Energy, the Environment, and Delaware Jobs:

Defining and Describing Green Businesses

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by

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Executive Summary

The Center for Applied Demography & Survey Research at the University of Delaware conducted this study to measure the size and scope of Delaware's green economy. The study was made possible by a grant from the American Recovery and Reinvestment Act. Although the work was performed in collaboration with the Delaware Department of Labor, the authors are solely responsible for its design and execution.

Although the environmental movement has been around for many decades, recent interest has sharply increased. That interest has placed strong pressure on our local, state, and federal governments to enact policies intended to transition to a cleaner, green economy. Although the term "green economy" has never been universally defined, it refers to those elements of the economy that are aligned with environmental concerns. This report's objective was to assemble important facts concerning those businesses that make up Delaware's green economy. We achieved this objective by combining survey results with multiple sources of labor market information.

Our survey found that 8.5% of Delaware business establishments produce green goods or offer green services. These companies employ approximately 16,250 persons in the state, or approximately 4.2% of the state's workforce. The majority of businesses in the green economy offer energy efficient goods and services, and the majority of these businesses are classified in the construction industry and the professional and technical services industry.

Businesses that sell output intended to reduce pollution and businesses that relied on recycled inputs comprised the second largest sector of Delaware's green economy. The third largest sector produced goods and services that were intended to conserve natural resources. Companies involved in the renewable energy sector employed the least number of people in the green economy. It is normal for businesses to fall into more than one green sector.

We also evaluated the wage and employment trends for companies that reported green goods and services in 2010. While all businesses reported falling employment during the recession, companies that sold green goods and services experienced stronger real wage growth than their non-green counterparts.

Our survey also identified those occupations that were most commonly found among green businesses, and they are mostly occupations requiring a trade. Plumbers, pipefitters, and steam fitters were the most common occupation and heating, ventilation, and air conditioning workers were the third most common occupation in green companies. Carpenters, electricians, and vehicle mechanics were also relatively common. Engineering occupations were also quite common among green businesses. Civil engineers, mechanical engineers, electrical engineers, engineering managers, and architectural drafters were quite common among Delaware's green businesses.

Green businesses distinguish themselves from similar, non green businesses by employing occupations requiring greater skills in science, math, and communication. Similar non-green counterparts are more inclined to employ the stereotypical blue-collar skills, such as installation and repair.

Green companies overwhelmingly stated that they thought a vo-tech high school certificate with a background in general construction was both relevant and desirable. Other frequently mentioned skills included LEED certification, energy management, HVAC training and geothermal technology. There was also a preference for employees to be trained in mechanical engineering, environmental engineering and the electrical trades. Green companies emphasized the importance of science and mathematics in developing the workforce.

Other relevant findings were:

- For every company that made green output and claimed to be green via marketing campaigns, 2.2 other companies claimed to be green without making green output. This could imply that there are nearly twice as many companies "greening" their operations than are actually making green output.
- Approximately 70% of green businesses reported that the government was somewhat important or very important to stimulating private demand. This was particularly true for businesses in the renewable energy and natural resource conservation sectors.
- Although businesses stated that energy costs were very important to their profitability, most businesses were apathetic to the prospect of actually investing in energy efficiency. Manufacturers showed the most interest, as did larger companies that owned multiple establishments. Businesses are most concerned with the perceived large up-front costs of making such investments. Finding qualified staff was not a major deterrent to making those investments.

Introduction

The green economy has garnered increased attention during the past decade as concerns over climate change and energy supplies have mounted. It has been touted by some as a pathway to lessen, or even reverse damage to the environment while simultaneously growing the economy. Policy makers across the country hope that targeted job training and career placement will achieve these goals, and they are looking for ways to support that transition. Despite the pace of policy directives, basic information regarding the green economy is missing. Before policies are designed, such information should be obtained.

To assist in this endeavor, the Center for Applied Demography & Survey Research (the Center) undertook an analytical review of Delaware's green economy. As part of this review, the Center is releasing a series of reports that analyze different topics of the green economy. This report is intended to address how the green economy is characterized by Delaware businesses and their workforce. The research was funded through the American Recovery and Reinvestment Act and performed in collaboration with the Delaware Department of Labor.

After a thorough review of the green literature and discussions with the state Department of Labor, we derived a list of primary questions to find out from Delaware businesses. The questions were:

1. What is "green" and how many and what kind of green businesses exist? How many and what kind of green jobs exist?
2. What skills are most important to the green economy?
3. Which training programs do green businesses request most?
4. How do green companies differ from non-green companies?

As will be explained in section 1, the first question is particularly difficult to answer. Ultimately, we refer to green output as those goods and services that the Bureau of Labor Statistics perceives as having environmental benefits. A green business was defined as an establishment that produces green output, and a green job is any person working for that business.

Overall, we found that there are 1,280 green businesses in Delaware. They employ approximately 16,250 workers, or approximately 4.2% of the state's workforce. Delaware's green economy primarily produces goods and services (G&S) related to energy efficiency, pollution reduction, and recycling. The renewable energy and natural resource conservation sectors were substantially smaller.

Plumbers, pipefitters, and steamfitters were the most common occupation employed by Delaware's green companies. Civil engineers were the next most common occupation, followed by supervisors and managers of construction workers and tradesmen. Civil engineers and HVAC installers were common in and unique to green businesses.

Based on the occupation composition of green businesses and similar businesses not selling green output, we concluded that green businesses employ a larger proportion of occupations with math and science backgrounds. They also employed proportionally more workers who were expected to interact with the public and government. Similarly, green companies employed relatively fewer occupations with more mechanical and blue collar skills, such as installation and repair. However, green and potentially green companies have much more in common compared to the overall workforce. We infer that industry composition is the most important factor in explaining skill differences in the workforce.

When employers were asked directly what specific training programs would be most helpful to their businesses, green companies overwhelmingly mentioned training in the construction and trades. Employers representing all Delaware businesses emphasized that training programs would be most helpful if they could improve the basic reading, writing, math, and computer skills in the workforce, as well as adjusting behavior. Green companies cited vo-tech high school degrees with a general construction background as very desirable and relevant. Degrees in green design practices and energy management were also very important, along with HVAC training.

The average wage for companies in the energy efficiency, renewable energy, and natural resource conservation sector (as of 2010) was higher compared to their potentially green counterparts. Though that premium declined substantially over the past decade, the wage growth in green companies fared better during the recession. Overall, companies making green products in 2010 did not have stronger employment growth over this past decade than similar, potentially green companies. Companies in the renewable energy and natural resource conservation sectors proved to be exceptions, but their relatively small employment base was not large enough to change the overall trend in the green economy.

We also took advantage of our survey to explore secondary issues that seem important to green economy. In particular, we sought to better understand the following questions.

1. How well does the BLS definition of green output perform in classifying Delaware's green economy?
2. How important is the government to the green economy?
3. Why do companies market themselves as green? What is the relationship between green marketing and our green definition?
4. What are the opinions of Delaware businesses as potential consumers of energy efficiency?

In general, we found that the BLS universe of green industries performs reasonably well in distinguishing green from non green businesses; three-quarters of Delaware's green employment falls into the BLS universe. The definition did not perform well classifying the renewable energy sector.

The overwhelming majority of green businesses also reported that government involvement was either somewhat important or very important to stimulate the demand for their output. This was particularly strong for the renewable energy and natural resource conservation sectors of the green economy.

The survey results also implied that less than 30% of firms that market themselves as "being green" actually makes green output. However, only 42% of firms that actually produce green output conduct green marketing. The main reason companies market themselves as green is to improve sales or customer satisfaction, and companies primarily make such claims primarily on websites and via postal mail.

When asked for their opinions about investing in energy efficiency, almost every business claimed that energy was very important to their profits. However, the average business was indifferent to making investments. Businesses in the manufacturing sector, businesses with multiple establishments, and businesses that owned their own buildings expressed the most interest in such investments, as did companies selling green output. Businesses are mostly concerned with the perceived large, up-front costs needed to invest in energy efficiency and the time they must wait before those costs can be recouped.

This report is organized into five major sections. In the first section we characterize green job definitions, discuss the version that was adopted in this report, and describe how we elicited that information in our survey. In the second section, we focus on the size of the green economy and its sectors and evaluate the BLS definition. In the third section, we analyze the occupations, skills, and training programs that characterize Delaware's green economy. We review the remaining miscellaneous questions in the fourth section. The final section summarizes our results and concludes.

Before we begin this report, we would be remiss if we did not mention the heated and partisan debate over green jobs and green energy. Critics emphasize that green policies will have large and negative economic repercussions, and they question the long term environmental advantage of making such economic sacrifice. Proponents counter that the environmental consequences of inaction are far too dire to ignore, and they question the economic damage of green policies. Our position is to avoid this ideological debate and just provide relevant facts about what has been defined as "green". Debate over policy will undoubtedly continue in the years ahead, and an informed citizenry is essential to guiding good policy.

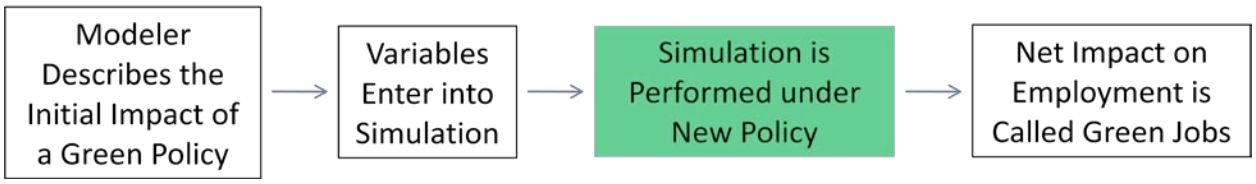
Defining Delaware's Green Economy

Discussion of Green Job Definitions

As of today, there is no commonly accepted definition of a green job, but typical reports count them in one of two ways. The first way begins with the premise that a specific policy is green, and an economic model simulates how that policy could hypothetically affect employment (U.S. Conference of Mayors, 2008; Center for American Progress, 2008; Pennsylvania Department of Labor & Industry, 2010; Chicagoland Green Collar Jobs Initiative, 2009; Green Building Alliance and GTech, 2009). The net employment impact of that scenario analysis is called green jobs.

The number of simulated green jobs can vary substantially in the literature. The results are sensitive to the economic model being used, how the analyst modeled the green policy and what kind of simulation was used. The typical report concludes "X many dollars spent on a green policy creates Y many green jobs". These simulations are usually intended to describe a hypothetical economy under a new policy, not the one that currently exists. Because our goal is to do the latter, we will not use simulated green jobs in this report.

Figure 1 Heuristic Process of Simulating Green Jobs

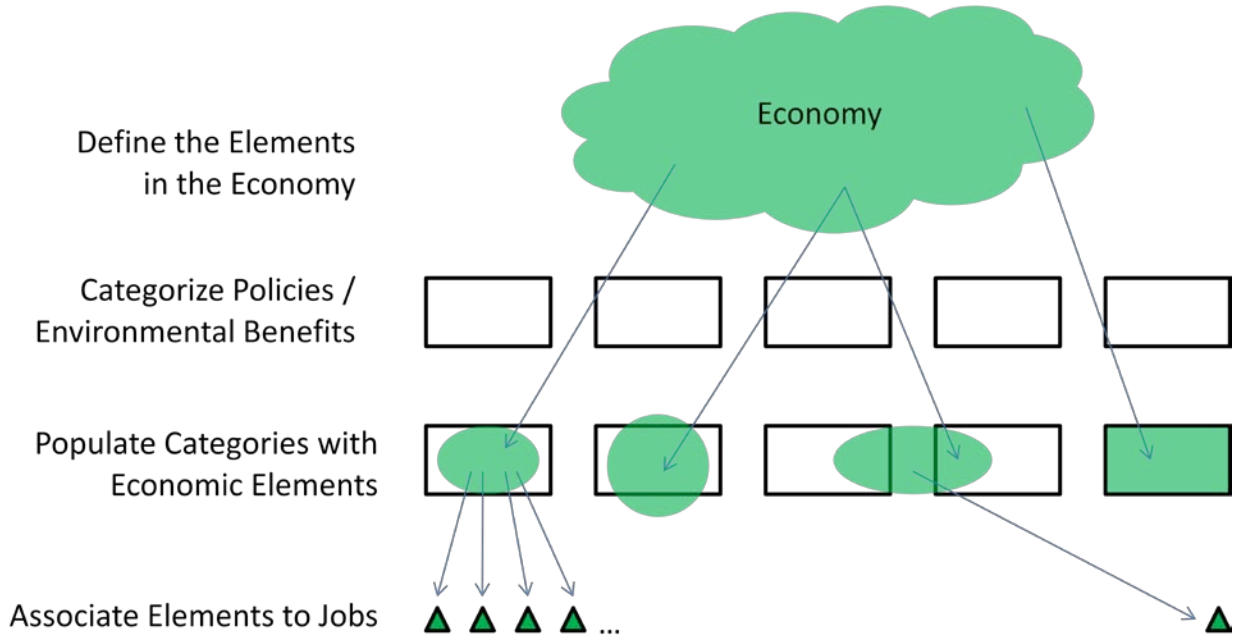


The second method assumes that certain jobs in the existing economy are green, and analysts measure these jobs through surveys or other sources of labor market information (Bureau of Labor Statistics, 2011; Center for American Progress, 2009; Michigan Department of Energy, Labor, & Economic Growth, 2009; Minnesota Green Jobs Task Force, 2010; New York State Department of Labor, 2009; Oregon Workforce Investment Board, 2009). Reports that measure green jobs face the difficult decision of which jobs should be considered green. Current practice does this in four steps (see Figure 2). In the first step, the researcher chooses what kind of elements to focus on in the economy. The most common choice is to focus on goods and services, however, some research uses occupations and work activities (Employment and Training Administration, 2009; Bureau of Labor Statistics, 2011).

