview

In spring 2011, a survey was conducted with private employers representing selected sectors within the *potential* green industry. The following report presents research results about employers and the labor force skills they require to be successful in Ohio's Green Industry.

As mentioned in earlier parts of this report series, there are many challenges to studying the green economy. The word "potential" in the first sentence of this report is a critical term, because there is no known listing of companies in the green industry. Green industry business association lists exist, but those are membership-based lists and not intended to be comprehensive. Using the U.S. Bureau of Labor Statistics (BLS) green industry framework and, to a lesser extent the U.S. Department of Commerce energy framework, a list of industries was selected for the Ohio "green skills" employer survey.

## Research Study Objectives and Questions

The purpose of this research project is to learn more about green jobs in Ohio and to find out about workforce challenges in the green industry. Workforce challenges may pertain to skill, training, or talent shortage issues. Survey results will provide guidance to schools, employment and training services, and workforce development organizations. The results will also assist companies and others in creating solutions to meet workforce challenges. Research questions which may be answered with survey results include:

- How many private companies have green jobs within the targeted industry classification codes?
- Within the targeted industries, how many employees have a primary and/or supporting function in producing green-related products and/or providing green-related services?
- What types of barriers—skill, training, and/or talent shortages—do companies face as they produce green-related products or provide green-related services?
- To whom do private companies turn, and to whom are they willing to turn, for assistance in facing workforce challenges?

## Targeted Sectors

With U.S. BLS and U.S. Department of Commerce guidance, along with other sources such as Global Insight, the State of California, O\*NET, and BioOhio, six targeted industry sectors were identified as the green sectors deemed important to the Ohio economy for this workforce skills and training survey.

1. **Renewable Energy and Alternative Fuels-** developing and using energy sources such as solar, wind, geothermal, and landfill gas and municipal solid waste.

2. **Energy Efficiency**-increasing energy efficiency (broadly defined), such as LEED certified design/construction, residential window retrofitting, and smart grid.
3. **Research, Design and Consulting Services**-energy consulting or research and development in the fields of biotechnology, engineering, and physical and life sciences, for example, related to reducing dependence on fossil fuels or increasing energy efficiency.
4. **Biosciences**-processing agricultural products into biofuels and manufacturing products from organic materials, for example, soybean processing, ethyl alcohol manufacturing.
5. **Manufacturing Green Products and/or Green Technology**-producing goods used in renewable power generation like turbines, and, for example, producing environmental and energy controls and testing equipment.
6. **Advanced Energy**-Replacement or modification of equipment that increases generation output without increasing carbon dioxide emissions; clean coal; advanced nuclear energy, and so on.

### ***Employer size and Sectors***

The first table below displays the number of employers and employees by size class in suspected green industries in Ohio as an aggregate view of the six targeted sectors listed above. The size classes selected for this study of employers include companies with 5-49 employees, 50-99 employees, 100-249 employees, and those with 250+ employees. Very small companies, or those having 1-4 employees, have been excluded from this analysis. Employers in this size class account for only 7.6% of employees in Ohio.

The second table below presents information about the number of private employers and employees within the targeted sectors for this study. Totals are for the sectors overall, and represent potential green sectors and jobs in Ohio.

**Table 1. Number of Employers and Employees in Ohio's Potential Green Economy**

<b>Employment Size Class (Nomenclature)</b>	<b>Number of Employers (Establishments)</b>		<b>Number of Employees Represented</b>	
5 to 49 Employees	11,414	86.8%	174,425	35.3%
50 to 99 Employees	931	7.1%	69,910	14.2%
100 to 249 Employees	573	4.4%	96,037	19.4%
250+ Employees	228	1.7%	153,599	31.1%
<b>Total</b>	<b>13,146</b>		<b>493,972</b>	

Source: Quarterly Census of Employment and Wages (QCEW), 2010, Quarter 2

**Table 2. Number of Employers and Employees in Ohio's Potential Green Industry Sectors**

<b>Green Sector</b>	<b>Number of Employers</b>		<b>Number of Employees</b>	
Advanced Energy	458	3.5%	28,920	5.9%
Biosciences	57	0.4%	6,423	1.3%
Energy Efficiency	9,089	69.1%	237,013	48.0%
Manufacturing Green Products and/or Green Technology	771	5.9%	92,153	18.7%
Renewable Energy and Alternative Fuels	1,458	11.1%	81,951	16.6%
Research, Design and Consulting Services	1,313	10.0%	47,513	9.6%
<b>Total</b>	<b>13,146</b>		<b>493,972</b>	

Source: Quarterly Census of Employment and Wages (QCEW), 2010, Quarter 2

## Methodology

### *Sampling Method*

The population of firms was selected from the Quarterly Census of Employment and Wages (QCEW) database—an administrative database maintained by the Ohio Department of Job and Family Services for ensuring appropriate unemployment compensation insurance by firms. A stratified random sample representing Ohio’s private employers was used.

Three stratification criteria were used to organize the population of firms in order to select a representative sample—targeted industry sector, the firm’s employment size, and the geographic location of firms within five major regions of the state aligned with Ohio’s 12 Economic Development Regions.

Firms in the QCEW database either designate their own industry sector code or are assigned a code by professional state government staff. A total of 204 six-digit NAICS codes were included for this analysis, which excluded NAICS 561310/20/30 (employment placement agencies, temporary help agencies, and professional employer organizations, which are establishments that provide human resources and human resource management services to staff client businesses) to avoid double counting job vacancies. The population of all companies was next organized into four employment class size groups—5-49, 50-99, 100-249, and 250+.

A representative sample from these NAICS-employment size class-geographic combinations was pulled according to the Neyman method. The Neyman Allocation method is recommended by the U.S. Bureau of Labor Statistics. This method optimally allocates sample units to cell strata in the case where the stratification criteria vary greatly in size (e.g., employment in industry sectors and the number of firms in industry sectors). The end of this discussion includes specific formulas and descriptions of the Neyman method as applied in this case.



The total sample size was set at 8,245; however, nearly 780 records had to be discarded due to apparent business closure (disconnected telephone numbers and return-to-sender mailed items). The sample size of 7,465 reflects the geographic and industry detail required for the reliable estimation of job vacancy results. Minimum cell size was fixed at 6 firms, because a response rate of 33% was assumed, resulting in at least two firms responding in each cell which is sufficient for the calculation of a standard deviation for future use.

### Study Implementation

Employers received:

- One letter co-signed by the Ohio Department of Job and Family Services, Ohio Board of Regents, and Wright State University
- A five-page questionnaire from Wright State University that comprised 20 questions, including company background information and future workforce needs.
- To standardize results, a listing of job titles and descriptions was inserted with the questionnaire.
- Telephone prompts and a postcard from Wright State requesting employers to complete the questionnaire online, by mail or fax, or over the telephone by April 22, 2011.

### Response Rates

The survey was conducted from March 11 to June 24, 2011. The study achieved an overall response rate of 50.1%. The total number of completed surveys returned was 3,742 with the vast majority of those companies reporting that they are not part of the Green Industry. Response rates by geography and industry sector follow:

**Table 3. Employer Survey Response Rates by Region and Sector**

<b>Geographic Region of Ohio:</b>	<b>Targeted Industry Sector:</b>
<ul style="list-style-type: none"> <li>• <b>Central – 46.0%</b></li> <li>• <b>Northeast – 46.7%</b></li> <li>• <b>Northwest – 55.6%</b></li> <li>• <b>Southeast – 60.3%</b></li> <li>• <b>Southwest – 52.5%</b></li> </ul>	<ul style="list-style-type: none"> <li>• Advanced Energy – 40.5%</li> <li>• Biosciences – 44.9% (very small sample size)</li> <li>• Energy Efficiency – 48.7%</li> <li>• Manufacturing Green Products and/or Green Technology – 53.5%</li> <li>• Renewable Energy and Alternative Fuels – 57.8%</li> <li>• Research, Design and Consulting Services – 51.2%</li> </ul>

## Study Limitations

Because the vast majority of private companies are not part of the green economy, the result is a low number of green employer respondents. Therefore, the results should be read with caution. Of the 3,742 respondents, 301 employers report that they have green jobs. These results are weighted to reflect the population of companies in the selected sectors for the remainder of this report.

Results for industries having a very small number of units, such as biosciences, had to be combined with another sector, the green manufacturing sector, to achieve a level of prudence in interpreting results.

## The Neyman Method

The Neyman method is composed of three items if targeting by total sample size.

1.  $N_h$  = population of stratum  $h$
2.  $S_h$  = standard deviation of # Job Vacancies in stratum  $h$
3.  $n$  = total sample size (sum of all strata sample sizes)

The first step was to calculate the sample size for each stratum  $h$  using the formula:

$$n_h = \frac{N_h S_h}{\sum N_h S_h}$$

Because this study has never been completed for Ohio, there were no available standard deviations for the number of Job Vacancies. However, it is generally assumed (as a starting point) by the Bureau of Labor Statistics that the number of Job Vacancies = 3% of the total number of jobs. Therefore, std. dev. (# Job Vacancies) = 0.03 \* std. dev. (Total # of Jobs)

Substituting this into the formula,  $n_h$  can be calculated.

The next step was to adjust each value of  $n_h$  according to these constraints:

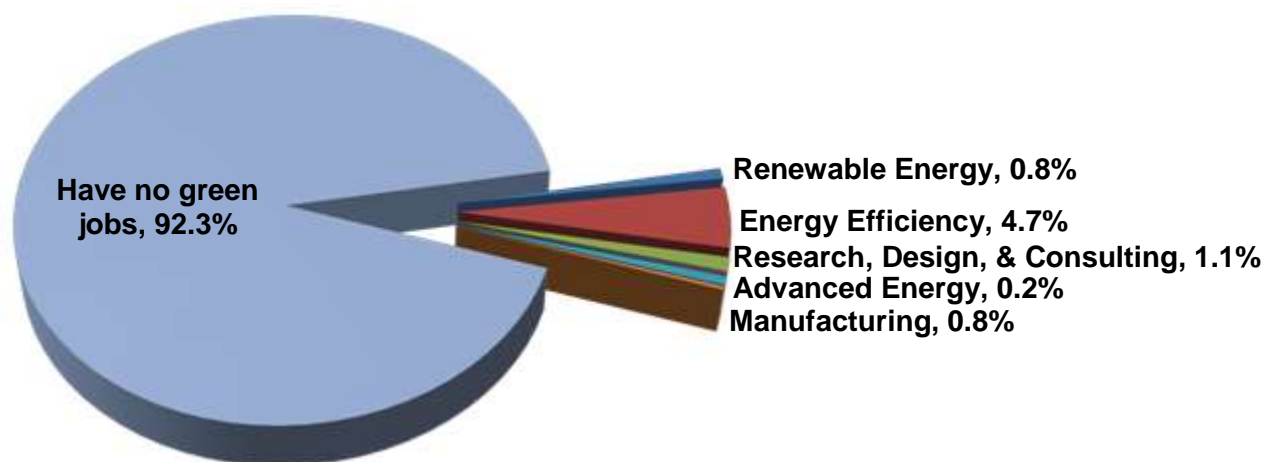
- $6 \leq n_h \leq N_h$ , for  $N_h \geq 6$ ,
  - Sample size could be no larger than the size of the population of stratum  $h$
  - Assuming a response rate of 33%, a minimum sample size of 6 would give a sample containing at least 2 observations, enough to calculate a standard deviation for future use.
- $n_h = N_h$ , for  $N_h \leq 6$ 
  - Because the population size is very small, the entire population would be sent the survey forms.

## Results

### *Green Industry Potential and Actual*

The pie chart below estimates the percentages of companies that do and do not have green jobs in suspected Ohio green industries. The vast majority of the companies report that they have no green jobs (92.3%). For purposes of this survey, a green job is a job that produces goods or provides services that benefit the environment or conserve natural resources. Given that there are 13,146 companies in the potential green sectors and 92.3 percent of them have no green jobs, the remainder of this report presents results that represent 1,021 companies in Ohio in the context of the figure below.