In the second step, specific elements or policies with perceived environmental benefits are organized into clusters. For example, one might describe the perceived environmental benefits of switching to alternative power generation as one cluster and reducing the demand for energy (without sacrificing output) as another cluster. Current directives recommend adopting different clusters to reflect different local policies (Workforce Information Council, 2009). Unfortunately, this makes it difficult to compare the output of one report to another. For example, labor market information experts in California used a mnemonic acronym "G.R.E.E.N." to organize the green economy into 5 clusters (California Employment Development Department, 2010).[1] However, ONET Online, a national labor market information organization, classifies the economy into twelve clusters (ONET Online, 2011).

[1] The "G" represents "generating renewable energy", the "R" represents "recycling used materials", the first "E" represents "energy efficient goods and services", the second "E" represents "education, compliance, and awareness of green activities", and the "N" represents "natural and sustainable products".

Figure 2 Heuristic Method of Defining Green Jobs



Once the organizer is content with that classification, each category is populated with elements from the economy deemed relevant. This process of categorizing policies and benefits and populating them with elements is iterative and subjective. It ends when the researcher deems the resulting definition sufficient for the report's objective.

Because the choice of populating each category is left to the discretion of each researcher, there is rarely definitional consistency between reports even when the categories seem comparable. For example, some reports treat alternative fuels as belonging solely to renewable energy (Washington State Employment Security Department, 2008), while others group renewable energy together with energy efficiency (Florida Department of Education, 2008). Some even question whether biofuels are environmentally beneficial (United Nations Environment Programme, 2008). In addition, elements can fall into multiple categories. For example, environmental consulting is ubiquitous enough to fall into energy efficiency, pollution reduction, natural resource conservation, and renewable energy categories (Bureau of Labor Statistics, 2011).

Once a green definition has been applied to an economy, the researcher evaluates each cluster to find relevant jobs (step 4). When goods and services (i.e. industries) populate the categories, green jobs usually refer to those employees in a firm that makes green goods and services. Some reports identify all employees in those companies as green jobs (Washington D.C. Economic Partnership, 2008), while other reports exclude workers deemed insufficiently associated with the green output (Oregon Workforce Investment Board, 2009).[2] When work activities populate the categories, green jobs refer to the employees that directly perform those activities (ONET Online, 2011).

Subjective Foundations

Researchers are commonly asked how the term 'green' should be defined. The question may be a loaded one, because the subjective and iterative process engenders complex answers with contradictory logic. To be clear, no objective method has ever fully explained the complex relationship between the environment, the economy, and promising new technologies.[3] Consequently, researchers have to rely on subjective criteria for deciding whether an output is green. Any decision to include or exclude specific output, occupations, or activities faces the repeated criticism of justification (Anderberg, 2009; Morriss et al., 2011; Slaper and Krause, 2009).

[2] Occasionally economic simulations are used to make these associations. In this case, green jobs are those direct, indirect, and induced jobs stimulated by additional final demand.

[3] Life-cycle assessment methodology pays attention to these issues, but real-world complexity becomes unwieldy as the scope expands past crude characterizations of the economy and environment.

In defense of such decisions, a pragmatist would concede that the problem is not that subjectivity *exists*. Any classification of a real-world economic system contains subjectivity. For example, the North American Industrial Classification System (NAICS) uses subjective criteria to organize goods and services. The NAICS is widely adopted because it is exceptionally useful. When such classifications are no longer useful, they are updated or dismissed.

Whether the green classification proves useful will only be known if research proceeds with an initial definition, albeit subjective. We fully endorse the process of updating the definition as part of an open process of scientific inquiry. The more transparent and explicit the process, the more objective the definition will become. Until that occurs, our strategy is to adopt the definition we feel has the greatest chance of being the first, official definition of a green job.

The Bureau of Labor Statistics' Definition of Green Jobs

The Bureau of Labor Statistics (BLS) is the government agency whose main responsibility is to release federal economic statistics concerning labor issues. Examples include the unemployment and participation rates, wages, job openings, inflation levels, etc. The agency also is responsible for creating official economic definitions and classifications. They have recently been tasked with measuring the green economy. In compliance with that assignment, the BLS released their definition of a "green job" in September 2010 (Bureau of Labor Statistics, 2011).

BLS defines green jobs using two separate approaches. In the first approach, BLS defines the elements of the economy in terms of goods and services. This "Output Approach", defines green jobs as "*jobs in businesses that produce goods or provide services that benefit the environment or conserve natural resources*". In the second, "process approach", work activities make up the elements of the economy. In this approach, green jobs are "*Jobs in which workers' duties involve making their establishments' production processes more environmentally friendly or use fewer natural resources.*"

Using an iterative process similar to Figure 2, BLS categorized the economy into five clusters.

1) *Renewable energy*
2) *Energy efficiency*
3) *Pollution reduction and removal, greenhouse gas reduction, and recycling and reuse*
4) *Natural resources conservation*
5) *Environmental compliance, education and training, and public awareness*

Under the output approach each category gets populated with "direct and indirect" goods and services including "research and development, installation, maintenance services, […] specialized inputs, and distribution of green goods", as well as "goods and services sold to customers". Table 1 gives examples of different areas the BLS considers will contain relevant goods and services. A finer level of specification lists examples of green goods and services within each 6-digit NAICS industry (Bureau of Labor Statistics, 2011).[4] The primary output of each industry was evaluated to generate a list of "potentially green industries". The list reduces the additional subjectivity influenced by the survey recipient's concept of green (Oregon Workforce Investment Board, 2009).

[4] http://www.bls.gov/green/final_green_def_8242010_pub.pdf

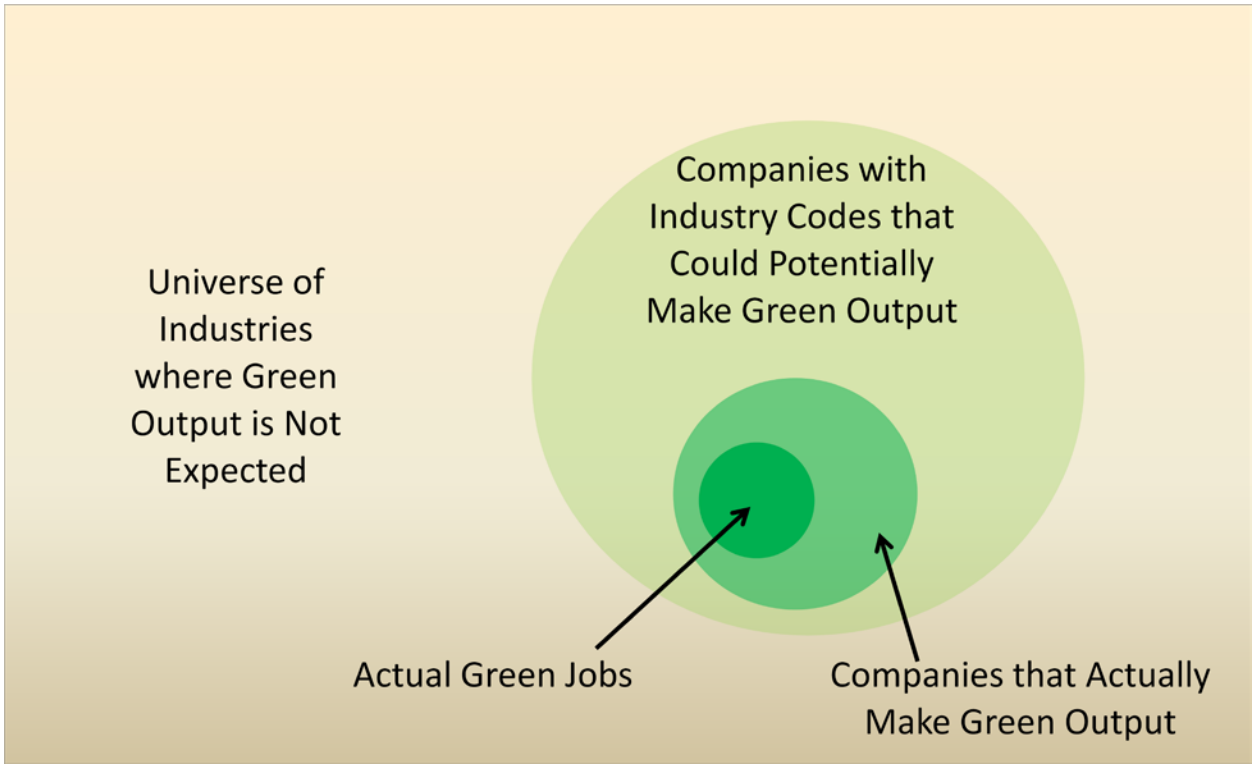
Table 1 Examples of Output BLS Considers Green

Renewable Energy	Energy Efficiency	Pollution Reduction and Removal, etc.	Natural Resource Conservation	Environmental Compliance, Education, etc.
Electricity generated by: Wind Biomass Geothermal Solar Ocean Hydropower Landfill Gas Solid Waste Ethanol Biofuel / Biodiesel	Energy Efficient Equipment Appliances Buildings Vehicles Industrial Processes Sustainable Construction & Materials Mass Transit	Soil Remediation Nuclear Energy Recycled Compost Wastewater Metals Other Materials Remanufactured Appliances Waste Management	Organic Agriculture Sustainable Forestry Parks & Nature Preserves Wildlife Conservation Stormwater mgmt	Environmental Regulations & Enforcement Energy & Environmental Awareness Programs Training & Education for Green Work Activities

The BLS is currently conducting a survey within these potentially green industries to identify which companies actually sell such output. BLS will scale each company's total employment down by the percent of revenue attributed to green G&S.[5] BLS counts this scaled down employment figure as green jobs under the output approach.[6] Figure 3 is a heuristic that characterizes this approach.

[5] Unlike surveys conducted by nongovernment organizations, BLS and its designated affiliates can make such confidential information compulsory. This information is protected by Title 13 confidentiality statutes.
[6] Unlike other reports that attach wage or quality standards to green jobs, all jobs will be included in the BLS approach (United Nations Environment Programme, 2008; White and Walsh, 2008; Van Jones, 2008)

Figure 3 Venn Diagram of BLS's Green Job Definition under the Output Approach



BLS has not yet fully described the approach it will be using to define green occupations in the process approach. Fundamentally, the scope of that approach should cover all industries. For example, the process approach would characterize an employee as green if his or her work activities directly reduced pollution or energy use. It would not matter if the employer is a coal mine or gasoline refinery. More details are expected to be released concerning which work activities and occupations the BLS considers green.

Our Green Jobs Definition

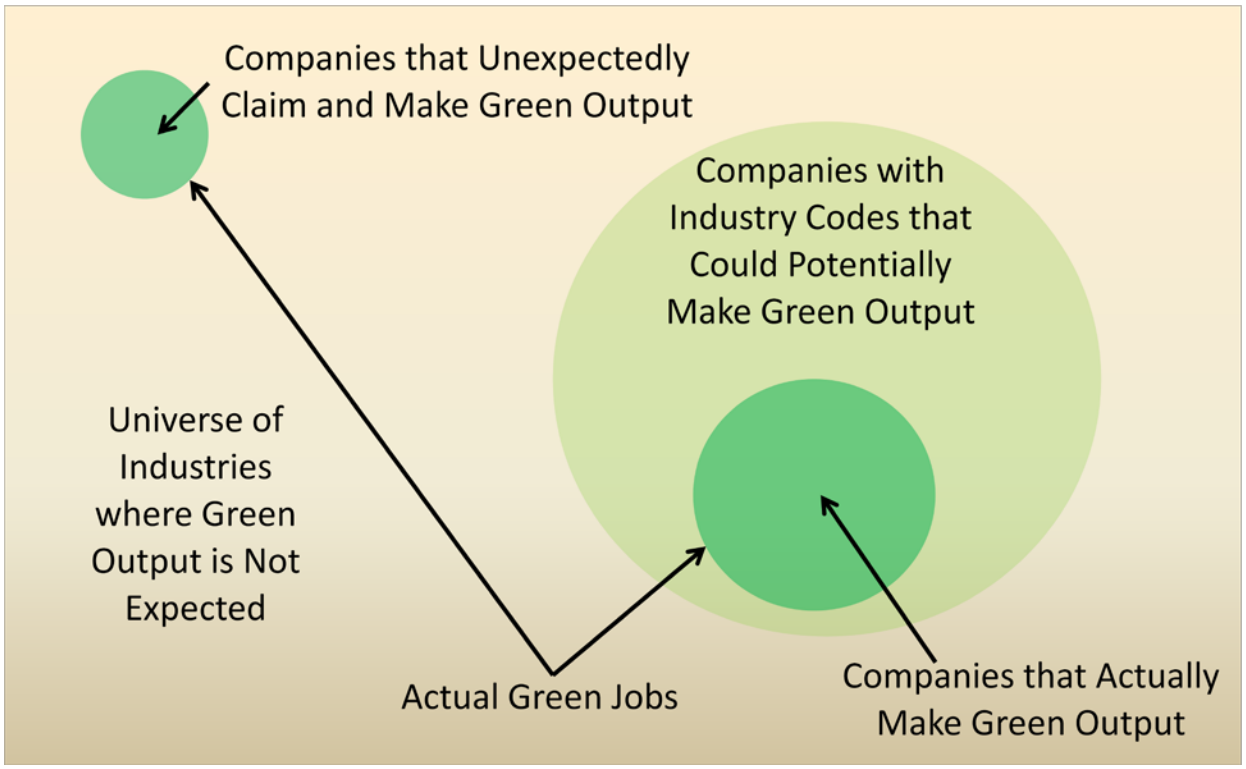
As discussed previously, our strategy was to follow BLS's output-definition of green jobs as closely as possible. However, due to the limitations of collecting Delaware specific business statistics, our definition had to be modified.[7]

Our definition ignores the percent of sales related to green goods and services, because such data would be very difficult to collect voluntarily. We did not want employers to identify fractions of their workforce directly, because it is not clear what criteria the employers use. Consequently, our definition includes every person working in a company that makes green output. For any company, our definition will result in no fewer jobs than the BLS definition.. To get a sense of these possible differences, we asked businesses to rank how important green goods and services were to their "total business". Approximately 93% of those companies identified as selling green output stated that those goods and services were somewhat important or very important to their total business.

Because employment is not adjusted to reflect the percent of green sales, large companies are particularly prone to bias estimates upward. Therefore, we inspected the employment size of the sampled population and adjusted our definition of green to mitigate the likely bias. Our final green definition does not include the environmental compliance, education, training, and public awareness sector, as these institutions overwhelmingly report aggregate employment to the Delaware Department of Labor. For the same reason, we also excluded mass transit companies from our definition of the energy efficiency sector.

[7] Voluntary mail surveys administered to businesses in Delaware face the compounded difficulties of a small population and historically low response rates.

Figure 4 Venn Diagram of Our Adaptation of BLSs' Green Job Definition



We also sampled companies falling outside of BLS's potentially green universe of industries and found a surprising number of companies citing output that the BLS would consider green if the company had an alternative industry code. In light of these findings, we call a company green if that company produces green output.

As an aside, we will often refer to "potentially green companies" in this text. When we do, we are referring to those companies with industry codes that the BLS deems could potentially make green output, but were deemed not to produce green output given their survey responses.

In summary, our definition of a green job includes all employees who work for a company that makes output which would normally fall into one of the following BLS categories:

1. Energy Efficiency (except mass transit)
2. Renewable Energy
3. Natural Resource Conservation
4. Pollution Reduction, Greenhouse Gas Reduction, and Recycling and Re-use

Data and Survey Description

Our survey of Delaware businesses used the unemployment insurance file from the first quarter of 2010 as the sampling universe. This file provided the names, addresses, employment size, quarterly wage, and industry code of almost every business in Delaware. This list excludes the self-employed, certain non-profits, the military, and segments of the agricultural sector. We ignored any firm with less than 2 employees and directed our attention to the remaining 98% of Delaware employment. Additional survey details are given in the appendix.

Our survey instrument elicited the "greenness" of each company's output with three questions. The first question asked companies to describe the main products and services that their company offered.[8] The second question asked companies whether any of the goods or services produced was "primarily intended" to conserve energy, use renewable energy, conserve natural resources, or reduce pollution. If the respondent answered affirmatively to any of the above categories, the third question requested examples of that output.

[8] Although we knew each company's industry code (along with employment and wages) from the unemployment insurance file, the description of products and services was very useful. Occasionally there were discrepancies between the industry codes on file and the description of the company's primary output.

The product descriptions and green examples were then classified into a particular green sector based on the full BLS definition and list of green output examples.[9,10] Most of the self-reported green output descriptions matched the BLS examples.

Throughout this report we mostly discuss the point estimates from the survey and address their implications. As detailed in the Appendix, we administered over 4,400 surveys and received 711 responses. Normally, 711 responses are more than sufficient for precise inferences. However, in the case of the green industry, we did not know which businesses would be classified as green in advance, so many of those surveys do not provide information on the green economy (see Figure 6). Consequently, the statistical uncertainty of our estimates increases for the more detailed questions. We provide conventional 95% margins of error where appropriate. Our discussion reflects the best answers provided by the data, but many answers are subject to high levels of uncertainty.

[9] http://www.bls.gov/green/final_green_def_8242010_pub.pdf

[10] When an existing taxonomy is applied to descriptive survey data, subjectivity can never be removed. By using BLS's definition, we feel that we have limited the subjectivity of the inclusion/exclusion criteria to just the one definition.

Describing Delaware's Green Economy

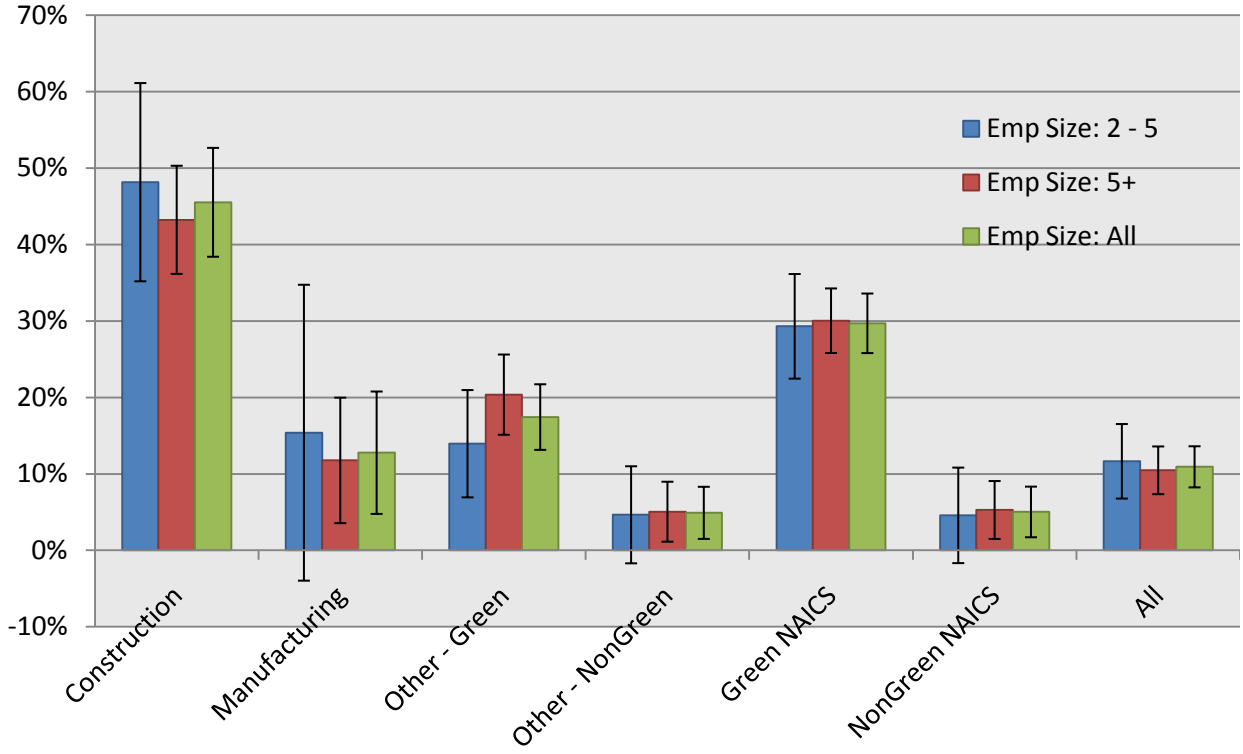
Overview of Green Jobs and Green Businesses

In this section, we describe Delaware's green economy. Figure 5 shows what percent of establishments claimed to produce green goods and services. The sample was sub-divided across industries, employment size, and whether the establishment fell into BLS's potentially green universe. The error bars express 95% confidence intervals for the mean of each group.

The first group of three bars indicates that between 43% and 48% of construction establishments claimed to produce green output.[11] The next group of three bars indicates that between 12% and 15% of manufacturing establishments claimed green output. Nearly 30% of establishments identified by the BLS as being potentially green ("Green NAICS") made claims to producing green output, as did 5% of establishments with non-green industry codes ("NonGreen NAICS"). Overall, nearly 11% of Delaware establishments made claims to green output. After checking these claims based on the examples provided, we estimated that 8.5% of Delaware establishments actually produce green output.[12]

[11] Establishments with at least 2 or more employees.
[12] Margin of Error (MoE) equals 1.9%

Figure 5 Percent of Establishments Claiming Green Products & Services



- 95% confidence intervals reported as bands[13]

There are a few important points to make about the results presented in Figure 5. First, there is a large degree of uncertainty for certain industries, such as manufacturing. Second, employment size does not seem to matter to whether a firm claims to have green output. In addition, establishments in the BLS universe are much more likely to claim green output than companies outside that universe. Note that this graph addresses the number of Delaware's business establishments, not employment. Moreover, the figure does not check whether these claims coincide with BLS's definition of green output.

[13] The 95% confidence intervals and 95% margins of error are both ways of expressing statistical confidence in our results. The larger are either of these measures, the lower confidence one has in the value of the point estimates. More technically, the 95% confidence interval is a numerical range for a particular sample parameter. If many such samples were drawn and had sample parameters and confidence intervals recalculated each time, the true population parameter will be contained in 95% of those intervals. The 95% MoE is half the range of the 95% confidence interval.

Table 2 Establishment Count and Employment Size of Delaware's Green Economy and its Four Sectors

Sector	In a BLS Industry		Not in a BLS Industry		Across All Industries	
	Estab.	Emp.	Estab.	Emp.	Estab.	Emp.
Total Green	1,039	12,437	241	3,824	1,280	16,261
	(141)	(2,648)	(250)	(3,144)	(287)	(4,095)
Energy Efficiency	690	7,956	191	3,758	881	11,713
	(122)	(2,431)	(168)	(3,081)	(207)	(3,904)
Renewable Energy	12	957	152	1,323	164	2,281
	(14)	(1,217)	(68)	(799)	(70)	(1,455)
Pollution Reduction and Recycling	305	3,816	145	2,650	450	6,467
	(86)	(1,287)	(124)	(1,884)	(150)	(2,262)
Natural Resource Conservation	69	1,740	164	804	233	2,544
	(43)	(1,349)	(193)	(733)	(198)	(1,529)

- 95% Margin of Error in parentheses

The table above reports the number of establishments that sold green output and their employment. The table differentiates between those companies that have a green industry code from those that do not. We found that 1,039 green establishments in Delaware have a potentially green NAICS code and employ 12,437 persons. We also estimated that 241 green establishments employ 3,824 persons outside of the BLS universe.[14] The final two columns in Table 2 are our expectations of both types of green companies in the state.

The establishment and employment count for each of the four sectors is also listed in the table. Energy efficiency was clearly the largest sector in the state (881 establishments and 11,713 employees), followed by pollution reduction (450 establishments and 6,467 employees), natural resource conservation (233 establishments and 2,544 employees), and finally the renewable energy sector (164 establishments and 2,281 employees).

[14] The precision of estimates outside of the BLS industry list is much lower, since the survey design sampled companies with those industry codes less frequently. The results imply that future studies of the green economy in Delaware should analyze all businesses, as there are potentially many businesses outside of BLS's scope.

Table 3 Overlapping Relationships between Different Sectors of Green Businesses

		Energy Efficiency		Renewable Energy		Natural Resource Conservation		Pollution Reduction	
		Yes	No	Yes	No	Yes	No	Yes	No
Energy Efficiency	Yes	11,713	0						
	No	0	324,036						
Renewable Energy	Yes	1,977	304	2,281	0				
	No	9,737	323,732	0	333,469				
Resource Conservation	Yes	1,012	1,532	957	1,586	2,544	0		
	No	10,702	322,504	1,323	331,883	0	333,206		
Pollution Reduction	Yes	3,443	3,024	484	5,983	791	5,676	6,467	0
	No	8,271	321,012	1,797	327,486	1,753	327,530	0	329,283

An immediate implication from Table 2 is that the green economy seems larger if one looked at the four sectors individually than as a whole. This is due to the fact that some companies sell more than one type of green output. For example, one construction company might weatherize a home and install a solar panel, and therefore be classified into two different sectors. Also, BLS considers some output as falling into multiple sectors. For example, weatherization falls under both the energy efficiency sector and the pollution reduction and recycling sector. Table 3 shows the overlap in employment between each of the four green sectors analyzed. Surprisingly, nearly 87% of the employees in the renewable energy sector are also classified in the energy efficiency sector.[15]

[15] This ratio was calculated as $\frac{1977}{2281}$.