**Figure 1. Proportion of Selected Ohio Industry Sectors with Green Jobs**



As a point of reference, a study of California's green economy identified 12,253 green establishments and 163,616 workers. However, the subsectors of the California study differed from the Ohio study in substantive ways. For example, the California study included recycling establishments which account for 26 percent of green businesses and 21 percent of green employment, whereas the recycling sector was not included in the Ohio targeted industry analysis.<sup>1</sup>

But growth in California's green economy is evident. The environmental services sector almost doubled between 1990 and 2008; green building started with a small base but grew 52 percent since 1990; energy research and services expanded by one-third; and in the early part of 2007, green employment grew as total employment declined.<sup>2</sup> A means of tracking Ohio's green economy over time will aid the snapshot analysis provided in this report.

In Ohio, these 1,021 companies employ 32,621 full-time employees and 1,663 part-time employees for a total of 34,284 employees. Employers were asked to specify the number of

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<sup>1</sup> Karen Chapple, Cynthia Kroll, William T. Lester, Sergio Montero, *Innovation in the Green Economy: An Extension of the Regional Innovation System Model?* Economic Development Quarterly 25, no. 1 (2011), 10, accessed February 3, 2011, <http://journals.ohiolink.edu/>

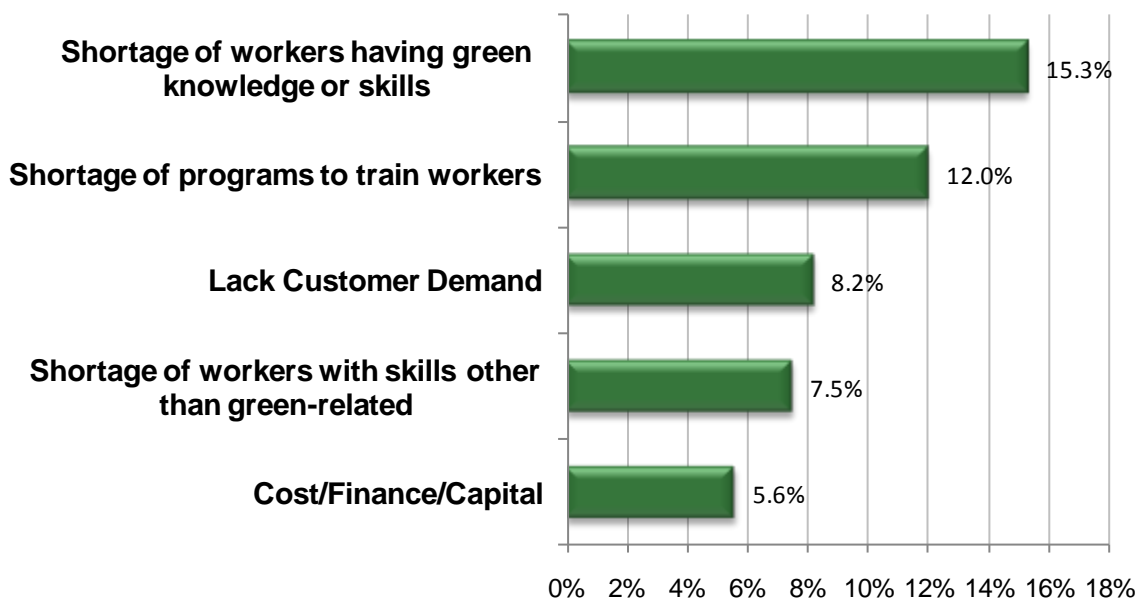
<sup>2</sup> *Ibid*, 10-11.

those employees having a primary function in producing green-related products and/or providing green-related services. A total of 8,145 of the 34,284 jobs (23.8%) have a primary role in green production or service provision. Employers report that an additional 5,557 workers hold support jobs for green-related business activities, that is, they directly support those holding primary functions and they support green related tasks.

### ***Barriers to Producing Green-related Products or Services***

Employers report various barriers to producing green-related products or providing green-related services, with the most commonly cited barriers pertaining to a shortage of workers with green knowledge or skills and a shortage of programs to train workers in green production, processes, or business (15.3% and 12.0%, respectively). Another 8.2 percent of employers report that a lack of customer demand is a barrier to growth (customers not accepting longer payback periods on energy efficiency investments for example). Another concern is the shortage of workers with needed skills other than green skills (7.5%). Nearly 6 percent of employers report cost, financing, and capital investment constraints.

**Figure 2. Barriers to Advancing the Green Economy**



### ***Training Needs, Sources, and Support***

Fifteen percent (15.3%) of green industry employers have training needs related to green knowledge or skills, wherein training is difficult to obtain or is currently unavailable. These employers predominantly expressed training needs in green building-related programs, especially LEED-related training.

Another common training need was in energy efficiency programs including: end use energy efficiency, energy audit and green installation/service training, weatherization, solar PV installation and design, RATA testing (measuring facility emissions data), and interaction with low-voltage electricity.

## Energy Efficiency Building Construction Issues

Building Assessment and Efficiency Remediation Design – Buildings differ in the ways they are designed and built, and in the ways they are inefficient. Wall or roof insulation can be inadequate, windows can provide inadequate insulation, windows and doors may leak air, heating and ventilation may be inadequate or non-uniform, lighting may be inefficient, etc. Each of these problems requires a different fix that has to also consider the existing materials and design of the building. To address this situation, a measurement-based building assessment needs to be conducted, and therefore the workforce needs to be trained in the underlying building design principles, assessment methodologies, and instrumentation (such as infra-red thermometers and air flow monitors) usage. Additionally, there needs to be an analysis [to determine] if the efficiency improvement techniques will produce poor indoor air quality, or excessive moisture retention in the building that will lead to mold formation. Training needs to be provided in the inspection techniques and instruments cited above and in the use and understanding of programs that are available to predict moisture buildup and HVAC requirements.

Building Materials (Selection and Use) – Buildings utilize a wide variety of materials including wood, metals, and numerous synthetic materials, and new materials are being introduced at an increasing rate. There are often several types of materials to choose from for a given construction component, for example cellulose-based insulation or fiberglass insulation. Each material has advantageous and disadvantages that need to be considered in light of the geographic region, the type and design of the building, and the prevailing weather conditions. Training needs to be provided in the major classes of building materials, and in how to find and understand materials' properties and how to make appropriate selections.

Construction and Installation Practices –The reality is that construction is the last manufacturing sector that has no formal quality control, and construction and installation mistakes are the norm. Flashing provides an excellent and germane example. Proper flashing is critical to prevent water leaks where different materials and components meet, but failure to install flashing or to install it properly is common. Improper flashing is a severe problem with conventional construction and causes structural damage, but improper flashing can be a catastrophic problem with new energy efficient materials such as Exterior Insulation and Finishing System (EIFS). Training needs to be provided in proper construction and installation practices, with an emphasis on newer, more energy efficient materials. Training in quality assurance methods is also critically needed.

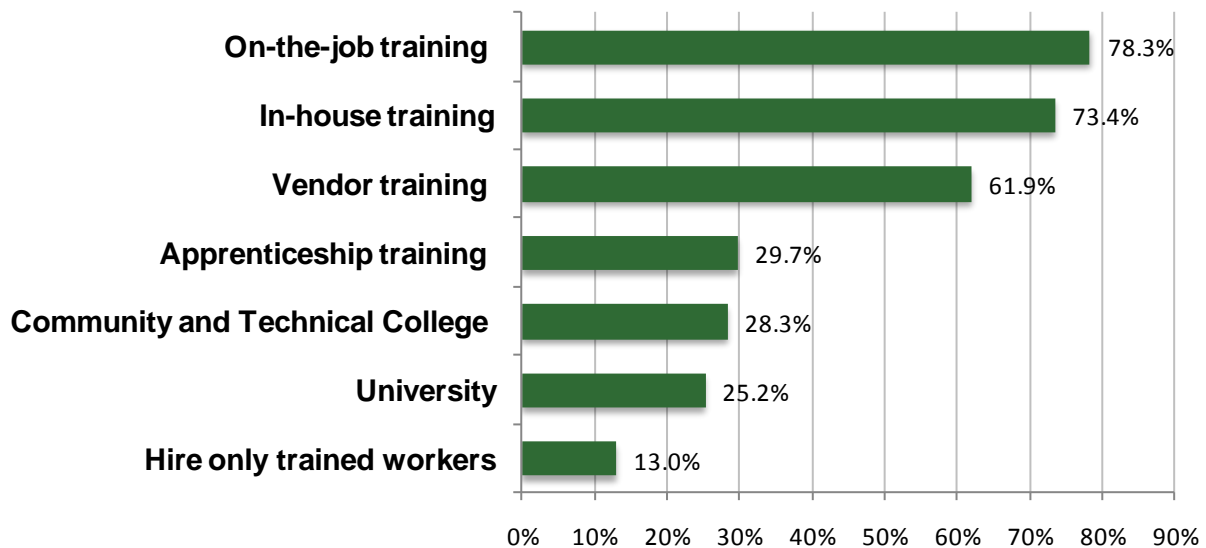
— Institute of Tribology and Coatings (a nonprofit R&D company), *Workforce Training for Green and Energy Technology Related Jobs*

The following charts present the training providers or sources that businesses *currently* use (first chart) and *would like to* use (second chart) to prepare green workers. Most commonly, green industry employers use on-the-job training and in-house training (78.3% and 73.4%, respectively). Vendor training is used by nearly two-thirds (61.9%) of surveyed employers. Lesser used options are apprenticeship programs, community and technical colleges, and universities. Thirteen percent of employers hire only trained workers. In a follow up question, employers were asked, “What sources of training would you consider to meet your green workforce needs that are not currently being met?” In this case, the percentage of employers

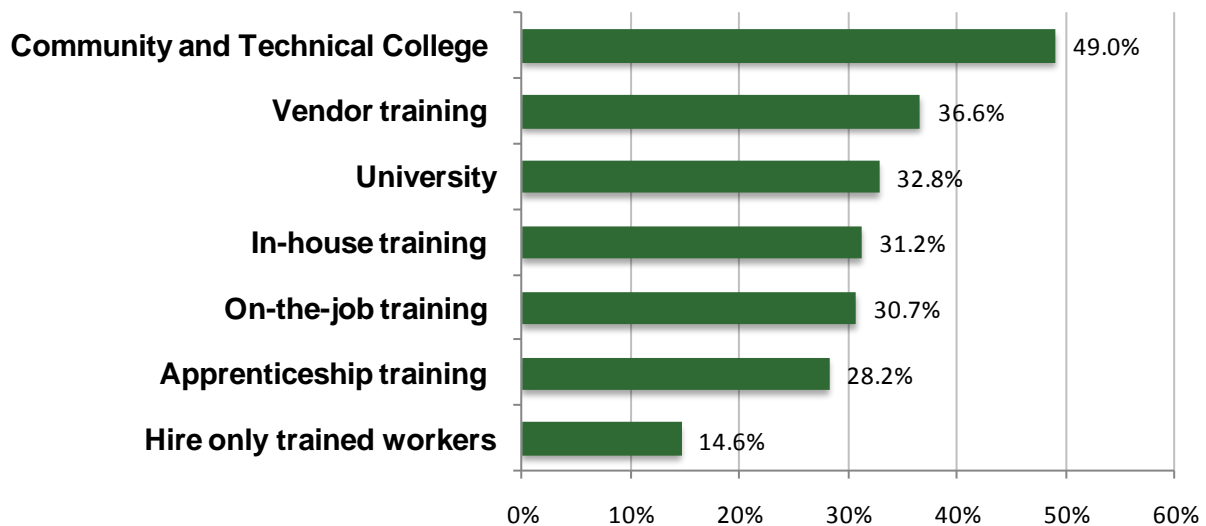
interested in community and technical colleges meeting their needs is 49.0 percent from a base of 28.3 percent currently using those institutions. This result implies an opportunity for community and technical colleges (as well as adult career centers) to communicate their existing green industry programs to employers; and to coordinate with employers to develop or modify programs to meet employer needs.