Figure 6 Employment Size in Delaware's Potential and Actual Green Economy

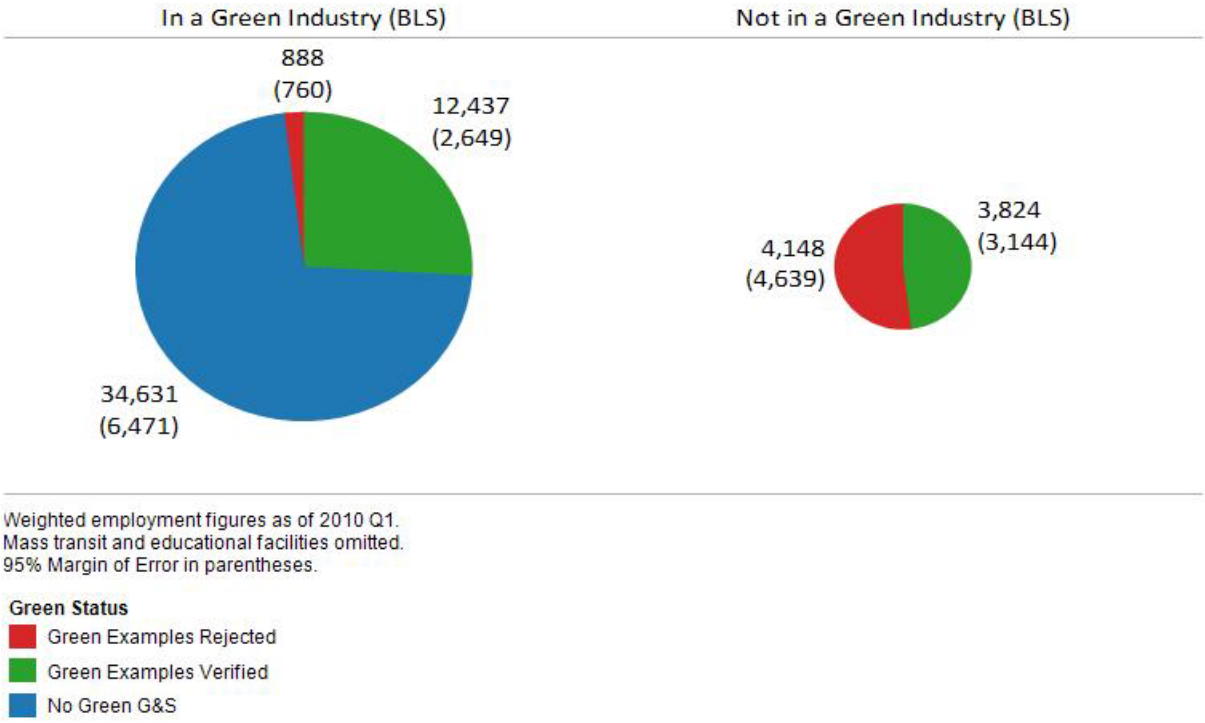


Figure 6 explores the green classification further. The pie chart on the left indicates the employment in those companies with an industrial code designated by the BLS as potentially green. Of the 47,956 persons employed by these companies, 12,437 were estimated to work for green companies. Only 1.8% of these companies made green claims but did not provide sufficient supporting examples. The pie chart on the right refers to businesses that claim green goods and services but fall outside of BLS's green universe. Although uncertain, the point estimates indicate that many more people outside the BLS industry claimed to sell green output that was not considered green. However, approximately a quarter of green employment may be missed by adhering to the restrictions of the BLS industry list.[16]

[16] Since industrial classification codes are only intended to classify primary products and services, businesses often produce secondary goods and services that would otherwise be classified in other industries. The Bureau of

Figure 7 presents similar decompositions for each of the four green sectors. Each row indicates a particular green sector. Companies with a potentially green industry code are listed in the left column of pie charts. Companies without a green industry code that also claim green output are listed in the right column of pie charts. We find that the majority of each potentially green sector does not actually produce green output. Approximately 8,000 out of 26,300 (30%) potential employees work for firms producing energy efficiency G&S. The respective proportions of the other three sectors are even smaller.

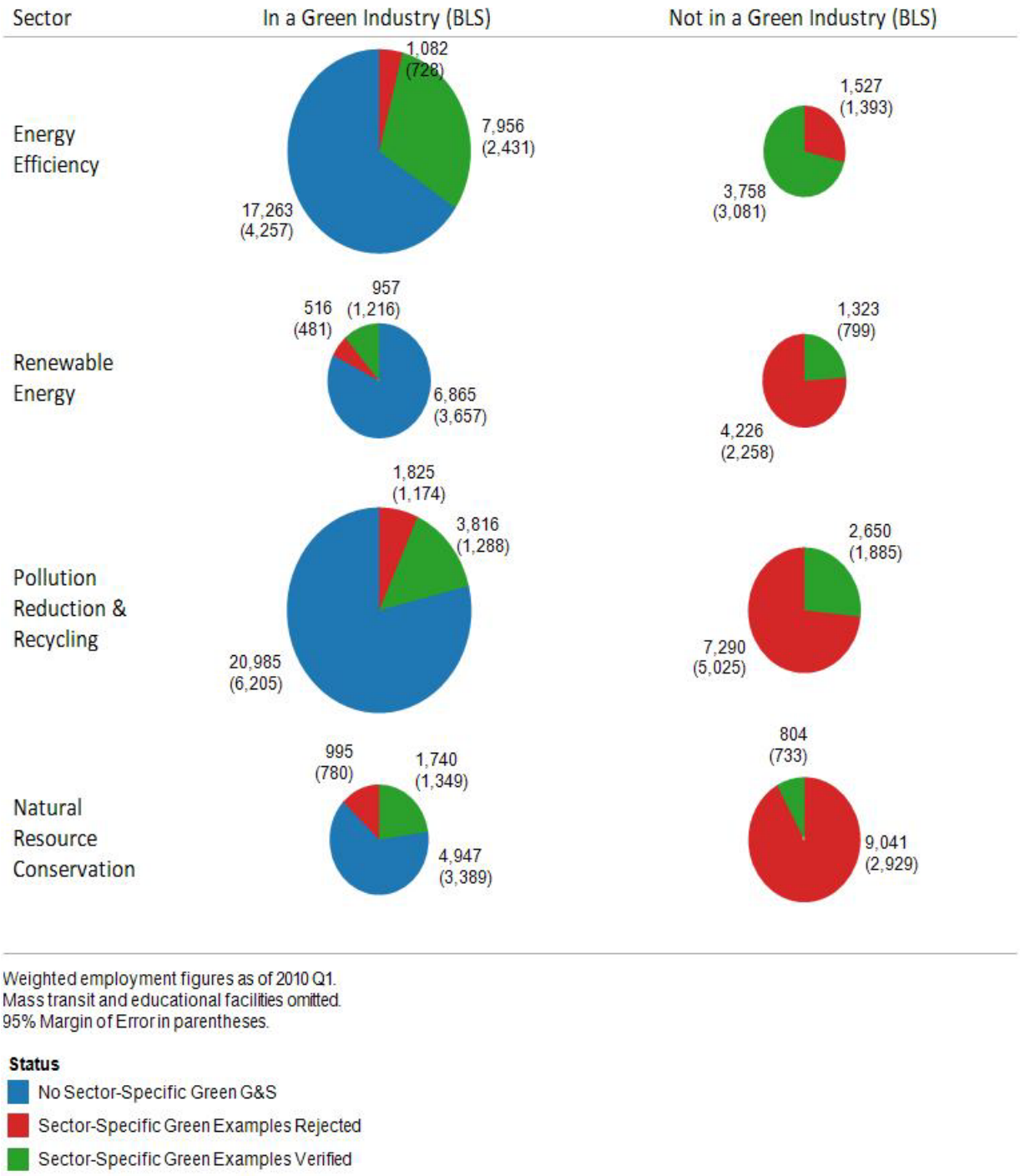
Figure 7 indicates that a large portion of employment making sector-specific green G&S falls outside that sector's restrictive industry list. That restricted list captures 59% of the relevant employment in the pollution reduction and recycling sector and 42% of the relevant employment in the renewable energy sector.[17] As before, we suspect that this stems from the fact companies often offer a scope of G&S, some of which falls outside their industrial classification.[18]

Economic Analysis faces this problem when producing the national input-output tables (Horowitz and Planting, 2009). Presumably, the scaling of employment by revenue sales might mitigate this bias.

[17] $\frac{3816}{3816+2650}$ and $\frac{952}{952+1323}$, respectively.

[18] A non-statistical inspection of the data indicates that companies in the energy efficiency sector are primarily in construction and the professional and technical services industries. The pollution reduction sector seems largely comprised of specialized trade contractor, professional and technical services, administrative and remediation services, and automotive services industries. The natural resource conservation sector primarily produces output in the professional and technical services and the administrative and remediation services industry. The renewable energy industry seems concentrated in specialized trade contractors and professional and technical services industry.

Figure 7 Employment Size in Delaware's Potential and Actual Green Sectors



Weighted employment figures as of 2010 Q1.
Mass transit and educational facilities omitted.
95% Margin of Error in parentheses.

Status

- No Sector-Specific Green G&S
- Sector-Specific Green Examples Rejected
- Sector-Specific Green Examples Verified

Green Perceptions vs. Green Definitions

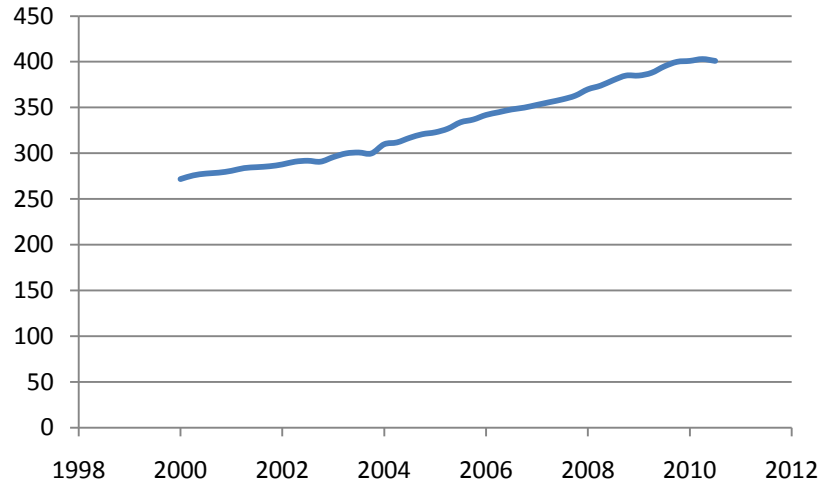
We were also able to use our survey to gauge the population's subjective understanding of "green". Figure 6 indicates that companies employing 21,296 persons claimed to sell green output. However, only 16,261 persons worked for companies that gave acceptable examples according to BLS definition. This implies that approximately 76% of the companies claiming green output likely meet BLS's green criteria.

Similarly, Figure 7 indicates 14,322 persons worked for businesses that claimed energy efficient goods and services, but 2,609 did not meet the BLS's criteria. This implies that the BLS definition excludes approximately 18% of the public's opinion on what constitutes an "energy efficient" good or service.[19] Similarly, the BLS definition excludes 68% of the public's opinion for the renewable energy sector, 22% of the public's opinion for the pollution reduction and recycling sector, and 30% of the public's opinion regarding natural resource conservation sector.

The overall public perception of "green" clearly does not correspond perfectly with BLS's more nuanced definition. Thus, misclassification error likely exists in surveys asking respondents to classify their own output into specific sectors. Of course, we do not know how well such surveys would perform if the green definition is primed in advance. However, our results suggest that existing methods place a substantial amount of faith on the respondent's ability to ignore her own perceptions and use that definition.

19 $\frac{1527+1082}{1527+1082+7956+3758}$

Figure 8 Count of Survey Respondents with a Green Industry Code Witnessed during the Last Ten Years



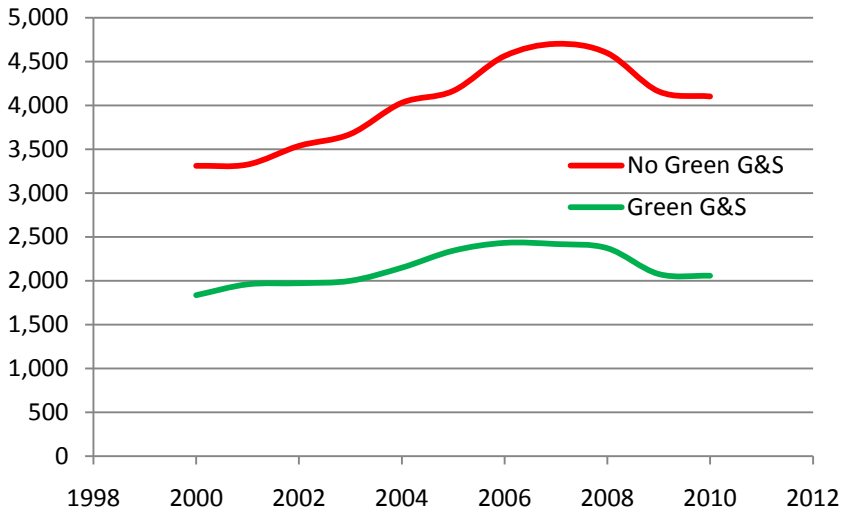
Historical Trends of Current Green Businesses

The previous section is a snapshot of Delaware businesses in the first quarter of 2010. However, much has changed in the economy in the most recent decade, and one snapshot does not indicate changes that have occurred over time. In this section, we present historical employment and wage profiles of the companies that responded to the survey. We compare the wage and employment trends of green companies to potentially green companies.[20]

Because we are evaluating the historical data of businesses sampled in 2010, we cannot adjust it to correct for sampling and response rates. Thus, the trends presented in this section are only applicable to the sample of companies that responded to the survey, and no implication is made for companies outside of the sample. In addition, these trends likely contain survivorship bias, since we did not witness which businesses closed prior to our survey (see Figure 8).

[20] "Potentially green companies" refers to businesses with a green industry code that do not produce green G&S.

Figure 9 Historical Trends in Employment of Potentially Green Establishments in 2010



Despite these technical cautions, the historical trends of survey respondents may still be informative. In particular, the trends of green companies in 2010 would appear to be comparable to the trends of potentially green companies in 2010. Figure 9 shows the employment trends of both types of businesses.[21]

Both green and potentially green companies (as of 2010) experienced substantial employment growth between 2000 and 2007, but reversed those trends between 2007 and 2010. Table 4 quantifies these changes. Overall, companies that sold green G&S in 2010 experienced a 12% increase in employment over the last decade, while similar companies that did not sell green G&S in 2010 increased employment 24%. The difference stems largely from unequal growth rates between 2000 and 2007.

[21] Due to a low probability of receiving a survey and the additional conflating effects of the industry classification, respondents with a non-green BLS industry code were excluded in these trends.

Table 4 Employment Change for Potentially Green Survey Respondents

	2000-2007	2007-2010	2000-2010
Green G&S	32%	-15%	12%
No Green G&S	42%	-13%	24%

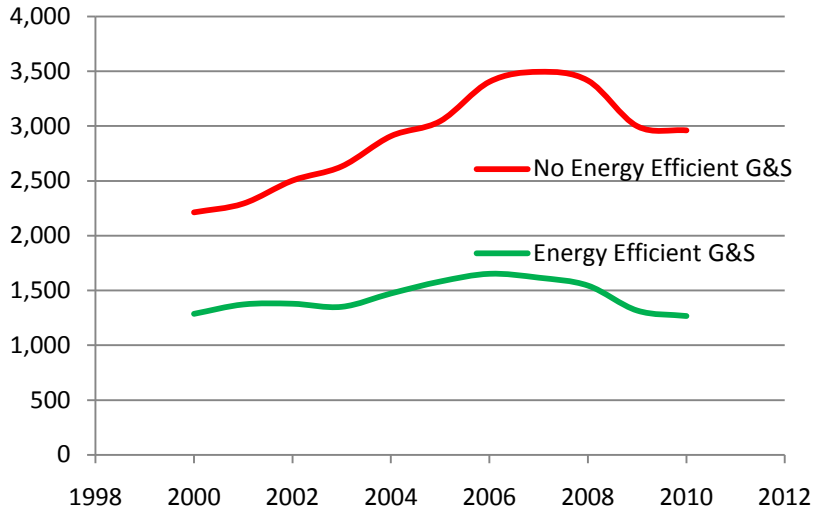
	2000-2007	2007-2010	2000-2010
Energy Efficient G&S	26%	-22%	-2%
No Energy Efficient G&S	58%	-15%	34%
Renewable Energy G&S *	29%	-7%	20%
No Renewable Energy G&S	26%	-8%	16%
Natural Resource Conservation G&S	31%	-8%	21%
No Natural Resource Conservation G&S	8%	-3%	-4%
Pollution Reduction & Recycling G&S	32%	-17%	10%
No Pollution Reduction & Recycling G&S	32%	-14%	14%

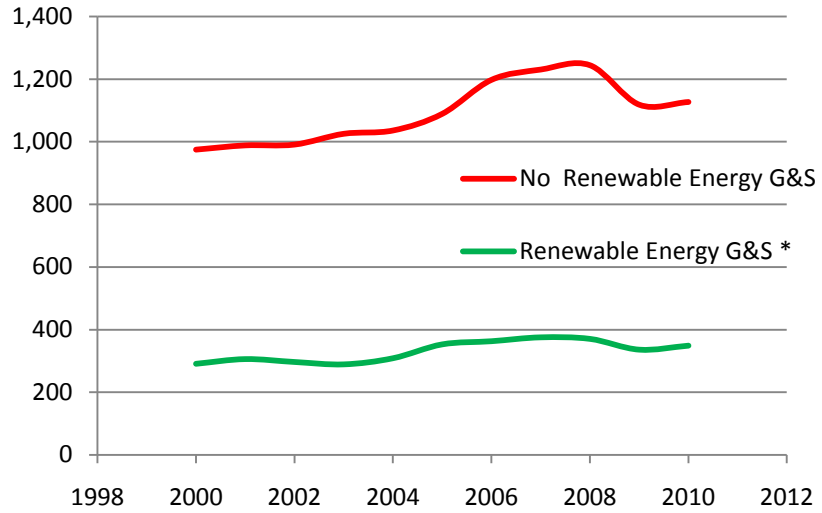
Figure 10 and the remainder of Table 4 presents similar employment trends for green and non green companies in each of the four green sectors. The energy efficient companies had considerably less growth over the last 10 years (-2%) than similar companies (34%). In the natural resource conservation sector, green companies experienced sharp employment gains in 2005, while their non-green counterparts did not. Green companies in the recycling and pollution reducing sector had growth rates that paralleled similar, non-green companies. The same was true for companies in the renewable energy universe.[22]

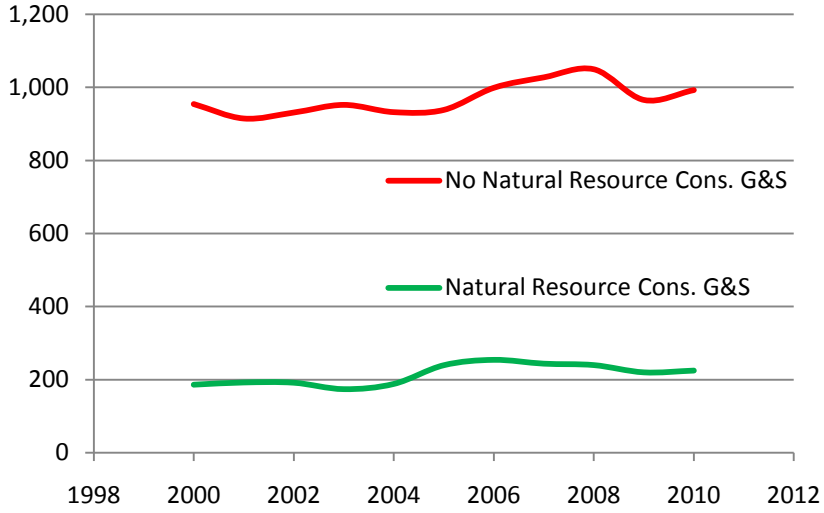
Although employment in all companies declined during the recession, companies in the renewable energy and natural resource conservation sectors fared better than companies in the other two green sectors.

[22] Because the renewable energy sector is so small and the BLS industry list is a poor match for Delaware companies, we include any company found to be selling renewable energy G&S, regardless of industry type.

Figure 10 Historical Trends in Employment of Potentially Green Establishments in 2010, by sector







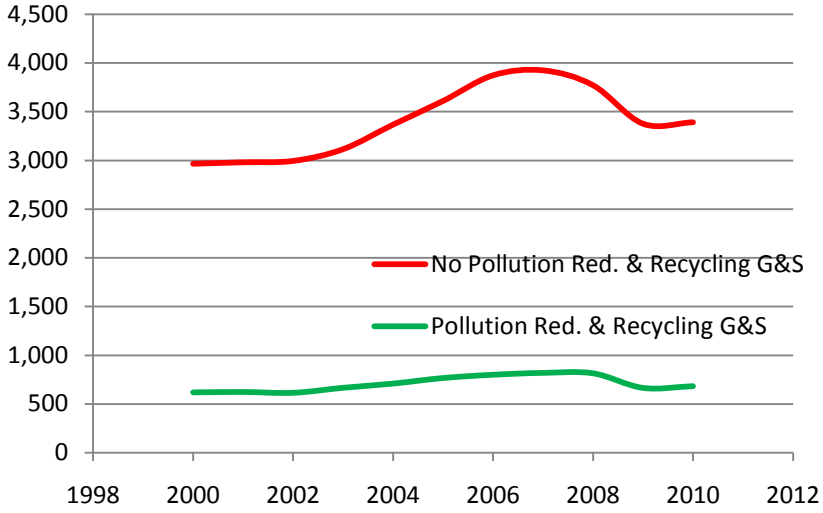


Figure 11 **Historical Trends in the Average Wage of Potentially Green Establishments in 2010 (2010 $)**

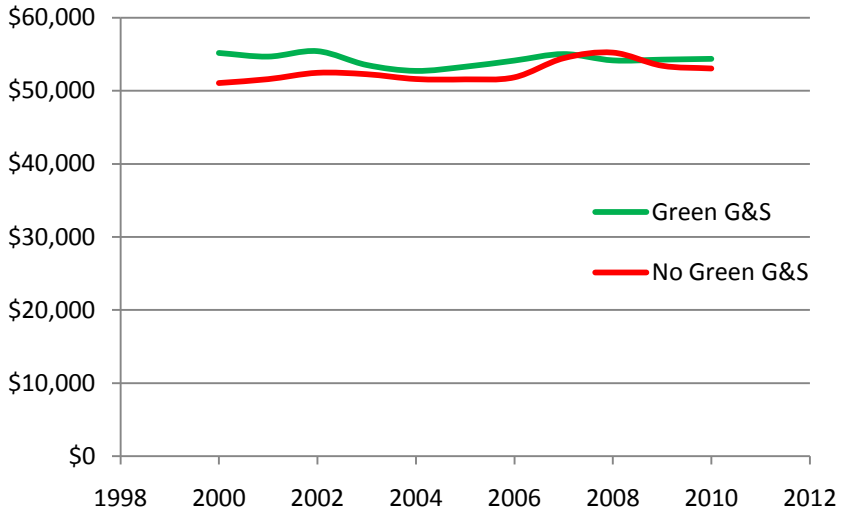


Figure 11 displays the historical average wage (2010 $) of survey respondents with a potentially green industry code. [23, 24] Companies selling green G&S in 2010 paid employees between $53,000 and $55,000 over the past decade. Similar firms not selling green G&S paid wages that were slightly lower, but grew at faster rates (see Table 5).[25]

[23] All dollars have been adjusted to 2010 prices using the annual CPI index for all urban consumers.
[24] The fourth quarter of 2010 was estimated using average seasonality factors for the last 5 years.
[25] Statistical tests were performed for the average wages per employee in the first quarter of 2010. Although the quarterly wages per employee in potentially green companies were, on average, nearly $1,000 above the wages in green companies ($13,061 and $12,093, respectively), the difference was not statistically significant at the 90% confidence level. No statistical difference was found among green and potentially green companies in each sector as well. Of course, since one quarter's wage differences do not reflect seasonality, it would be premature to reach a conclusion for annual wages.

Table 5 Change in the Average Wage of Green and Potentially Green Establishments Operating in 2010, by sector (2010 $)

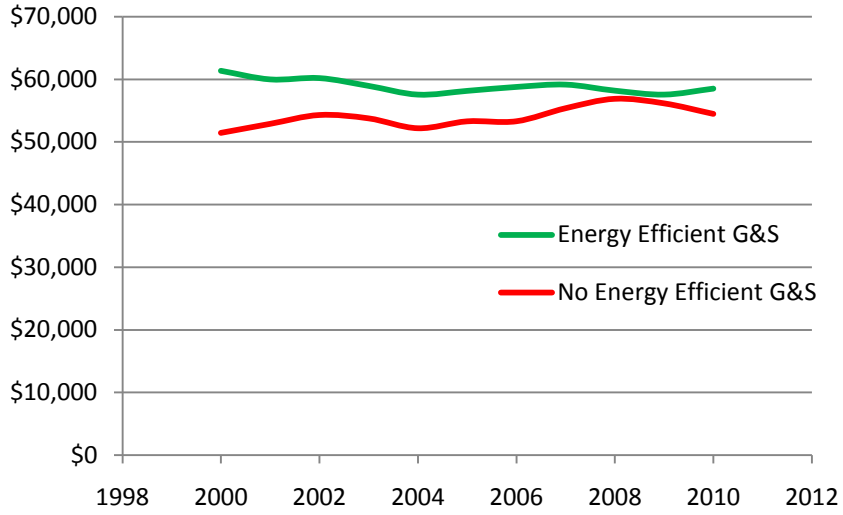
	2000-2007	2007-2010	2000-2010
Green G&S	0%	-1%	-1%
No Green G&S	7%	-3%	4%