At the same time, many employers are willing to take financial responsibility for the training needs they have. Nearly half of these employers (48.6%) are willing to support occupation-specific green certification programs and 43.6 percent are willing to support the cost of specialized off-site training.

**Figure 3. Training Providers/Sources Businesses use to Prepare Green Workers**

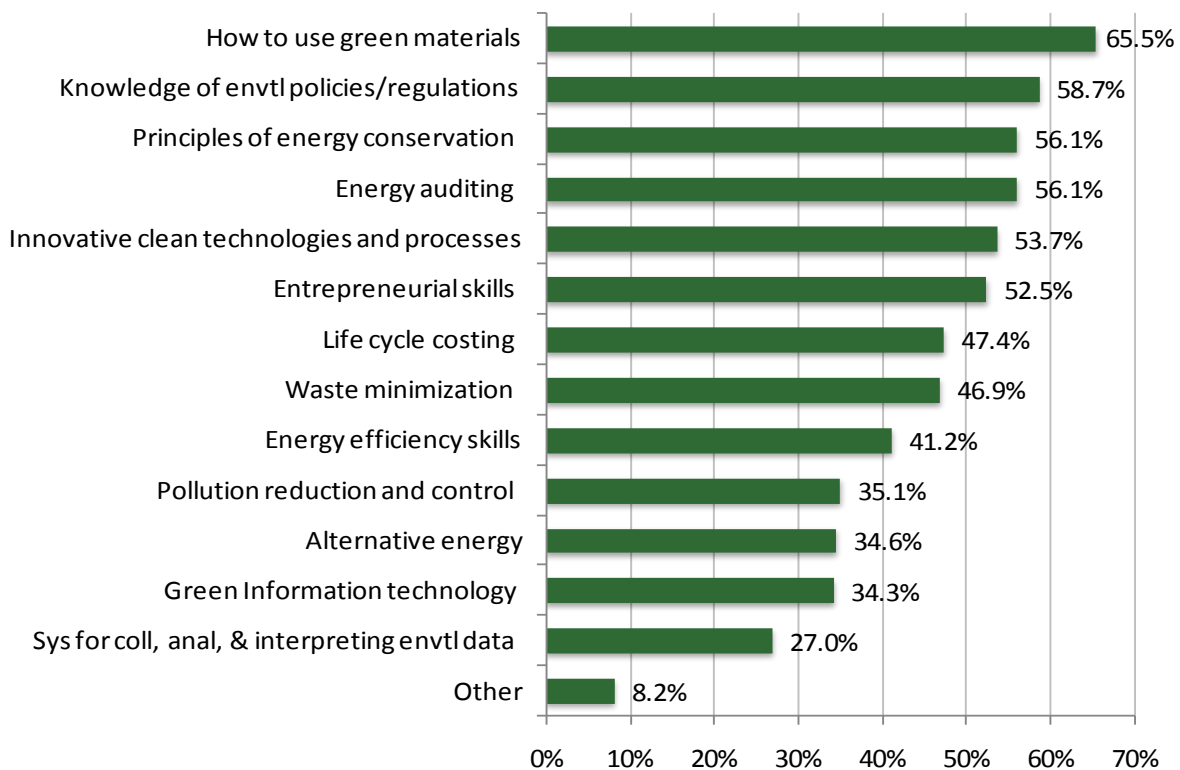


**Figure 4. Sources of Training Employers would consider to meet Green Workforce Needs not currently being Met**



Green workforce knowledge and skill sets are fairly commonly researched across the states pursuing green industry and workforce analyses.<sup>3</sup> In Ohio’s survey, employers were asked to cite the new skills or knowledge that employees will need. The most common new skills or knowledge that current and future employees will need in order to perform green activities are, “How to use green materials in manufacturing/construction processes.” “... workforce training for a “green” economy is not so much about learning entirely new skills, but rather learning new methods and how to use new materials with existing skills. This point is the key difference and has extremely significant implications because conventional industrial practices are based on performing well-established recipes, whereas green industrial practices will require the workforce to evaluate and adopt new materials and methods.”<sup>4</sup> Several other knowledge and skill sets were cited by employers and are listed in the chart below, with a larger majority citing knowledge-based elements such as environmental policies and regulations and principles of energy conservation, than skill-based elements like energy auditing, clean tech, and entrepreneurship. These findings corroborate the Institute of Tribology and Coatings’ viewpoint, in that new knowledge has to precede the application of skills, so that reason can drive evaluation, which drives right action.

**Figure 5. New Skills or Knowledge Current and Future Employees will Need to Perform Green Activities**



<sup>3</sup> Timothy Nolan, Minnesota Pollution Control Agency, *Progressive Green Economy Terms and Concepts*, accessed May 3, 2011, <http://www.environmental-initiative.org/>

<sup>4</sup> Institute of Tribology and Coatings, *Workforce Training for Green and Energy Technology Related Jobs*, accessed June 28, 2011, <http://www.tribologyinstitute.org/Library/WorkforceTrainingForGreenEnergyTechnologies.pdf>, 3.

## Internships and Cooperative Education

Some companies use internships or “co-ops” as a way to train potential candidates. Therefore, questions about such programs were probed in the survey. Over one-third of companies (38.3%) offer internships and/or cooperative education opportunities to college students. Another 28.7 percent of employers are pursuing or are interested in pursuing internship or co-op programs. In over half the cases (57.4%) where an internship or co-op opportunity is offered, the employer provides payment to interns.

## Certifications

The primary source to identify certifications for this research effort was the *CareerOneStop* sponsored by the U.S. Department of Labor, Employment and Training Administration. This source presented a large number of certifications relevant to the six sectors targeted for this green industry analysis. On the survey questionnaire, the list of certifications was customized for each of the six sectors, with the list of certifications spanning about 10 options for the Energy Efficiency and Green Manufacturing sectors, and listing about five certifications for the other sectors. The survey probed two questions regarding certifications:

1. Indicate the level of importance you place on the following certificates/certifications
2. Would having this [certificate/certification] make a job applicant attractive?

The most common certification of importance to green employers is Leadership in Energy & Environmental Design (LEED) certification. On a four-point scale, that is the only certification on the important rather than on the unimportant side of the scale. Results of these questions provide an interesting view when comparing the scores for the first and second questions (above). There is strong agreement that the certificate/certification listed below “makes an applicant attractive,” but measures of the degree of importance attributed to those certificates/certifications is markedly lower. Referring to comments shared by employers, one interpretation is likely. Employers see the benefit of an applicant having certain certificates / certifications, but such certifications are an expensive investment for the employer to obtain and sustain for her/his incumbent workforce. While the nine most commonly cited certificates / certifications are listed below, a total of 35 were rated by employers.

**Table 4. Certifications analyzed in Ohio's Green Employer Survey**

Certification	Responses	Importance (1.0 = Very Important)	Makes job applicant attractive? (1.0 = Strong Agreement)
LEED (Leadership in Energy & Environmental Design)	691	1.95	1.20
Sustainability Professional Certificate	127	2.43	1.42
ASHRAE (American Society of Heating, Refrigeration and Air Conditioning Engineers)	525	2.46	1.49
BPI (Building Performance Institute)	595	2.86	1.68



Certification	Responses	Importance (1.0 = Very Important)	Makes job applicant attractive? (1.0 = Strong Agreement)
AEE (Association of Energy Engineers)	147	2.86	1.65
ACCE (American Council for Construction Education)	474	2.87	1.67
NAHB (National Association of Home Builders) Certified Green Professional)	505	2.88	1.73
NATE (North American Technician Excellence)	512	2.91	1.69
NICET (National Institute for Certification in Engineering Technologies)	468	2.95	1.72

## Job Vacancies

The survey for this project asked employers to provide specific information for occupations critical to the green industry pursuits of their company. Employers presented information for about 50 standard occupations, in which 14,435 people are currently employed. This number exceeds the total number of primary and supporting green occupations that were reported earlier in the results section of this report. Employers may be including occupations critical to their green industry pursuits, but that do not have a primary function in producing green related products or services.

In the survey packet mailed to employers was a standard list of occupational titles, including several new and emerging green job titles, along with a definition of the occupations. The intent of this insert was to obtain standard results back from employers that could be aggregated and analyzed. The complex stratified random sampling method that was utilized for the employer survey was primarily employed for the purpose of accurately estimating job vacancies.

Employers did use standard occupational titles to report their job vacancies. As might be expected during an economic downturn, a limited number of job vacancies was identified—628 among the 14,435 people in critical green occupations. The top job vacancies are highlighted in the table below for selected occupations and occupational groups, accounting for 457 of the 628 job vacancies identified. Of note, further research of the results shows that the majority of green job vacancies are in occupations that require a Bachelor degree or higher per the employers' responses pertaining to the education level that they require.

Job vacancies, however, are not the only workforce challenge affecting employers. Employers also reported the percentage of employees in specified occupations that are retirement eligible in the next 5 years. For the five job groupings below, the total number of retirement eligible employees indicates the trend between new versus replacement jobs, where retirements are expected to outpace the job vacancies. For the critical occupations cited by employers in the list below, 1,349 will become retirement eligible within five years. Combining retirement and job

vacancies, about 1,800 jobs that are critical to the green industry pursuits of companies could be affected.

**Table 5. Job Vacancies and Retirements among Ohio's Green Incumbent Workforce**

<b>Job Title(s) for Selected Occupations</b>	<b>Total Employed*</b>	<b>Job Vacancies</b>	<b>Retirement Eligible</b>
Architects & Engineers	3,451	151	656
Plumbers, Pipefitters, and Steamfitters	1,190	32	253
Construction Managers/Laborers/Carpenters	2,625	138	228
Electricians	1,286	62	135
Heating, air conditioning, and refrigeration mechanics and installers	1,588	73	78
<b>Total</b>	<b>10,140</b>	<b>457</b>	<b>1,349</b>

\*Note: Total Employed is the number of workers employed in that position per employers in Ohio as represented by the respondents to the employer survey.

Besides responding to the standard occupational titles that were provided with the survey, employers cited another 67 occupations that were not pre-listed by researchers. Some of those occupational titles represent new and emerging green titles such as: solar energy installer, PV designer/engineer, and Environmental Project Manager. Most of these “unlisted” occupational titles referred to installers and technicians of energy efficient products and systems, accounting for one-fifth of the occupations. While these occupations are critical to employers, among them, very few job vacancies were reported.

### ***Green Enhanced Skills for Selected Occupations***

Job vacancies are most prevalent for the Energy Efficiency and the Research Design and Consulting sectors as can be presumed by viewing the list of occupations in the job vacancy table above. In this section of the report, the enhanced skills required by the green industry for selected occupations will be highlighted.

The National Center for O\*NET Development investigated the impact of green economy activities and technologies on occupational requirements and the development of new and emerging occupations. Funded by the U.S. Department of Labor, Employment and Training Administration, this work results in, among other things, identification of the new and/or enhanced skills that will be required of people in the green economy. These skills have been specified by occupation.

#### **Architects**

Architects are in a Green Enhanced Skills occupation, which means that green economy activities and technologies are likely to cause significant change to the work and worker requirements. New tasks, skills, knowledge, credentials may be needed. Increased employment

demand for architects by businesses in Ohio is modest according to the employer survey results. New green skills are indicated with an asterisk.