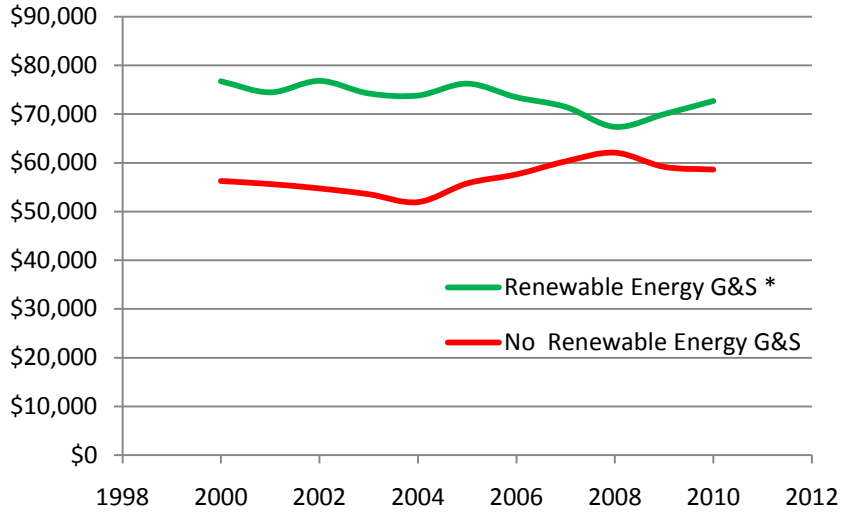
	2000-2007	2007-2010	2000-2010
Energy Efficient G&S	-4%	-1%	-5%
No Energy Efficient G&S	8%	-2%	6%
Renewable Energy G&S *	-7%	2%	-5%
No Renewable Energy G&S	7%	-3%	4%
Natural Resource Conservation G&S	-7%	7%	0%
No Natural Resource Conservation G&S	8%	-2%	6%
Pollution Reduction & Recycling G&S	-1%	-4%	-5%
No Pollution Reduction & Recycling G&S	5%	-2%	3%

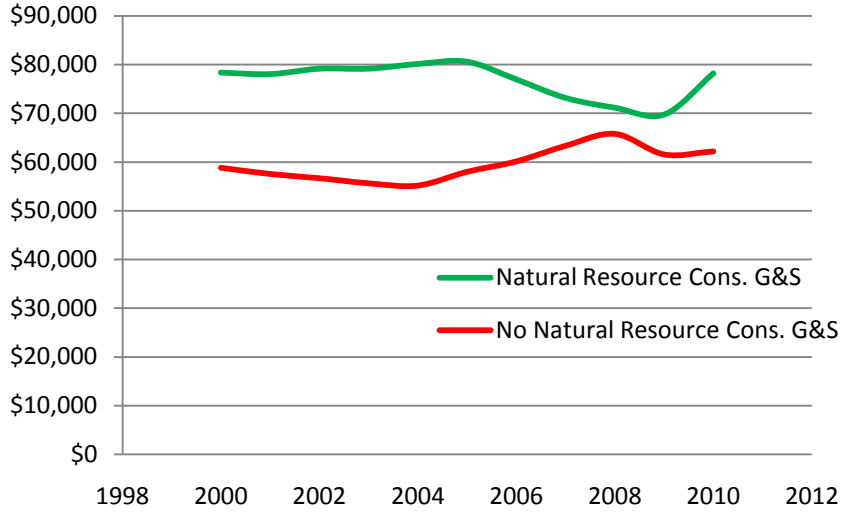
Figure 12 shows the historical average wage per worker in each of the potentially green sectors.[26] Green companies paid higher wages overall than their non-green counterparts in all sectors except the pollution reduction and recycling sector. However, that wage premium has fallen over time. Green companies selling energy efficient G&S in 2010 had an average real wage in 2000 that was $10,000 larger than companies not offering these G&S. By 2010, this premium was $4,000. Similar trends in the wage premium occurred among the sample's natural resource conservation and renewable energy companies.

[26] The renewable energy sector again includes all companies selling a renewable energy good or service with a "green" industry code.

Figure 12 Historical Trends in the Average Wage of Potentially Green Establishments in 2010, by sector (2010 $)







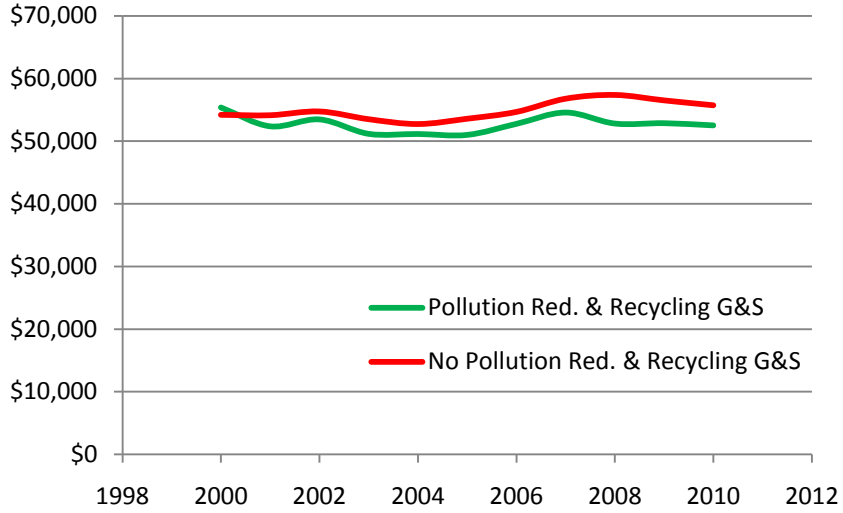


Table 6 Change in Employment and Average Wages (2010 $) for Green and Potentially Green Establishments Operating in 2000 and 2010

	Total Employment			Average Wage		
	00-07	07-10	00-10	00-07	07-10	00-10
Green G&S	12%	-20%	-11%	1%	0%	1%
No Green G&S	23%	-18%	1%	11%	-2%	8%
Energy Efficient G&S	7%	-28%	-23%	-2%	0%	-2%
No Energy Efficient G&S	31%	-20%	5%	14%	-2%	12%
Renewable Energy G&S *	24%	-14%	6%	-5%	5%	1%
No Renewable Energy G&S	12%	-15%	-5%	13%	2%	15%
Natural Resource Conservation G&S	15%	-12%	1%	-4%	8%	3%
No Natural Resource Conservation G&S	3%	-13%	-11%	10%	5%	15%
Pollution Reduction & Recycling G&S	22%	-19%	-1%	1%	-2%	0%
No Pollution Reduction & Recycling G&S	19%	-18%	-2%	7%	-2%	5%

To test the impact of survivor bias, we also analyzed the percentage change in employment and wages for companies that could be traced back to 2000.[27] The results are summarized in Table 6. Green companies in the energy efficiency sector still had lower employment growth than other potentially green companies in that sector. Green companies also experienced lower real wage gains over the last decade compared to their non green counterparts, but better real wage growth during the recession.

In summary, green companies in our sample did not show better employment or wage growth than their non-green counterparts over the last decade, but this result was largely driven by firms in the energy efficiency sector. Firms in the renewable energy and natural resource conservation sectors had higher employment growth than their counterparts, but these sectors are relatively small. We found that the green companies in our sample paid higher wages than similar companies, but those premiums have declined over time.

[27] This new sample could also be problematic if companies that operated in 2000 and 2010 were substantively different than companies born after 2000.

Evaluating Occupations and Skills

Green Occupations

In this section, we use supplemental data on the occupational composition of establishments in Delaware to explore the occupations employed by green and potentially green businesses. The Delaware Department of Labor had such data on 324 potentially green businesses.[28] Of the 216 potentially green businesses, 70 establishments reported identifiably green products and services, 39 of which were in the energy efficiency and 33 of which were in the pollution reduction and recycling sector. This section identifies the most common occupations in green businesses, as well as those that are unique to green businesses.

Table 7 lists the most frequent occupations among Delaware green firms. The most common occupations were plumbers, pipefitters, steamfitters, civil engineers, and supervisors and managers of construction workers and tradesmen. HVAC-R mechanics and installers were the fourth most common occupation. Three of the top ten occupations among green output businesses require managerial/business skills in the construction and the trades (first-line supervisor/manager, cost estimators, and construction managers).[29]

[28] Matches were made beginning with occupational survey conducted as early as 2002, though the majority of matches were in surveys dated in 2007or later. All occupational compositions were reweighted to reflect changes in employment, though the composition remained fixed. The matching of historical occupational data interferes with our ability to measure statistical uncertainty for each occupation.

[29] Multiplying each of these percentages by the total number of employment in that industry, in this case 16,261, will yield the estimated number of green occupations.

Table 7 Major Occupational Composition of Potentially Green Businesses

Green Rank	SOC Code	Occupation Title	Potentially Green	Actually Green
1	47-2152	Plumbers, Pipefitters, and Steamfitters	3.0%	6.6%
2	17-2051	Civil Engineers	0.2%	5.6%
3	47-1011	First-Line Sups/Mgrs of Construction Trades and Extraction Workers	2.1%	5.1%
4	49-9021	Heating, Air Conditioning, and Refrigeration Mechanics and Installers	0.9%	4.1%
5	37-3011	Landscaping and Groundskeeping Workers	2.6%	2.9%
6	47-2061	Construction Laborers	3.7%	2.7%
7	11-1021	General and Operations Managers	2.5%	2.3%
8	43-3031	Bookkeeping, Accounting, and Auditing Clerks	2.0%	2.3%
9	13-1051	Cost Estimators	1.5%	2.2%
10	43-9061	Office Clerks, General	3.6%	2.1%
11	17-2141	Mechanical Engineers	1.1%	2.1%
12	43-6014	Secretaries, Except Legal, Medical, and Executive	1.2%	2.1%
13	11-9021	Construction Managers	1.7%	2.0%
14	49-3023	Automotive Service Technicians and Mechanics	1.1%	1.9%
15	17-3011	Architectural and Civil Drafters	0.4%	1.9%
16	11-9041	Engineering Managers	0.5%	1.9%
17	53-5022	Motorboat Operators	0.0%	1.7%
18	19-2041	Environmental Scientists and Specialists, Including Health	0.0%	1.6%
19	47-2221	Structural Iron and Steel Workers	0.1%	1.5%
20	47-2111	Electricians	5.0%	1.5%
21	53-7062	Laborers and Freight, Stock, and Material Movers, Hand	0.1%	1.5%
22	47-2211	Sheet Metal Workers	0.5%	1.5%
23	53-3032	Truck Drivers, Heavy and Tractor-Trailer	0.8%	1.5%
24	17-3013	Mechanical Drafters	0.9%	1.5%
25	13-2011	Accountants and Auditors	1.7%	1.4%
26	17-3022	Civil Engineering Technicians	0.1%	1.2%
27	47-3015	Helpers--Pipelayers, Plumbers, Pipefitters, and Steamfitters	0.4%	1.2%
28	53-7081	Refuse and Recyclable Material Collectors	0.0%	1.2%
29	49-1011	First-Line Sups/Mgrs of Mechanics, Installers, and Repairers	0.7%	1.1%
30	17-2071	Electrical Engineers	0.4%	1.0%
31	49-3031	Bus and Truck Mechanics and Diesel Engine Specialists	0.4%	1.0%
32	27-3031	Public Relations Specialists	0.6%	1.0%
33	41-3099	Sales Representatives, Services, All Other	0.7%	1.0%
34	17-3012	Electrical and Electronics Drafters	0.5%	0.9%
35	47-2031	Carpenters	1.9%	0.9%
36	41-4012	Sales Reps, Wholesale and Mfg, Except Tech and Scientific Products	0.8%	0.9%
37	47-3019	Helpers, Construction Trades, All Other	0.0%	0.9%
38	47-3013	Helpers--Electricians	0.2%	0.8%
39	47-2041	Carpet Installers	0.2%	0.8%
40	49-9042	Maintenance and Repair Workers, General	0.3%	0.8%

Table 7 also indicates how green businesses differed from potentially green businesses. General construction laborers and office clerks, for example, are more prevalent in potentially green companies than they are in green companies. Electricians (#20) and carpenters (#35) are also relatively unique to potentially green businesses. Civil engineers and HVAC-R mechanics and installers, on the other hand, are common and unique to green businesses.

Table 8 lists the most frequent occupations among Delaware businesses in the energy efficient sector. Plumbers, pipefitters, and steamfitters are again the most common occupation, but also fairly common in potentially green companies too. HVAC-R technicians and civil engineers are the second and third most frequently cited occupation among identifiably green businesses. Mechanical engineers and architectural and civil drafters are also relatively common and unique. Occupations such as office clerks, bookkeepers & accountants, and construction managers are common, but not unique to green businesses in this sector.

Table 9 lists the most frequent green occupations in Delaware's pollution reduction and recycling sector. The rightmost column again lists the proportion of the most common occupations in the pollution reduction and recycling sector. Landscapers, groundskeepers, and construction laborers were found to be the most frequent, but these occupations were not especially unique to green businesses. However, occupations in the automotive trades were also relatively common and unique, as were environmental scientists and refuse and recyclable material collectors.[30]

[30] This result is largely due to the decision to including emission repairs as a pollution reducing activity.