- Prepare information regarding design, structure specifications, materials, color, equipment, estimated costs, operational efficiency, environmental sustainability, or construction time. (This is an existing task that translates to the green economy.)
- Calculate potential energy savings by comparing estimated energy consumption of proposed design to baseline standards.\*
- Design environmentally sound structural upgrades to existing buildings, such as natural lighting systems, green roofs, or rainwater collection systems.\*
- Design or plan construction of green building projects to minimize adverse environmental impact or conserve energy.\*
- Design structures that incorporate environmentally friendly building practices or concepts, such as Leadership in Energy and Environmental Design (LEED) standards.\*
- Perform predesign services, such as feasibility or environmental impact studies.\*
- Plan or design structures such as residences, office buildings, theatres, factories, or other structural properties in accordance with environmental, safety, or other regulations.\*

## Engineers

The job vacancies reported for engineering occupations span many engineering disciplines. The most job vacancies exist among mechanical, electrical and civil engineers; therefore, new green tasks are listed only for those three engineering occupations. On the other hand, several other engineering occupations are expected to require greater skill enhancement than these three engineering occupations. It appears that these other engineering occupations—such as Water/Wastewater Engineers, Wind Energy, and Solar System Engineers—are not prevalent or the titles are not prevalently used among green employers in Ohio yet.

### Mechanical Engineers (new green tasks are listed):

- Calculate energy losses for buildings, using equipment such as computers, combustion analyzers, or pressure gauges.
- Design integrated mechanical or alternative systems, such as mechanical cooling systems with natural ventilation systems, to improve energy efficiency.
- Direct the installation, operation, maintenance, or repair of renewable energy equipment, such as heating, ventilating, and air conditioning (HVAC) or water systems.
- Evaluate mechanical designs or prototypes for energy performance or environmental impact.
- Recommend the use of utility or energy services that minimize carbon footprints.

- Select or install combined heat units, power units, cogeneration equipment, or trigeneration equipment that reduces energy use or pollution.

Electrical Engineers (new green tasks are listed):

- Design electrical systems or components that minimize electric energy requirements, such as lighting systems designed to account for natural lighting.
- Develop systems that produce electricity using renewable energy sources, such as wind, solar, or biofuels.
- Integrate electrical systems with renewable energy systems to improve overall efficiency.

Civil Engineers (new green tasks are listed):

- Analyze manufacturing processes or byproducts to identify engineering solutions to minimize the output of carbon or other pollutants.
- Design energy efficient or environmentally sound civil structures.
- Design or engineer systems to dispose efficiently of chemical, biological, or other toxic wastes.
- Develop or implement engineering solutions to clean up industrial accidents or other contaminated sites.
- Direct engineering activities ensuring compliance with environmental, safety, or other governmental regulations.
- Identify environmental risks and develop risk management strategies for civil engineering projects.

## Plumbers

The Plumber occupation is a Green Enhanced Skills occupation, which means that green economy activities and technologies are likely to cause significant change to the work and worker requirements.<sup>5</sup> New tasks (indicated with an asterisk below), skills, knowledge, and credentials may be needed.

- Calculate costs or savings for water- or energy-efficient appliances or systems.
- Compile information on governmental incentive programs related to the installation of energy or water saving plumbing systems or devices.\*
- Determine sizing requirements for solar hot water heating systems, taking into account factors such as site orientation, load calculations, or storage capacity requirements.\*

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<sup>5</sup> Erich C. Dierdorff, Jennifer J. Norton, Donald W. Drewes, Christina M. Kroustalis, David Rivkin, Phil Lewis, *Greening the World of Work: Implications for O\*NET –SOC and New and Emerging Occupations*, (The National Center for O\*NET Development, Raleigh, NC, 2009), 4.

- Install alternative water sources, such as rainwater harvesting systems or graywater reuse systems.\*
- Install green plumbing equipment, such as faucet flow restrictors, dual-flush or pressure-assisted flush toilets, or tankless hot water heaters.\*
- Install, test, or commission solar thermal or solar photovoltaic hot water heating systems.\*
- Perform domestic plumbing audits to identify ways in which customers might reduce consumption of water or energy.\*
- Recommend energy or water saving products, such as low-flow faucets or shower heads, water-saving toilets, or high-efficiency hot water heaters.\*
- Weld small pipes or special piping, using specialized techniques, equipment, or materials, such as computer-assisted welding or microchip fabrication.\*

### Pipefitters and Steamfitters

Most of the skills required by Pipefitters and Steamfitters are considered to be “non-green”; however, the following short list presents the new green tasks that will be required.

- Install fixtures, appliances, or equipment designed to reduce water or energy consumption.
- Install or test gray water systems, such as recycling, treatment, or irrigation systems.
- Install pipe systems to support alternative energy-fueled systems, such as geothermal heating and cooling systems.

### Construction Managers

Construction Managers is a Green Enhanced Skills occupation — green economy activities and technologies are likely to cause significant change to the work and worker requirements. New tasks, skills, knowledge, credentials may be needed. Employment demand remains the same, but there is potential for an increase.<sup>6</sup> The non-asterisked skills are tasks that have been required of this occupation in the past and which translate as green activities.

- Develop and implement programs, such as safety, environmental protection, or quality control programs.
- Inspect or review projects to monitor compliance with building and safety codes or environmental or other regulations.
- Apply green building strategies to reduce energy costs or minimize carbon output or other sources of harm to the environment.\*
- Develop construction budgets that compare green and non-green construction alternatives in terms of short-term costs, long-term costs, or environmental impacts.\*

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<sup>6</sup> *Ibid*, 4.

- Implement training programs on environmentally responsible building topics to update employee skills and knowledge.\*
- Perform or contract others to perform prebuilding assessments, such as conceptual cost estimating, rough order of magnitude estimating, feasibility, or energy efficiency, environmental, and sustainability assessments.\*
- Procure Leadership in Energy Efficient Design (LEED) or other environmentally certified professionals to ensure responsible design and building activities or to achieve favorable LEED ratings for building projects.\*

### **Construction Laborers**

New green tasks have been identified for the construction laborer occupation, and these are indicated with an asterisk in the list below. The non-asterisked skills are tasks that have been required of this occupation in the past and which translate as green activities.

- Identify, pack, or transport hazardous or radioactive materials.
- Raze buildings or salvage useful materials.
- Apply weather-stripping to reduce energy loss.\*
- Perform building weatherization tasks, such as repairing windows, adding insulation, or applying weather-stripping materials.\*
- Perform construction laborer duties at green building sites, such as renewable energy plants or wind turbine installations.\*
- Perform site activities required of green certified construction practices, such as implementing waste management procedures, identifying materials for reuse, or installing erosion or sedimentation control mechanisms.\*

### **Carpenters, Construction and Rough**

Construction and Rough Carpenters are Green Increased Demand occupations, meaning that green economy activities and technologies are likely to increase the employment demand, but will not lead to significant changes in the work and worker requirements.<sup>7</sup>

### **Electricians**

Electricians is a Green Increased Demand occupation, meaning that green economy activities and technologies are likely to increase the employment demand, but will not lead to significant changes in the work and worker requirements. Therefore no new green skills are identified.

### **Heating, Air Conditioning, and Refrigeration Mechanics and Installers**

The impact of green economy activities and technologies is a significant change to the work and worker requirements of some existing occupations. New green skills have been specified for the Heating, Air Conditioning, and Refrigeration Mechanics and Installers occupation, which primarily pertain to minimizing energy usage and preserving energy. The enhanced skills follow.

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<sup>7</sup> *Ibid*, 4.

- Install and test automatic, programmable, or wireless thermostats in residential or commercial buildings to minimize energy usage for heating or cooling.
- Install dehumidifiers or related equipment for spaces that require cool, dry air to operate efficiently, such as computer rooms.
- Install magnetic-centrifugal chillers, compressors, or related equipment to cool air temperatures through the use of recirculating water.
- Install or repair air purification systems.
- Install or repair self-contained ground source heat pumps or hybrid ground or air source heat pumps to minimize carbon-based energy consumption and reduce carbon emissions.
- Install radiator controls for room-level zone control heating of residential or commercial buildings.
- Repair or service heating, ventilating, and air conditioning (HVAC) systems to improve efficiency.

### ***Profile of Employers Most Supportive of Training***

Because this survey was designed to uncover workforce challenges related to skill gaps among certain green industry employers, this profile focuses on employers reporting that they have training needs. Cross tabulating responses for employers that have training needs, along with their willingness to support the cost of training, enables a targeted analysis about where training investments may be cost shared and most efficacious.

The Energy Efficiency sector, the Research, Design, and Consulting sector, and the Advanced Energy sector are more likely to support the cost of occupation-specific or specialized off-site training programs than the other sectors. Perhaps not surprisingly, the Energy Efficiency and the Research, Design and Consulting sectors are the sectors experiencing the highest number of job vacancies and that may be the motivation to invest in training. The Green Manufacturing sector and the Renewable Energy sector are generally not willing to financially support occupation-specific or specialized off-site training programs.

### **Conclusion**

With policies in place to drive it and the consumer base to support it, green industries and green jobs in Ohio will grow. Investment in green technologies is a worldwide focus, while policy in the U.S. is starting to gain traction.

“2010 marks a historic point for investment in green technologies throughout the world. The amount of money being invested in green technology and green markets through national government economic stimulus spending is staggering. Nearly every developed nation is pumping billions of dollars into green industry research and development at the same time. According to the Financial Times, China leads the way with over \$218 billion, followed by the United States with

\$117.2 billion. Although the total economic stimulus spending of the US government eclipses most all other countries spending combined, the percentage targeted specifically for green investment is relatively low. When China invests \$100 billion dollars more in green markets, it is clear that the US as a whole will have to be more creative, inventive, and targeted with its investment in green markets in order to remain competitive in global markets.”<sup>8</sup>

## **Investment Strategy and Policy**

Federal tax credits are one means of influencing policy. The Qualifying Advanced Energy Manufacturing Investment Tax Credit to encourage the development of a U.S.-based renewable energy manufacturing sector and the Energy-Efficient Appliance Tax Credit for manufacturers of high-efficiency residential appliances are two examples.

“The state remains the most important actor in promulgating cleantech innovation and green economy growth.”<sup>9</sup> California, for example, has some of the most stringent new climate change legislation in the U.S. and this has spurred the largest concentration of green innovation in the country.<sup>10</sup> In fact, venture capital investments in California’s clean technology industry rose from nearly zero in 2005 to \$1.1 billion in 2008—more than two-thirds was in solar technology, 18% in energy management, and 9% in wind energy.<sup>11</sup>

In Ohio, state policy includes House Bill 1, Special Energy Improvement Districts. Ohio House Bill 1 allows local governments to assist property owners in financing solar energy improvements to their properties by requesting a special assessment from the local government.<sup>12</sup> Participating local governments must pass legislation to establish a "special improvement district" to facilitate the financing. Ohio Senate Bill 232 expanded the PACE legislation to include wind, geothermal, biomass, gasification, and energy efficiency technologies.<sup>13</sup>

Ohio also has a Renewable Energy Portfolio Standard, which requires electric distribution utilities and electric services companies to secure a portion of their electricity supplies from alternative energy resources. By the year 2025, 25 percent of the electricity sold by each utility or electric services company within Ohio must be generated from alternative energy sources.<sup>14</sup> To foster economic development within the state, state policy will need to be proactive,

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<sup>8</sup> Shawn Hesse, Heather Wehby, *Green Manufacturing in Dayton: A Policy Road Map toward Green Job Growth*, Blue Green Alliance and emersion DESIGN, (2010), 17.

<sup>9</sup> Karen Chapple, Cynthia Kroll, William T. Lester, Sergio Montero, *Innovation in the Green Economy: An Extension of the Regional Innovation System Model?* Economic Development Quarterly 25, no. 1 (2011), 5-25, accessed February 3, 2011, <http://journals.ohiolink.edu/>

<sup>10</sup> *Ibid.*

<sup>11</sup> *Ibid.*

<sup>12</sup> *Property Assessed Clean Energy (PACE) Financing/Special Energy Improvement Districts (SID)*, The Ohio State University, accessed June 14, 2011, <http://energizeohio.osu.edu/incentives/property-assessed-clean-energy-pace-financingspecial-energy-improvement-districts-sid>.

<sup>13</sup> *Ibid.*

<sup>14</sup> *Public Utilities Commission of Ohio (PUCO)*, Public Utilities Commission of Ohio, accessed June 14, 2011, <http://www.puco.ohio.gov/puco/>.



providing incentives and alternative strategies that encourage energy conservation and the reuse of materials.<sup>15</sup>

Regions play a critical role in fostering innovation. "...local government matters to green innovation and to the green economy more generally; local climate action plans, building codes, financing schemes, and procurement can all help build a market for green products and processes. Thus, the more proactive local governments will likely emerge as the winners, at least initially, in the green economy."<sup>16</sup>

This same research uncovered that embeddedness in local/regional markets plays a significant role for both green and traditional establishments. Green companies that innovate may need not just markets but also the resources of support networks to translate new ideas, products, and services into new business.<sup>17</sup>

### ***The Role of a Skilled, Green Labor Force***

In this economically challenging period, green industry investments and policies are not yet leading to thousands of job vacancies among Ohio's green employers. Not measured is the number of jobs that were able to be retained as these new investments and policies opened up markets for some of Ohio's businesses, while other markets were in decline.

Moving into new markets is common business practice, but adaptability and speed to market gain competitive edge. The green economy is a manageable slice of the market, but it can be argued that all sectors in the knowledge economy gain competitive edge if they have an adaptable labor force.

Overall, the intent of this employer survey was to gain insights into the skills of the green labor force, based on the principle that a flexible workforce enables businesses to pursue new market opportunities as they arise. Market structure—typically measured as the distribution of firm size within the economy—shapes innovation. Different characteristics create an "innovation advantage" for small versus large businesses. Large firms tend to have the relative innovative advantage in industries which are capital intensive and concentrated, while small firms tend to have the relative innovation advantage in industries that are highly innovative, utilize a large proportion of skilled labor, and where the industry is represented by a relatively high proportion of large firms [that may serve as customers to the small firm's products/services].<sup>18</sup> Because diversity of firm size is part of the innovation ecosystem, the clustering and networking of businesses in the green industry, of all sizes, is underscored. The small-firm innovative advantage tends to occur in industries in the early stages of the life cycle. Given the early stage of much of the green industry, an accessible skilled workforce is essential to innovation, which

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<sup>15</sup> Karen Chapple, Cynthia Kroll, William T. Lester, Sergio Montero, *Innovation in the Green Economy: An Extension of the Regional Innovation System Model?* *Economic Development Quarterly* 25, no. 1 (2011), 5-25, accessed February 3, 2011, <http://journals.ohiolink.edu/>

<sup>16</sup> *Ibid.*

<sup>17</sup> *Ibid.*

<sup>18</sup> Zoltán J. Ács, David B. Audretsch, *Innovation, Market Structure, and Firm Size*, *Review of Economics and Statistics*, 69 (1987), 567

leads to economic growth in terms of productivity and jobs, thus giving life to the innovation ecosystem.<sup>19</sup>

### Common Barriers Related to Upskilling the Green Labor Force

How can progress in upskilling the labor force be measured? The beginning of this report described the data challenges of measuring the green economy. Ohio needs a systemic approach to define and measure green-economy jobs. It is crucial to develop a baseline to track progress and understand changes in the entire green economy, and to hold recipients of public dollars accountable for promised results.<sup>20</sup>

How will workforce development and education need to evolve to address green upskilling? Many of the green technologies stem from cross-discipline collaboration and applying knowledge learned in one industry to aid other industries.<sup>21</sup> For example, the European Union's (EU) Environmental Technologies Action Plan (etap) reports that skills can be transferred from older and failing industries – such as the welding and materials abilities of workers in shipbuilding – to newer areas of renewable energy manufacturing and installations.<sup>22</sup>

Research by O\*NET shows that the greening of the economy will likely result in both creating new jobs and the need for new skills in existing jobs, likely placing new skill demands on industries and occupations that already have skill gaps.<sup>23</sup>

The research for this report shows that within the green economy alone, which represents a small portion of Ohio's employment, job vacancies exist. Occupations within the architecture and engineering group as well as several construction occupations have job vacancies. On top of that new skill requirements are being added, creating greater demands on new trainees and continuing education for current skilled workers.<sup>24</sup> Furthermore, other countries such as those in the EU and China are finding management level positions in the green economy challenging to fill. As retirement forecasts are realized, those same burdens will impact green employers in the U.S.

Trends, according to the research conducted by O\*NET, indicate the need for broad-based upskilling:

- 64 occupations were found to qualify as “green increased demand” occupations; these green occupations are not expected to require new skills, but the demand for people with existing skills is likely to increase as green industries grow. However,
- 60 occupations were found to qualify as “green enhanced skills” occupations,

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<sup>19</sup> Karen Chapple, Cynthia Kroll, William T. Lester, Sergio Montero, *Innovation in the Green Economy: An Extension of the Regional Innovation System Model?* Economic Development Quarterly 25, no. 1 (2011), 6, accessed February 3, 2011, <http://journals.ohiolink.edu/>

<sup>20</sup> *Washington State's Green Economy: A Strategic Framework* (2009), 18.

<sup>21</sup> *Ibid*, 28.

<sup>22</sup> "Developing Green Skills for New and Existing Professions," etap, July 2010, 19.

<sup>23</sup> *Washington State's Green Economy: A Strategic Framework* (2009), 28.

<sup>24</sup> *Ibid*, 28.

- 45 occupations previously identified through research on in-demand industry clusters were found to qualify as “green new and emerging” occupations, and
- 46 candidate occupations in the green economy were found to qualify as “green new and emerging” occupations.

Washington State cites that, “Current levels of public and private training to upgrade skills of incumbent workers may not be adequate for the new demand for greening current jobs. Because demand for skill-upgrade training grants for incumbent workers already outstrips state support, it will be challenging for the state’s education and training system to readily help businesses expand into new green products and services.”<sup>25</sup> With the budget crisis, the same may be uncovered in Ohio.

Ohio’s green employer survey shows 12 percent of employers report a shortage of training programs as a barrier. Training needs primarily pertain to green building programs and certifications, especially LEED, and to energy efficiency training programs. Fifteen percent of employers cites a shortage of workers having green knowledge or skills. The most commonly needed skill is for workers who know how to use green materials in manufacturing and construction processes.

### Potential Solutions to Labor Force Skill Challenges

**Economic Development.** Regional and local economic development officials need to be proactive. They can enable green industry innovation by clustering and networking businesses. Diversity of firm size should be a priority to advance the innovation ecosystem. And they should not stop there. Cross-sector initiatives are paramount. Given that many of the green technologies stem from cross-discipline collaboration, inducing interaction between green and non-green industries, paired based on common workforce skill requirements, is the next step.

**Workforce Development.** While 28 percent of employers use community and technical colleges to address training needs, 49 percent would like to meet their training needs with those institutions. This is an opportunity to promote the green industry training programs offered by community and technical colleges as well as adult career centers.

The fact that nearly half of the employers are willing to help support the cost of specialized training and occupation-specific green certification programs is another opportunity. **Incumbent worker training dollars** will stretch further if distributed on a matching funds basis. Survey results show that the Energy Efficiency sector should be the primary target. Networking businesses together to pool their demand and training resources may be a key to training program evolution and sustainability.

**Skill Development.** Green industry evolution will result in greater demands on new trainees and continuing education for current skilled workers. “One of the most significant sectors [in the green economy] is construction, of which the single most important component is ecofriendly design. Raising the environmental performance of new and existing buildings and promoting the use of renewable sources of energy are among the most cost efficient ways to reduce our

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<sup>25</sup> *Ibid*, 28.

environmental footprint.”<sup>26</sup> As reported earlier in this report, the ability to communicate ideas and green concepts, paired with the right diagnostic skills to enable workers to evaluate decisions, are essential skills, without which the industry could fall on its face. Recall the Exterior insulation finishing systems, EIFS, bungle in the 1970s. “In the late 1980s problems started developing due to water leakage in EIFS-clad homes. This created a national controversy and numerous lawsuits. The problem was not that EIFS allowed water penetration. The problem was that barrier-type EIFS systems do not allow water – that may penetrate the building envelope due to leaks around windows and flashing for example – to escape. Many buildings with barrier type EIFS systems developed mold and rot problems that prevented inhabitation of the structures and that required complete removal of the buildings’ exterior, removal of the mold, repair of rotted areas, and reapplication of an exterior covering. The EIFS itself was not leaking, but use of EIFS required use of improved construction practices in conventionally used components of the building, and in some cases the EIFS was improperly installed without the necessary means to allow water that did enter the structure to escape.”<sup>27</sup>

**Policy Development.** Given that skilled labor induces innovation, and innovation breeds economic growth via productivity and job gains, environmental strategies and environmental policy should always have a skills development component and should advance workforce policy.

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<sup>26</sup> "Developing Green Skills for New and Existing Professions," etap, July 2010, 19.

<sup>27</sup> Institute of Tribology and Coatings, *Workforce Training for Green and Energy Technology Related Jobs*, accessed June 28, 2011, <http://www.tribologyinstitute.org/Library/WorkforceTrainingForGreenEnergyTechnologies.pdf>, 3.

# Appendix A: Employer Survey, Energy Efficiency Sector

## Ohio Green Skills Survey

### Energy Efficiency

**About the Survey.** The State of Ohio is interested in obtaining workforce skills and training information about green jobs in Ohio. For the purposes of this survey, a green job is a job that produces goods or provides services that benefit the environment or conserve natural resources, directly or indirectly.

Your input on this survey will help guide education and workforce decisions. All individual responses are confidential; results will be presented in the aggregate. If you have multiple locations, please fill out the survey only for this location. Do **NOT** include consultants, outside contractors, vendors, and others who are not considered to be employees when responding to the questions below.

#### **SURVEY OPTIONS Save money, save paper, save time!**

- Respond online at [www.wright.edu/cupa/greenskills](http://www.wright.edu/cupa/greenskills)
- Call us toll free at 800-877-6181 or fax pages to 937-775-2422
- Mail in the enclosed postage-paid envelope

1. Which of the following defines your company's role in the Green Industry? (*Select all that apply.*)

- Renewable Energy and Alternative Fuels-** developing and using energy sources such as solar, wind, geothermal, and landfill gas and municipal solid waste.
- Energy Efficiency-** increasing energy efficiency (broadly defined), such as LEED certified design/construction, residential window retrofitting, and smart grid.
- Research, Design and Consulting Services-** energy consulting or research and development in the fields of biotechnology, engineering, and physical and life sciences, e.g., related to reducing dependence on fossil fuels or increasing energy efficiency.
- Biosciences-** processing agricultural products into biofuels and manufacturing products from organic materials, e.g., soybean processing, ethyl alcohol manufacturing.
- Manufacturing Green Products and/or Green Technology** -producing goods used in renewable power generation like turbines, and, e.g., producing environmental and energy controls and testing equipment.
- Advanced Energy-**Replacement or modification of equipment that increases generation output without increasing carbon dioxide emissions; clean coal; advanced nuclear energy; etc.
- None of these green categories was essential to any job in our organization in 2010**—If you check this box, **END SURVEY & return this page**

2. How many employees do you currently have at this specific location? Full-time | Part-time  
\_\_\_\_\_
3. How many employees have **a primary function** in producing green-related products and/or providing green-related services? \_\_\_\_\_
4. How many employees hold **support jobs** for your green-related business activities? (They directly support those holding primary functions and they support green related tasks.) \_\_\_\_\_
5. How many employees engage in business functions unrelated to your green business activities? \_\_\_\_\_
6. Does your business create a product that has an environmental certification?  Yes  No  
If yes, *specify products certified and type of certification.* \_\_\_\_\_
7. For calendar year 2010, what was your company's annual gross revenue? \_\_\_\_\_
8. Does your business face barriers to producing green-related products or providing green-related services? (Select all that apply.)
- Shortage of workers currently having green knowledge or skills
  - Shortage of workers with other non-green related knowledge or skills
  - Shortage of programs to train workers in green production, processes or business
  - Government policies
  - Other, *specify* \_\_\_\_\_
  - Not applicable

	9. Indicate the level of importance you place on the following certificates/certifications.				10. Would having this make a job applicant attractive?	
	Very Important	Important	Un-important	Very un-important	Yes	No
	1	2	3	4	Yes	No
ACCE (American Council for Construction Education)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
ASHRAE (American Society of Heating, Refrigeration and Air Conditioning Engineers)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
BPI (Building Performance Institute)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
LEED (Leadership in Energy and Environmental Design)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
NAHB (National Association of Home	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

9. Indicate the level of importance you place on the following certificates/certifications.					10. Would having this make a job applicant attractive?	
	Very Important	Important	Un-important	Very un-important	Yes	No
	1	2	3	4	Yes	No
Builders) Certified Green Professional						
NATE (North American Technician Excellence)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
NCCER (National Center for Construction Education & Research)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
NICET (National Institute for Certification in Engineering Technologies)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
RESNET (Residential Energy Services Network)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
RSES (Refrigeration Service Engineers Society)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Other, specify	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

11. Do you have training needs related to green knowledge or skills, wherein training is difficult to obtain or is currently unavailable?