Table 8 Major Occupational Composition of Businesses that Potentially Produce Energy Efficient G&S

Green Rank	SOC Code	Occupation Title	Potentially Energy Efficient	Actually Energy Efficient
1	47-2152	Plumbers, Pipefitters, and Steamfitters	5.8%	9.4%
2	49-9021	Heating, Air Conditioning, and Refrigeration Mechanics and Installers	1.6%	6.2%
3	17-2051	Civil Engineers	1.6%	6.0%
4	47-1011	First-Line Sups/Mgrs of Construction Trades and Extraction Workers	4.2%	4.4%
5	17-2141	Mechanical Engineers	0.2%	3.8%
6	17-3013	Mechanical Drafters	0.6%	3.6%
7	47-2061	Construction Laborers	2.3%	3.2%
8	49-3023	Automotive Service Technicians and Mechanics	2.0%	3.0%
9	11-9041	Engineering Managers	0.2%	3.0%
10	17-3011	Architectural and Civil Drafters	0.6%	2.4%
11	19-2041	Environmental Scientists and Specialists, Including Health	0.0%	2.4%
12	43-3031	Bookkeeping, Accounting, and Auditing Clerks	2.3%	2.3%
13	13-1051	Cost Estimators	2.1%	2.3%
14	43-9061	Office Clerks, General	2.9%	2.3%
15	47-2211	Sheet Metal Workers	1.0%	2.3%
16	17-2071	Electrical Engineers	0.3%	2.2%
17	11-9021	Construction Managers	3.2%	2.1%
18	17-3012	Electrical and Electronics Drafters	0.3%	2.0%
19	43-6014	Secretaries, Except Legal, Medical, and Executive	1.3%	2.0%
20	11-1021	General and Operations Managers	3.2%	2.0%
21	17-3022	Civil Engineering Technicians	0.0%	1.9%
22	17-3027	Mechanical Engineering Technicians	0.0%	1.6%
23	47-3015	Helpers--Pipelayers, Plumbers, Pipefitters, and Steamfitters	1.1%	1.3%
24	47-3019	Helpers, Construction Trades, All Other	0.0%	1.3%
25	47-2031	Carpenters	2.8%	1.3%

Table 9 Major Occupational Composition of Businesses that Potentially Produce Pollution Reducing or Recycled G&S

Green Rank	SOC Code	Occupation Title	Potentially Pollution Reduction & Recycle	Actually Pollution Reduction & Recycle
1	37-3011	Landscaping and Groundskeeping Workers	4.5%	6.3%
2	47-2061	Construction Laborers	6.6%	4.6%
3	49-3023	Automotive Service Technicians and Mechanics	1.9%	4.5%
4	47-1011	First-Line Sups/Mgrs of Construction Trades and Extraction Workers	4.9%	3.7%
5	17-2141	Mechanical Engineers	2.1%	3.6%
6	17-2051	Civil Engineers	3.6%	3.6%
7	53-7062	Laborers and Freight, Stock, and Material Movers, Hand	0.0%	3.5%
8	43-6014	Secretaries, Except Legal, Medical, and Executive	1.3%	3.5%
9	19-2041	Environmental Scientists and Specialists, Including Health	0.1%	3.3%
10	11-1021	General and Operations Managers	2.6%	3.0%
11	53-3032	Truck Drivers, Heavy and Tractor-Trailer	0.7%	3.0%
12	43-3031	Bookkeeping, Accounting, and Auditing Clerks	1.3%	2.8%
13	17-3011	Architectural and Civil Drafters	1.1%	2.7%
14	53-7081	Refuse and Recyclable Material Collectors	0.0%	2.7%
15	13-1051	Cost Estimators	2.1%	2.5%
16	11-9041	Engineering Managers	1.4%	2.4%
17	49-3031	Bus and Truck Mechanics and Diesel Engine Specialists	0.6%	2.3%
18	17-3013	Mechanical Drafters	1.2%	2.2%
19	47-2221	Structural Iron and Steel Workers	0.7%	2.1%
20	43-9061	Office Clerks, General	2.4%	1.9%
21	47-2041	Carpet Installers	0.3%	1.9%
22	13-2011	Accountants and Auditors	1.9%	1.9%
23	47-2161	Plasterers and Stucco Masons	0.0%	1.8%
24	11-9021	Construction Managers	2.8%	1.6%
25	37-2019	Building Cleaning Workers, All Other	0.3%	1.6%

Skill Implications Derived from Occupations

The occupational differences between green and potentially green companies likely imply that there are probable skill differences as well. For example, since green companies tend to employ relatively more plumbers, pipefitters and steamfitters, it may be that companies selling green output require more blue-collar skills than potentially-green companies. On the other hand, green companies also had a smaller proportion of electricians than their potentially green counterparts, so perhaps the opposite conclusion should be drawn. In this section we evaluate the skill differences between green and potentially green companies based on their occupational composition.

To make these comparisons, we complemented Delaware Department of Labor's occupational data provided by ONET Online. ONET Online is a free online database that gives descriptive details for approximately 1000 occupations. In particular, the database contains a survey that ranks how important various kinds of knowledge, skills, abilities, work activities and work contexts are to a particular occupation. The survey is administered to both occupational experts and incumbents. For example, Figure 13 summarizes the average level of importance of various skills for persons working as Medical and Clinical Laboratory Technologists (Tsacoumis and Willisson, 2010). The database offers the means, standard errors, and even some limited micro-data for each occupation-skill combination.[31]

[31] Version 14 of the ONET database was used as the main source of survey data. http://www.xwalkcenter.org/index.php?option=com_content&view=article&id=101:onet-140&catid=31

Figure 13 **Example of ONET Survey Data: Mean Importance of Job Tasks, Supplementary Job Tasks, and Knowledge**

29-2011.00 Medical and Clinical Laboratory Technologists

Job Zone: 4

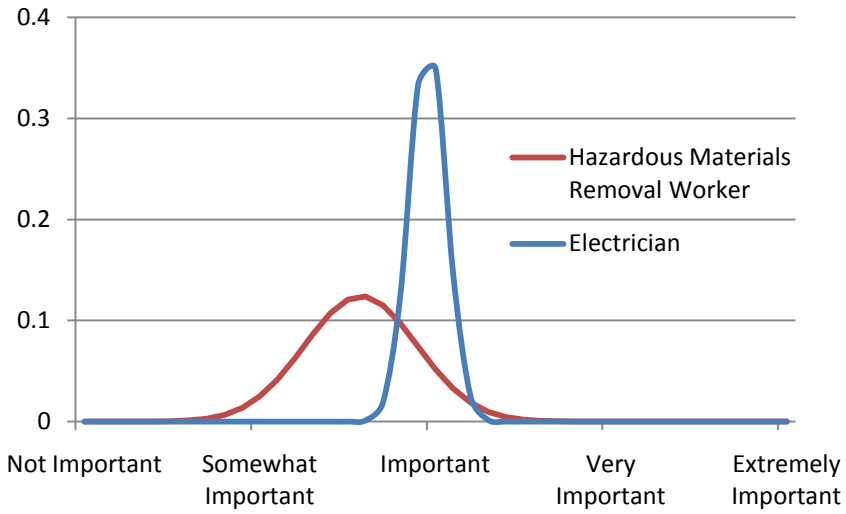
Perform complex medical laboratory tests for diagnosis, treatment, and prevention of disease. May train or supervise staff.

1 = Not Important | 2 = Somewhat Important | 3 = Important Important | 4 = Very Important | 5 = Extremely Important

	Core Task	Importance
1	Analyze laboratory findings to check the accuracy of the results.	4.8
2	Conduct chemical analysis of body fluids, including blood, urine, and spinal fluid, to determine presence of normal and abnormal components.	4.8
3	Enter data from analysis of medical tests and clinical results into computer for storage.	4.7
4	Operate, calibrate and maintain equipment used in quantitative and qualitative analysis, such as spectrophotometers, calorimeters, flame photometers, and computer-controlled analyzers.	4.6
5	Establish and monitor quality assurance programs and activities to ensure the accuracy of laboratory results.	4.6
6	Set up, clean, and maintain laboratory equipment.	4.4
7	Provide technical information about test results to physicians, family members and researchers.	4.3
8	Supervise, train, and direct lab assistants, medical and clinical laboratory technicians and technologists, and other medical laboratory workers engaged in laboratory testing.	4.1
	Supplementary Task	**Importance**
9	Collect and study blood samples to determine the number of cells, their morphology, or their blood group, blood type, and compatibility for transfusion purposes, using microscopic techniques.	4.7
10	Obtain, cut, stain, and mount biological material on slides for microscopic study and diagnosis, following standard laboratory procedures.	4.6
11	Analyze samples of biological material for chemical content or reaction.	4.6
12	Cultivate, isolate, and assist in identifying microbial organisms, and perform various tests on these microorganisms.	4.6
13	Select and prepare specimen and media for cell culture, using aseptic technique and knowledge of medium components and cell requirements.	4.5
14	Develop, standardize, evaluate, and modify procedures, techniques and tests used in the analysis of specimens and in medical laboratory experiments.	4.1
15	Harvest cell cultures at optimum time based on knowledge of cell cycle differences and culture conditions.	4.1
16	Conduct medical research under direction of microbiologist or biochemist.	3.1

	Knowledge	Importance
1	Biology	4.2
2	Chemistry	3.8
3	Customer and Personal Service	3.7
4	Medicine and Dentistry	3.6
5	English Language	3.5
6	Mathematics	3.5
7	Clerical	3.3
8	Computers and Electronics	3.2
9	Mechanical	3.1

Figure 14 **Expected Importance of Equipment Selection between Two Occupations**

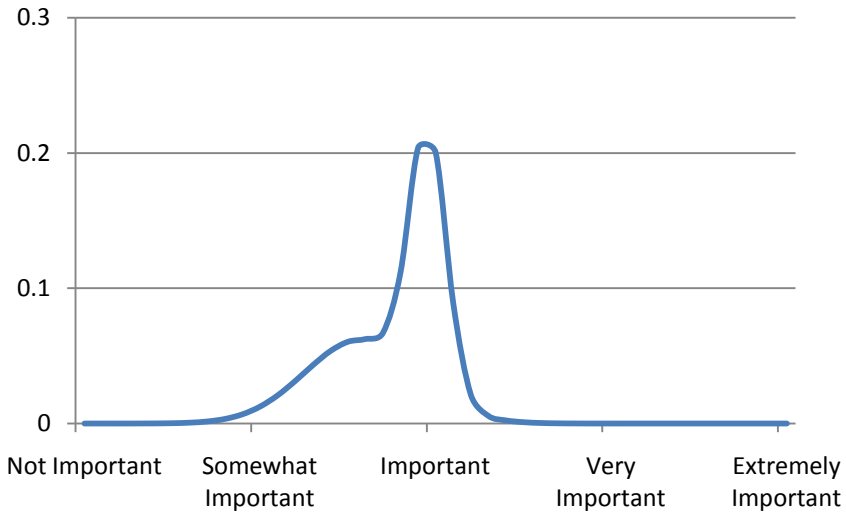


We interpret the reported means and standard errors from a Bayesian perspective and consider such distributions as expectations of the population mean.[32] For example, the blue line in Figure 14 represents our expectations of how important equipment selection is likely to be to an electrician. The red line indicates our expectations of that same skill for a hazardous materials removal worker. The distributions tell us electricians are expected to place a greater importance on equipment selection than hazardous materials removal workers. The tighter spread indicates that we are more certain of our expectations with respect to electricians than with respect to hazardous materials removal workers.

Using the Bayesian interpretation, we can estimate the probability that the population mean of a particular occupation-skill combination falls within a narrow range. For example, we estimated that there was a 1.9% chance that the average electrician finds equipment selection to have an importance level between 2.7 and 2.8 (on a scale of 1 to 5). The probability that an average hazardous materials removal worker has this level of importance attached to this skill is 11.5%.

[32] This interpretation implicitly assumes that the choice of a prior distribution has a negligible impact on the posterior distribution and was made for convenience. Future research can explore the implications that various prior distributions will have on the distribution.

Figure 15 **Expected Importance of Equipment Selection to a Hypothetical Company**

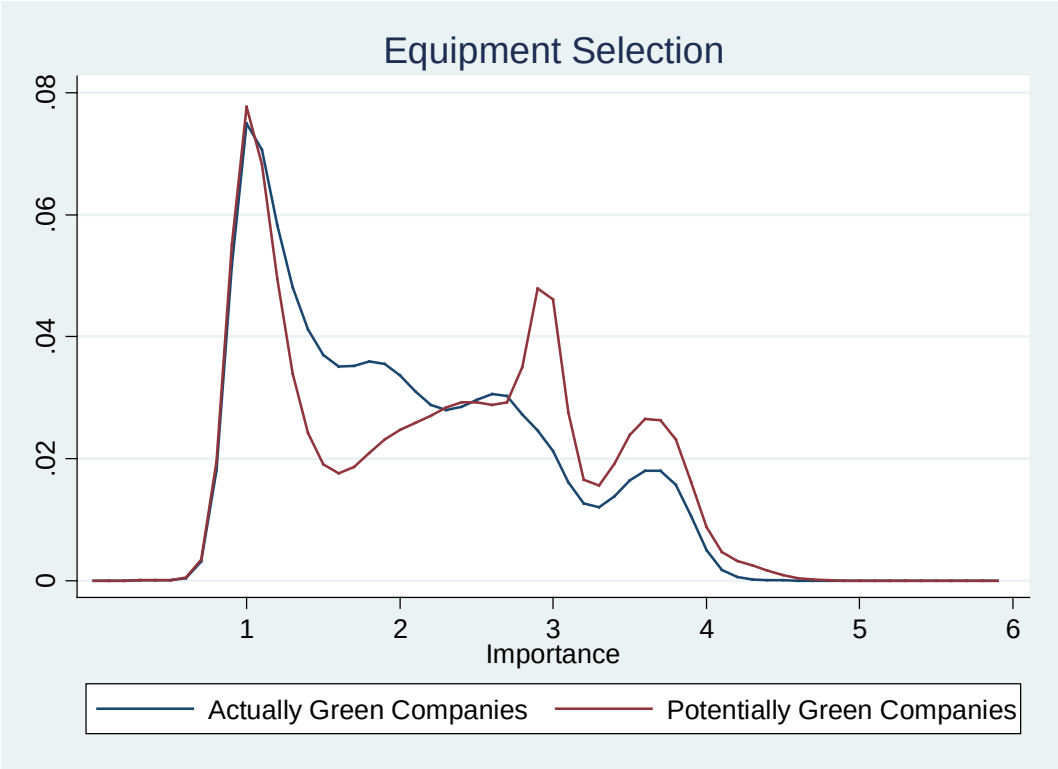


Next we asked what the probability would be of randomly selecting an occupation with a particular mix of occupations. For example, if a company hired one electrician and one hazardous materials removal worker, we ask what the chance is of selecting an employee with an expected importance of equipment selection between 2.7 and 2.8. Given an equal chance of drawing either occupation, the probability of drawing such an occupation is 6.7%.[33] Figure 15 shows these probabilities across all narrow skill ranges. The figure is an equally weighted mixture of the densities in Figure 14.[34]

[33] The expectation is calculated as 50%×1.9% + 50%×11.5%.