- Yes, *specify* \_\_\_\_\_
- No

	12. What training providers or sources does your business use to prepare green workers? <i>(Select all that apply.)</i>	13. What sources of training would you consider to meet your green workforce needs that are not currently being met? <i>(Select all that apply.)</i>
In-house training	<input type="checkbox"/>	<input type="checkbox"/>
On the job training	<input type="checkbox"/>	<input type="checkbox"/>
Vendor training	<input type="checkbox"/>	<input type="checkbox"/>
Apprenticeship training	<input type="checkbox"/>	<input type="checkbox"/>
Community/technical college	<input type="checkbox"/>	<input type="checkbox"/>
University	<input type="checkbox"/>	<input type="checkbox"/>
We hire only workers who are already trained	<input type="checkbox"/>	<input type="checkbox"/>

14. Is your business willing to support the cost of specialized off-site training and occupation-specific green certification programs?

Specialized off-site training?  Yes  No

Occupation-specific green certification programs?  Yes  No

15. What new skills or knowledge will current and future employees need in order to perform green activities for your business? (*Select all that apply.*)

- Entrepreneurial skills to take advantage of green growth opportunities
- How to use green materials in manufacturing/construction processes
- Knowledge of innovative clean technologies and processes
- Life cycle costing for those in procurement and management
- Energy efficiency skills for business support advisors and brokers, such as conducting feasibility and cost-benefit studies for environmental remediation projects
- Green Information technology (e.g., environmentally sustainable computing)
- Systems for collecting, analyzing, and interpreting environmental data and creating models or scenarios to predict the impact of changing circumstances
- Energy auditing
- Principles of energy conservation
- Waste minimization
- Pollution reduction and control
- Knowledge of environmental policies/regulations
- Alternative energy, *specify* \_\_\_\_\_
- Other, *specify* \_\_\_\_\_

16. Some companies use internships or “co-ops” as a way to train potential candidates. Does this company offer internship and/or cooperative education opportunities to college students?

- Yes
- No. Is your company pursuing or interested in pursuing an internship or cooperative education program?  Yes  No (If “no,” *skip next question*)

17. Do you offer paid internships?

- Yes. What is an average hourly rate you pay for interns? \_\_\_\_\_
- No



For Energy Efficiency

<b>Job Titles*</b> 18. Complete this table for occupations critical to green industry pursuits of your company. • Include full- and part-time, temporary and permanent workers • Exclude consultants, outside contractors, vendors, and others not considered employees.	Total Green Employment  Write in total # of employees in the occupation in 2011	Write in # of current job vacancies	Full-time = F** Part-time = P Casual = C	% of your employees in this occupation that are retirement eligible in the next 5 years	<b>What education level is usually required?</b> Enter one of the following education codes 1. No requirement 2. High school diploma/GED 3. Some college, no degree 4. Vocational training 5. Associate's degree 6. Bachelor's degree 7. Advanced degree	
					Educ code	List any required special "green" licenses, certificates, or other training.
<i>(Example)</i> Construction Managers	5	1	F	40%	6	BPI (Building Performance Institute)
Architects, except landscape and naval						
Computer programmers						
Computer software engineers, applications						
Carpenters, Construction						
Carpenters, Rough						
Construction laborers						
Electricians						
Heating, air conditioning, and refrigeration mechanics and installers						
Plumbers, pipefitters, and steamfitters						
Solar Energy Installation Managers						
Other _____						
Other _____						
Other _____						
Other _____						

Notes:

\*Please see the job descriptions page inserted with your package to reference as needed.

\*\* **Full-time** = 35+ hours per week; **Part-time** = 1-34 hours per week; Casual is a temporary worker that works on an as-needed basis

	19. Are there any other issues or gaps faced by your company when employing green skilled workers where colleges and universities can or should provide the necessary coursework or training?						Are you able to reasonably fill positions for the occupation(s)?	
	...difficulty recruiting workers that have green industry skills?		...to hire someone without the desired credential and then train them to meet the needs of the job?		...difficulty keeping employees that have green industry skills?			
	Yes	No	Yes	No	Yes	No	Yes	No
<i>(Example) Construction Managers</i>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

20. Are there any other issues or gaps faced by your company when employing green skilled workers where colleges and universities can or should provide the necessary coursework or training?

Questions? Contact our survey team at 1-800-877-6181 or email [jane.dockery@wright.edu](mailto:jane.dockery@wright.edu)

## Appendix B: NAICS by Green Industry Sector

### ***Renewable Energy and Alternative Fuels***

*Developing and using energy sources such as solar, wind, geothermal, and landfill gas and municipal solid waste*

- 113310 - Logging
- 221330 - Steam and air-conditioning supply
- 325211 - Plastics Material and Resin Manufacturing
- 326113 - Unlaminated Plastics Film and Sheet (Except Packaging)
- 326199 - All Other Plastics Product Manufacturing
- 331210 - Iron and Steel Pipe and Tube Manufacturing
- 331511 - Iron Foundries
- 331512 - Steel investment foundries
- 331513 - Steel foundries, except investment
- 331521 - Aluminum die-casting foundries
- 331522 - Nonferrous, except Al, die-casting foundries
- 331524 - Aluminum foundries, except die-casting
- 331525 - Copper foundries, except die-casting
- 331528 - Other nonferrous foundries, exc. Die-casting
- 332111 - Iron and steel forging
- 332112 - Nonferrous forging
- 332322 - Sheet Metal Work Manufacturing
- 332410 - Power Boiler and Heat Exchanger Manufacturing
- 332420 - Metal Tank (Heavy Gauge) Manufacturing
- 333120 - Construction Machinery Manufacturing
- 333511 - Industrial mold manufacturing
- 333612 - Speed changer, drive, and gear manufacturing
- 333613 - Mechanical power transmission equipment mfg.
- 333911 - Pump and Pumping Equipment Manufacturing
- 333912 - Air and Gas Compressor Manufacturing
- 333922 - Conveyor and Conveying Equipment Manufacturing
- 333923 - Overhead Traveling Crane, Hoist, and Monorail System
- 333995 - Fluid Power Cylinder and Actuator Manufacturing
- 333997 - Scale and Balance (except Laboratory) Manufacturing
- 333999 - All Other Miscellaneous General Purpose Machinery
- 334418 - Printed circuits and electronics assemblies
- 335313 - Switchgear and Switchboard Apparatus Manufacturing
- 335931 - Current-Carrying Wiring Device Manufacturing
- 423720 - Plumbing & Heating Equipment & Supplies (Hydronics) Merchant Wholesalers
- 541370 - Other surveying and mapping services

## **Energy Efficiency**

*Increasing energy efficiency (broadly defined), such as LEED certified design/construction, residential window retrofitting, and smart grid*

- 236115 - New single-family general contractors
- 236116 - New multifamily general contractors
- 236117 - New housing operative builders
- 236118 - Residential remodelers
- 236210 - Industrial building construction
- 236220 - Commercial building construction
- 238111 - Residential poured foundation contractors
- 238112 - Nonresidential poured foundation contractors
- 238131 - Residential framing contractors
- 238132 - Nonresidential framing contractors
- 238141 - Residential masonry contractors
- 238142 - Nonresidential masonry contractors
- 238151 - Residential glass and glazing contractors
- 238152 - Nonresidential glass and glazing contractors
- 238161 - Residential roofing contractors
- 238162 - Nonresidential roofing contractors
- 238171 - Residential siding contractors
- 238172 - Nonresidential siding contractors
- 238191 - Other residential exterior contractors
- 238192 - Other nonresidential exterior contractors
- 238211 - Residential electrical contractors
- 238212 - Nonresidential electrical contractors
- 238221 - Residential plumbing and HVAC contractors
- 238222 - Nonresidential plumbing and HVAC contractors
- 238291 - Other residential building equipment contractors
- 238292 - Other nonresidential bldg equipment contractors
- 238311 - Residential drywall contractors
- 238312 - Nonresidential drywall contractors
- 238351 - Residential finish carpentry contractors
- 238352 - Nonresidential finish carpentry contractors
- 238391 - Other residential finishing contractors
- 238392 - Other nonresidential finishing contractors
- 314110 - Carpet and rug mills
- 314121 - Curtain and drapery mills
- 321114 - Wood preservation
- 321219 - Reconstituted wood product manufacturing
- 321911 - Wood window and door manufacturing

- 321918 - Other millwork, including flooring
- 321991 - Manufactured home, mobile home mfg
- 321992 - Prefabricated wood building mfg
- 324122 - Asphalt shingle and coating materials mfg.
- 327121 - Brick and structural clay tile mfg
- 327122 - Ceramic wall and floor tile manufacturing
- 327123 - Other structural clay product manufacturing
- 327124 - Clay refractory manufacturing
- 327125 - Nonclay refractory manufacturing
- 327310 - Cement manufacturing
- 327320 - Ready-mix concrete manufacturing
- 327331 - Concrete block and brick manufacturing
- 327332 - Concrete pipe manufacturing
- 327390 - Other concrete product manufacturing
- 327410 - Lime manufacturing
- 327420 - Gypsum product manufacturing
- 327993 - Mineral wool manufacturing
- 327999 - Miscellaneous nonmetallic mineral products
- 332312 - Fabricated structural metal mfg
- 332321 - Metal window and door manufacturing
- 332913 - Plumbing fixture fitting and trim mfg.
- 332919 - Other metal valve and pipe fitting mfg.
- 332996 - Fabricated pipe and pipe fitting mfg.
- 333311 - Automatic vending machine mfg
- 333312 - Commercial laundry and drycleaning machinery
- 333315 - Photographic and photocopying equipment mfg.
- 333412 - Industrial and commercial fan and blower mfg.
- 333414 - Solar Power Heating Equipment, Heating equipment, except warm air furnaces
- 333415 - AC, refrigeration, and forced air heating
- 334111 - Electronic computer manufacturing
- 334113 - Computer terminal manufacturing
- 334119 - Other computer peripheral equipment mfg.
- 334210 - Telephone apparatus manufacturing
- 334220 - Broadcast and wireless communications equip.
- 334290 - Other communications equipment mfg
- 334310 - Audio and video equipment mfg
- 334513 - Industrial process variable instruments
- 334514 - Totalizing fluid meters and counting devices
- 334519 - Other measuring and controlling device mfg.
- 335110 - Electric lamp bulb and part mfg

- 335121 - Residential electric lighting fixture mfg.
- 335122 - Nonresidential electric lighting fixture mfg.
- 335129 - Other lighting equipment mfg
- 335211 - Electric housewares & household fan mfg
- 335221 - Household cooking appliance manufacturing
- 335222 - Household refrigerator and home freezer mfg.
- 335224 - Household laundry equipment mfg.
- 335228 - Other major household appliance mfg.
- 335312 - Motor and generator manufacturing
- 335911 - Storage battery manufacturing
- 335999 - Miscellaneous electrical equipment mfg.
- 337920 - Blind and shade manufacturing
- 541310 - Architectural services
- 541320 - Landscape architectural services
- 541410 - Interior design services
- 541420 - Industrial design services
- 541511 - Custom computer programming services
- 541512 - Computer systems design services
- 561730 - Landscaping services
- 811211 - Consumer electronics repair and maintenance
- 811212 - Computer and office machine repair
- 811213 - Communication equipment repair
- 811219 - Other electronic equipment repair
- 811310 - Commercial machinery repair and maintenance
- 811412 - Appliance repair and maintenance

## ***Research, Design and Consulting Services***

*Energy consulting or research and development in the fields of biotechnology, engineering, and physical and life sciences, e.g., related to reducing dependence on fossil fuels or increasing energy efficiency*

- 541330 - Engineering services
- 541360 - Geophysical surveying and mapping services
- 541380 - Testing laboratories
- 541614 - Process and logistics consulting services
- 541620 - Environmental consulting services
- 541690 - Other technical consulting services
- 541711 - Research and development in biotechnology
- 541712 - Other physical and biological research

## **Biosciences**

*Processing agricultural products into biofuels and manufacturing products from organic materials, e.g., soybean processing, ethyl alcohol manufacturing*

- 311221 - Wet Corn Milling
- 311222 - Soybean Processing
- 325193 - Ethyl alcohol manufacturing
- 325199 - All other basic organic chemical mfg.
- 325221 - Cellulosic Organic Fiber Manufacturing
- 325311 - Nitrogenous fertilizer manufacturing

## **Manufacturing Green Products and/or Green Technology**

*Producing goods used in renewable power generation like turbines, and, e.g., producing environmental and energy controls and testing equipment*

- 322110 - Pulp mills
- 322121 - Paper, except newsprint, mills
- 322122 - Newsprint mills
- 322130 - Paperboard mills
- 324121 - Asphalt paving mixture and block mfg.
- 325510 - Paint and coating manufacturing
- 325520 - Adhesive manufacturing
- 325611 - Soap and other detergent manufacturing
- 325612 - Polish and other sanitation good mfg.
- 325910 - Printing ink manufacturing
- 325991 - Custom compounding of purchased resins
- 325998 - Other miscellaneous chemical product mfg.
- 326299 - All other rubber product manufacturing
- 327211 - Flat glass manufacturing
- 327212 - Other pressed and blown glass and glassware
- 327213 - Glass container manufacturing
- 331111 - Iron and steel mills
- 331314 - Secondary smelting and alloying of aluminum
- 331315 - Aluminum sheet, plate, and foil mfg
- 331316 - Aluminum extruded product mfg
- 331423 - Secondary processing of copper
- 331492 - Secondary processing of other nonferrous
- 332911 - Industrial valve manufacturing
- 333411 - Air purification equipment mfg
- 334512 - Automatic environmental control mfg
- 334515 - Electricity and signal testing instruments

- 334516 - Analytical laboratory instrument mfg.
- 336111 - Automobile manufacturing
- 336112 - Light truck and utility vehicle manufacturing
- 336311 - Carburetor, piston, ring, and valve mfg.
- 336312 - Gasoline engine and engine parts mfg.
- 336322 - Other motor vehicle electric equipment mfg.
- 336340 - Motor vehicle brake system manufacturing
- 336350 - Motor vehicle power train components mfg.
- 336399 - All other motor vehicle parts manufacturing
- 336510 - Railroad rolling stock manufacturing
- 336611 - Ship building and repairing

## **Advanced Energy**

*Replacement or modification of equipment that increases generation output without increasing carbon dioxide emissions; clean coal; advanced nuclear energy; etc.*

- 211111 - Petroleum and Natural Gas Extraction
- 213111 - Drilling Oil and Gas Wells
- 221111 - Hydroelectric power generation
- 221112 - Power generation, Electric power generation, fossil fuel (e.g., coal, oil, gas)
- 221113 - Nuclear electric power generation
- 221119 - Other electric power generation
- 221121 - Transmission of electric power
- 221122 - Electric power distribution systems
- 221210 - Oil and Gas Distribution Systems
- 237130 - Power and communication system construction
- 333131 - Mining and Oil & Gas Field Machinery Manufacturing
- 333132 - Oil & Gas Field Machinery and Equipment Manufacturing
- 333611 - Turbine and turbine generator set units mfg.
- 334413 - Semiconductors and related device mfg.
- 335311 - Electric power and specialty transformer mfg.
- 562213 - Solid waste combustors and incinerators
- 926130 - Utility regulation and administration



## Appendix C: Occupational Titles and Green Industry Sector

SOC Code	Occupation	Description	Sector
17-2011	Aerospace Engineers	Perform a variety of engineering work in designing, constructing, and testing aircraft, missiles, and spacecraft. May conduct basic and applied research to evaluate adaptability of materials and equipment to aircraft design and manufacture. May recommend improvements in testing equipment and techniques.	Research, Design & Consulting
17-1011	Architects, except landscape and naval	Plan and design structures, such as private residences, office buildings, theaters, factories, and other structural property.	Energy Efficiency, Research, Design & Consulting
17-3011	Architectural and civil drafters	Prepare detailed drawings of architectural and structural features of buildings or drawings and topographical relief maps used in civil engineering projects, such as highways, bridges, and public works. Utilize knowledge of building materials, engineering practices, and mathematics to complete drawings.	Research, Design & Consulting
17-3027.01	Automotive engineering technicians	Assist engineers in determining the practicality of proposed product design changes, and plan and carry out tests on experimental test devices and equipment for performance, durability and efficiency.	Research, Design & Consulting
17-2141.02	Automotive engineers	Develop new or improved designs for vehicle structural members, engines, transmissions and other vehicle systems, using computer-assisted design technology. Direct building, modification, and testing of vehicle and components.	Research, Design & Consulting

SOC Code	Occupation	Description	Sector
<b>51-8099.01</b>	Biofuels processing technicians	Calculate, measure, load, mix, and process refined feedstock with additives in fermentation or reaction process vessels and monitor production process. Perform, and keep records of, plant maintenance, repairs, and safety inspections.	Biosciences
<b>11-9041</b>	Biofuels/ Biodiesel technology and product development managers	Plan, direct, or coordinate activities in such fields as architecture and engineering or research and development in these fields.	Renewable Energy
<b>51-8099.03</b>	Biomass plant technicians	Control and monitor biomass plant activities and perform maintenance as needed.	Biosciences
<b>17-2199.01</b>	Biomedical engineers	Apply knowledge of biology, chemistry, and engineering to develop usable, tangible products. Solve problems related to materials, systems and processes that interact with humans, plants, animals, microorganisms, and biological materials.	Research, Design & Consulting
<b>17-2041</b>	Chemical engineers	Design chemical plant equipment and devise processes for manufacturing chemicals and products, such as gasoline, synthetic rubber, plastics, detergents, cement, paper, and pulp, by applying principles and technology of chemistry, physics, and engineering.	Biosciences
<b>51-9011</b>	Chemical equipment operators and tenders	Operate or tend equipment to control chemical changes or reactions in the processing of industrial or consumer products. Equipment used includes devulcanizers, steam-jacketed kettles, and reactor vessels.	Biosciences

SOC Code	Occupation	Description	Sector
<b>51-8091</b>	Chemical plant and systems operators	Control or operate an entire chemical process or system of machines.	Biosciences
<b>19-4031</b>	Chemical technicians	Conduct chemical and physical laboratory tests to assist scientists in making qualitative and quantitative analyses of solids, liquids, and gaseous materials for purposes, such as research and development of new products or processes, quality control, maintenance of environmental standards, and other work involving experimental, theoretical, or practical application of chemistry and related sciences.	Biosciences
<b>19-2031</b>	Chemists	Conduct qualitative and quantitative chemical analyses or chemical experiments in laboratories for quality or process control or to develop new products or knowledge.	Biosciences
<b>17-2051</b>	Civil engineers	Perform engineering duties in planning, designing, and overseeing construction and maintenance of building structures, and facilities, such as roads, railroads, airports, bridges, harbors, channels, dams, irrigation projects, pipelines, power plants, water and sewage systems, and waste disposal units. Includes architectural, structural, traffic, ocean, and geo-technical engineers.	Research, Design & Consulting
<b>51-4011</b>	Computer-controlled machine tool operators, metal & plastic	Operate computer-controlled machines or robots to perform one or more machine functions on metal or plastic work pieces.	Renewable Energy, Manufacturing

SOC Code	Occupation	Description	Sector
15-1021	Computer programmers	Convert project specifications and statements of problems and procedures to detailed logical flow charts for coding into computer language. Develop and write computer programs to store, locate, and retrieve specific documents, data, and information. May program web sites.	Energy Efficiency
15-1031	Computer software engineers, applications	Develop, create, and modify general computer applications software or specialized utility programs. Analyze user needs and develop software solutions. Design software or customize software for client use with the aim of optimizing operational efficiency. May analyze and design databases within an application area, working individually or coordinating database development as part of a team.	Energy Efficiency
15-1032	Computer software engineers, systems software	Research, design, develop, and test operating systems-level software, compilers, and network distribution software for medical, industrial, military, communications, aerospace, business, scientific, and general computing applications. Set operational specifications and formulate and analyze software requirements. Apply principles and techniques of computer science, engineering, and mathematical analysis.	Research, Design & Consulting
15-1051	Computer systems analyst	Analyze science, engineering, business, and all other data processing problems for application to electronic data processing systems. Analyze user requirements, procedures, and problems to automate or improve existing systems and review computer system capabilities, workflow, and scheduling limitations. May analyze or recommend commercially available software. May supervise computer programmers.	Energy Efficiency

SOC Code	Occupation	Description	Sector
<b>47-2031.01</b>	Construction carpenters	Construct, erect, install, and repair structures and fixtures of wood, plywood, and wallboard, using carpenter's hand tools and power tools.	Energy Efficiency
<b>47-2061</b>	Construction laborers	Perform tasks involving physical labor at building, highway, and heavy construction projects, tunnel and shaft excavations, and demolition sites. May operate hand and power tools of all types: air hammers, earth tampers, cement mixers, small mechanical hoists, surveying and measuring equipment, and a variety of other equipment and instruments. May clean and prepare sites, dig trenches, set braces to support the sides of excavations, erect scaffolding, clean up rubble and debris, and remove asbestos, lead, and other hazardous waste materials. May assist other craft workers.	Energy Efficiency
<b>11-9021</b>	Construction managers	Plan, direct, coordinate, or budget, usually through subordinate supervisory personnel, activities concerned with the construction and maintenance of structures, facilities, and systems. Participate in the conceptual development of a construction project and oversee its organization, scheduling, and implementation.	Energy Efficiency
<b>51-4031</b>	Cutting, punching, & press machine setters, operators, & tenders, metal & plastic	Set up, operate, or tend machines to saw, cut, shear, slit, punch, crimp, notch, bend, or straighten metal or plastic material.	Renewable Energy, Manufacturing

SOC Code	Occupation	Description	Sector
<b>17-3023</b>	Electrical and electronic engineering technicians	Apply electrical and electronic theory and related knowledge, usually under the direction of engineering staff, to design, build, repair, calibrate, and modify electrical components, circuitry, controls, and machinery for subsequent evaluation and use by engineering staff in making engineering design decisions.	Advanced Energy
<b>49-2095</b>	Electrical and electronics repairers, powerhouse, substation and relay	Inspect, test, repair, or maintain electrical equipment in generating stations, substations, and in-service relays.	Advanced Energy
<b>17-2071</b>	Electrical engineers	Design, develop, test, or supervise the manufacturing and installation of electrical equipment, components, or systems for commercial, industrial, military, or scientific use.	Advanced Energy, Research, Design & Consulting
<b>49-9051</b>	Electrical power-line installers and repairers	Install or repair cables or wires used in electrical power or distribution systems. May erect poles and light or heavy duty transmission towers.	Advanced Energy
<b>47-2111</b>	Electricians	Install, maintain, and repair electrical wiring, equipment, and fixtures. Ensure that work is in accordance with relevant codes. May install or service street lights, intercom systems, or electrical control systems.	Advanced Energy, Energy Efficiency, Manufacturing

SOC Code	Occupation	Description	Sector
<b>17-2071</b>	Electronics engineers, except computer	Research, design, develop, and test electronic components and systems for commercial, industrial, military, or scientific use utilizing knowledge of electronic theory and materials properties. Design electronic circuits and components for use in fields such as telecommunications, aerospace guidance and propulsion control, acoustics, or instruments and controls.	Research, Design & Consulting
<b>13-1199.01</b>	Energy auditors (business operation specialists, all other)	Conduct energy audits of buildings, building systems and process systems. May also conduct investment grade audits of buildings or systems.	Research, Design & Consulting
<b>17-2199.03</b>	Energy engineers	Design, develop, and evaluate energy-related projects and programs to reduce energy costs or improve energy efficiency during the designing, building, or remodeling stages of construction. May specialize in electrical systems; heating, ventilation, and air-conditioning (HVAC) systems; green buildings; lighting; air quality; or energy procurement.	Research Design & Consulting
<b>11-9041</b>	Engineering managers	Plan, direct, or coordinate activities in such fields as architecture and engineering or research and development in these fields.	Research, Design & Consulting

SOC Code	Occupation	Description	Sector
<b>17-3029</b>	Engineering technicians, except drafters, all other	17-3029.01 Non-Destructive Testing Specialists 17-3029.02 Electrical Engineering Technologists 17-3029.03 Electromechanical Engineering Technologists 17-3029.04 Electronics Engineering Technologists 17-3029.05 Industrial Engineering Technologists 17-3029.06 Manufacturing Engineering Technologists 17-3029.07 Mechanical Engineering Technologists 17-3029.08 Photonics Technicians 17-3029.09 Manufacturing Production Technicians 17-3029.10 Fuel Cell Technicians 17-3029.11 Nanotechnology Engineering Technologists 17-3029.12 Nanotechnology Engineering Technicians	Research, Design & Consulting
<b>51-2031</b>	Engine and other machine assemblers	Construct, assemble, or rebuild machines, such as engines, turbines, and similar equipment used in such industries as construction, extraction, textiles, and paper manufacturing.	Manufacturing
<b>17-3025</b>	Environmental engineering technicians	Apply theory and principles of environmental engineering to modify, test, and operate equipment and devices used in the prevention, control, and remediation of environmental pollution, including waste treatment and site remediation. May assist in the development of environmental pollution remediation devices under direction of engineer.	Research, Design & Consulting



SOC Code	Occupation	Description	Sector
17-2081	Environmental engineers	Design, plan, or perform engineering duties in the prevention, control, and remediation of environmental health hazards utilizing various engineering disciplines. Work may include waste treatment, site remediation, or pollution control technology.	Research, Design & Consulting
51-9041	Extruding, forming, pressing, and compacting machine setters, operators, and tenders	Set up, operate, or tend machines, such as glass forming machines, plodder machines, and tuber machines, to shape and form products, such as glassware, food, rubber, soap, brick, tile, clay, wax, tobacco, or cosmetics.	Biosciences
47-1011	First-line supervisors/managers of construction trades and extraction workers	Directly supervise and coordinate activities of construction or extraction workers.	Energy Efficiency
	First-line supervisors/managers of mechanics, installers, and repairers	Supervise and coordinate the activities of mechanics, installers, and repairers.	Advanced Energy
	First-line supervisors/managers of production and operating workers	Supervise and coordinate the activities of production and operating workers, such as inspectors, precision workers, machine setters and operators, assemblers, fabricators, and plant and system operators.	Advanced Energy, Manufacturing, Renewable Energy

SOC Code	Occupation	Description	Sector
<b>17-2141.01</b>	Fuel cell engineers	Design, evaluate, modify, and construct fuel cell components and systems for transportation, stationary, or portable applications.	Renewable Energy, Research, Design & Consulting
<b>49-9099.01</b>	Geothermal technicians	Perform technical activities at power plants or individual installations necessary for the generation of power from geothermal energy sources. Monitor and control operating activities at geothermal power generation facilities and perform maintenance and repairs as necessary. Install, test, and maintain residential and commercial geothermal heat pumps.	Renewable Energy
<b>49-9021</b>	Heating, air conditioning, and refrigeration mechanics and installers	Install or repair heating, central air conditioning, or refrigeration systems, including oil burners, hot-air furnaces, and heating stoves.	Energy Efficiency
<b>17-2112</b>	Industrial engineers	Design, develop, test, and evaluate integrated systems for managing industrial production processes including human work factors, quality control, inventory control, logistics and material flow, cost analysis, and production coordination.	Manufacturing, Research, Design & Consulting
<b>49-9041</b>	Industrial machinery mechanics	Repair, install, adjust, or maintain industrial production and processing machinery or refinery and pipeline distribution systems.	Advanced Energy, Biosciences, Manufacturing, Renewable Energy

SOC Code	Occupation	Description	Sector
<b>11-3051</b>	Industrial production managers	Plan, direct, or coordinate the work activities and resources necessary for manufacturing products in accordance with cost, quality, and quantity specifications.	Biosciences, Manufacturing, Renewable Energy
<b>53-7051</b>	Industrial truck and tractor operators	Operate industrial trucks or tractors equipped to move materials around a warehouse, storage yard, factory, construction site, or similar location.	Renewable Energy
<b>51-9061</b>	Inspectors, testers, sorters, samplers, and weighers	Inspect, test, sort, sample, or weigh nonagricultural raw materials or processed, machined, fabricated, or assembled parts or products for defects, wear, and deviations from specifications. May use precision measuring instruments and complex test equipment.	Advanced Energy, Biosciences, Manufacturing, Renewable Energy, Research, Design & Consulting
<b>51-4041</b>	Machinists	Set up and operate a variety of machine tools to produce precision parts and instruments. Includes precision instrument makers who fabricate, modify, or repair mechanical instruments. May also fabricate and modify parts to make or repair machine tools or maintain industrial machines, applying knowledge of mechanics, shop mathematics, metal properties, layout, and machining procedures.	Manufacturing, Renewable Energy

SOC Code	Occupation	Description	Sector
<b>49-9042</b>	Maintenance and repair workers, general	Perform work involving the skills of two or more maintenance or craft occupations to keep machines, mechanical equipment, or the structure of an establishment in repair. Duties may involve pipe fitting; boiler making; insulating; welding; machining; carpentry; repairing electrical or mechanical equipment; installing, aligning, and balancing new equipment; and repairing buildings, floors, or stairs.	Advanced Energy, Biosciences, Manufacturing, Renewable Energy
<b>49-9043</b>	Maintenance workers, machinery	Lubricate machinery, change parts, or perform other routine machinery maintenance.	Biosciences
<b>17-2141</b>	Mechanical engineers	Perform engineering duties in planning and designing tools, engines, machines, and other mechanically functioning equipment. Oversee installation, operation, maintenance, and repair of such equipment as centralized heat, gas, water, and steam systems.	Manufacturing, Renewable Energy,
<b>51-9023</b>	Mixing and blending machine setters, operators, and tenders	Set up, operate, or tend machines to mix or blend materials, such as chemicals, tobacco, liquids, color pigments, or explosive ingredients.	Biosciences, Manufacturing
<b>17-2161</b>	Nuclear engineers	Conduct research on nuclear engineering problems or apply principles and theory of nuclear science to problems concerned with release, control, and utilization of nuclear energy and nuclear waste disposal.	Advanced Energy

SOC Code	Occupation	Description	Sector
<b>47-2073</b>	Operating engineers and other construction equipment operators	Operate one or several types of power construction equipment, such as motor graders, bulldozers, scrapers, compressors, pumps, derricks, shovels, tractors, or front-end loaders to excavate, move, and grade earth, erect structures, or pour concrete or other hard surface pavement. May repair and maintain equipment in addition to other duties.	Advanced Energy
<b>47-2152</b>	Pipe fitters and steamfitters	Assemble, install, alter, and repair pipelines or pipe systems that carry water, steam, air, or other liquids or gases. May install heating and cooling equipment and mechanical control systems.	Advanced Energy
<b>47-2152</b>	Plumbers, pipefitters, and steamfitters	Assemble, install, alter, and repair pipelines or pipe systems that carry water, steam, air, or other liquids or gases. May install heating and cooling equipment and mechanical control systems.	Energy Efficiency
<b>51-8013</b>	Power plant operators	Control, operate, or maintain machinery to generate electric power. Includes auxiliary equipment operators.	Advanced Energy
<b>51-9199.01</b>	Production workers, Recycling and Reclamation	Prepare and sort materials or products for recycling. Identify and remove hazardous substances. Dismantle components of products such as appliances.	Biosciences
<b>47-2181</b>	Roofers	Cover roofs of structures with shingles, slate, asphalt, aluminum, wood, and related materials. May spray roofs, sidings, and walls with material to bind, seal, insulate, or soundproof sections of structures.	Energy Efficiency

SOC Code	Occupation	Description	Sector
<b>47-2031.02</b>	Rough carpenters	Build rough wooden structures, such as concrete forms, scaffolds, tunnel, bridge, or sewer supports, billboard signs, and temporary frame shelters, according to sketches, blueprints, or oral instructions.	Energy Efficiency
<b>51-9012</b>	Separating, filtering, clarifying, precipitating, and still machine setters, operators, and tenders	Set up, operate, or tend continuous flow or vat-type equipment; filter presses; shaker screens; centrifuges; condenser tubes; precipitating, fermenting, or evaporating tanks; scrubbing towers; or batch stills. These machines extract, sort, or separate liquids, gases, or solids from other materials to recover a refined product. Includes dairy processing equipment operators.	Biosciences
	Team assemblers	Work as part of a team having responsibility for assembling an entire product or component of a product. Team assemblers can perform all tasks conducted by the team in the assembly process and rotate through all or most of them rather than being assigned to a specific task on a permanent basis. May participate in making management decisions affecting the work. Team leaders who work as part of the team should be included.	Energy Efficiency, Manufacturing, Renewable Energy
<b>49-9052</b>	Telecommunications line installers and repairers	String and repair telephone and television cable, including fiber optics and other equipment for transmitting messages or television programming.	Advanced Energy

SOC Code	Occupation	Description	Sector
<b>53-3032</b>	Truck drivers, heavy and tractor trailer	Drive a tractor-trailer combination or a truck with a capacity of at least 26,000 GVW, to transport and deliver goods, livestock, or materials in liquid, loose, or packaged form. May be required to unload truck. May require use of automated routing equipment. Requires commercial drivers' license.	Energy Efficiency
<b>49-9099</b>	Wind turbine service technicians	Inspect, diagnose, adjust, or repair wind turbines. Perform maintenance on wind turbine equipment including resolving electrical, mechanical, and hydraulic malfunctions.	Renewable Energy