[34] Ideally, we would like to use actual level of skill required by each worker in the company. The second best solution would be to use the population's distribution of a skill's importance for each occupation. Since neither is available, the third best solution is to use the variation in the expected value. Distributions like Figure 14 show the distribution of expected values, not the expected distribution of values.

Figure 16 Density Mixture of Expected Importance for Equipment Selection across Employees of Green and Potentially Green Survey Respondents



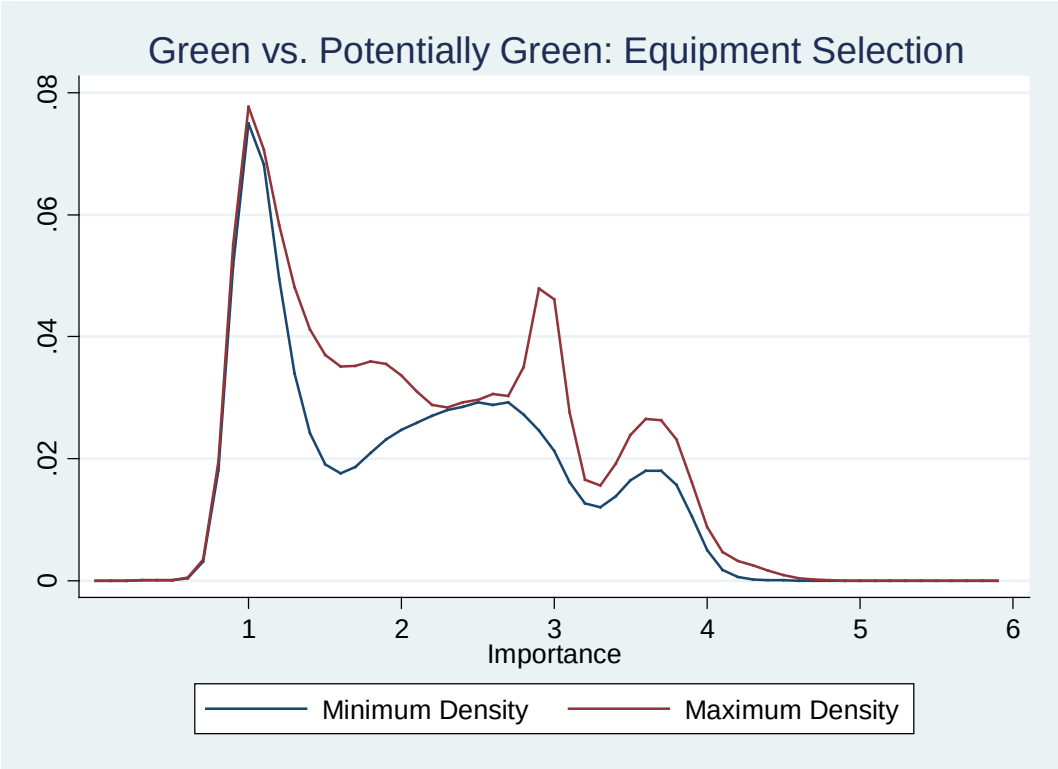
The process of mixing skill densities was performed for all survey respondents for whom the Delaware Department of Labor had occupational information. These mixed densities use common features across occupations to reveal what the most common skills are in a particular mix of occupations.

To continue the previous example, suppose we were interested in comparing the importance of equipment selection between green and potentially green companies. By a similar process of mixing the occupational densities, the blue line in Figure 16 shows just how common occupations are in green companies at different levels of equipment selection's importance. The red line shows how common different levels of that skill are in potentially green companies. Visual inspection of the two distributions indicates that a greater proportion of the potentially green companies' workforce is in occupations where equipment selection is more important.

We need a systematic way of comparing the skill sets of green companies to the skill sets of potentially green companies. We accomplish this by evaluating two measures. The first measure is the difference in expected value (i.e. mean) between the two distributions. For example, the average importance of equipment selection is approximately 2.0 for green companies and 2.2 for potentially green companies. This implies that potentially green companies hire proportionately more occupations where this skill is of greater importance. Inspection of the underlying skill distribution in Figure 16 shows that this is indeed the case.

The second measure evaluates the ratio of non-overlapping probability mass to overlapping probability mass for any two distributions. This was constructed by integrating over the maximum of two distributions (the area under the red distribution in Figure 17) and then over the minimum of the two distributions (the area under the blue distribution). Our measure divides the maximum area by the minimum area. As green and potentially green companies hire similar proportions of employees with a particular skill level, the maximum and the minimum of the two densities converge and the ratio approaches 1. As the two densities differ more from one another, the maximum area approaches 2, the minimum area approaches 0, and the ratio approaches infinity.

Figure 17 Minimum and Maximum Densities for Equipment Selection across Employees of Green and Potentially Green Survey Respondents



We interpret this ratio as how much larger the distributional differences are compared to the similarities for a particular skill. For example, the densities in Figure 14 have a ratio of 1.32, implying that for equipment selection, the differences between green and potentially green companies are approximately 32% as large as their similarities. A similar measure was created for each of the 215 other knowledge sets, skills, abilities, work activities and work contexts defined by ONET Online.

Figure 18 **Skill Comparison between Employees in Green and Potentially Green Companies**

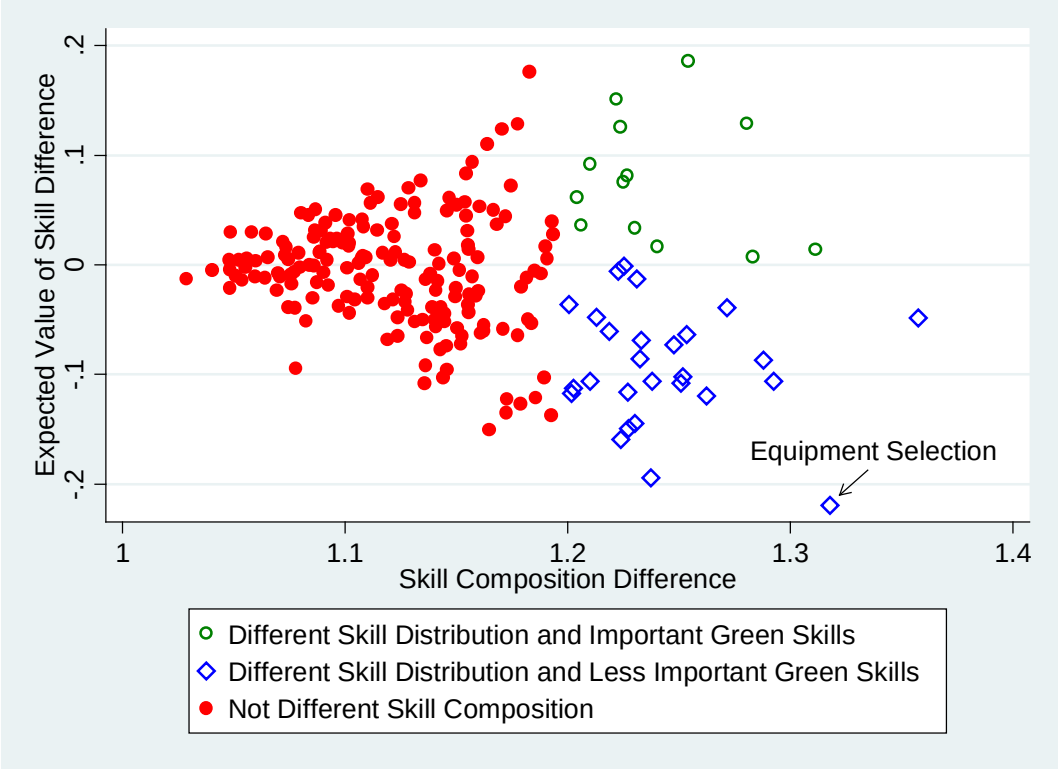


Figure 18 shows 216 points; each one indicates the difference in expected values along the y-axis for a particular skill and the ratio of distributional difference along the x-axis. The filled-in red dots indicate those skills where the distributions of green and potentially green companies differed by less than 20%. The green circles and blue diamonds indicate those distributions that differed by more than 20%. The green circles refer to skills that had higher expected values in green companies relative to potentially green companies. The blue diamonds refer to those skills that had higher expected values in potentially green companies.

Table 10 Skills Used by Green Companies More than Potentially Green Companies

Description	Type	Distribution Difference	Expected Value Diff.	Cond'l Expected Value Diff. Low	Medium	High	Cond'l Probability Mass Diff. Low	Medium	High
Mathematical Reasoning	Ability	1.31	0.01	0.05	-0.08	-0.02	1%	-7%	5%
Engineering and Technology	Knowledge	1.28	0.01	0.01	-0.05	0.19	6%	-11%	5%
Chemistry	Knowledge	1.28	0.13	-0.04	0.16	-0.35	-10%	9%	1%
Transportation	Knowledge	1.25	0.19	-0.01	0.09	0.02	-6%	0%	6%
Mathematics	Skill	1.24	0.02	0.04	-0.04	0.03	2%	-6%	4%
Exposed to Contaminants	Work Context	1.23	0.03	0.10	-0.10	0.04	-1%	-1%	2%
Working indoors in non-controlled environ.	Work Context	1.23	0.08	0.07	-0.05	0.00	-5%	5%	0%
Working Directly with the Public	Work Activity	1.22	0.08	-0.02	0.06	-0.09	-6%	7%	-1%
Spend Time Sitting	Work Context	1.22	0.13	0.05	0.09	-0.09	-4%	-1%	5%
Geography	Knowledge	1.22	0.15	0.03	0.12	-0.08	-8%	8%	1%
Communicating with Persons Outside Org.	Work Activity	1.21	0.09	-0.07	0.07	-0.02	0%	-7%	6%
Number Facility	Ability	1.21	0.04	0.04	0.01	-0.11	-1%	-1%	2%
Law and Government	Knowledge	1.20	0.06	-0.05	0.09	-0.08	-4%	2%	2%

Table 10 shows which skills are distributionally different between green companies and potentially green companies and are more common in green companies (green circles). Green companies are distinguished by employing relatively more occupations that emphasize mathematics, mathematical reasoning, number facility, chemistry, geography, and engineering and technology. Green companies in Delaware also tend to employ more persons that work with the public, communicate with people outside of the organization, and have knowledge of law and government.

Table 10 also lists how green and potentially green companies compare within different sections of a skill distribution. We divided each distribution into a low importance category, a medium importance category, and a high importance category and then calculated the expected value within each category. In green companies, for example, the expected importance of mathematical reasoning was 1.74 among those occupations that tend not to use that skill very much. In potentially green companies, the importance of those occupations was 1.69 among those occupations.[35] We conclude that even for occupations that do not use much math, the skill is still more important for green companies than for potentially green companies.

The final three columns list the probability mass differences within each section of the skill distribution. For example, 23% of occupations in green companies are in the "high importance" category of the engineering and technology skill distribution, but only 18% of occupations in potentially green companies fall in that category. Thus, compared to potentially green companies, green companies employ approximately 5% more occupations requiring advanced knowledge in engineering and technology.[36]

[35] The 0.05 difference is listed in the first row and third column of Table 10.
[36] This 5% difference is listed in the second row and final column of Table 10.

Table 11 Skills Used by Potentially Green Companies More than Green Companies

Description	Type	Distribution Difference	Expected Value Diff.	Cond'l Expected Value Diff. Low	Medium	High	Cond'l Probability Mass Diff. Low	Medium	High
Design	Knowledge	1.36	-0.05	0.04	-0.07	0.25	8%	-12%	4%
Equipment Selection	Skill	1.32	-0.22	0.06	-0.06	-0.05	13%	-9%	-4%
Exposed to Hazardous Equipment	Work Context	1.29	-0.11	0.13	-0.05	-0.08	1%	7%	-8%
Mechanical	Knowledge	1.29	-0.09	0.08	-0.12	0.04	0%	6%	-6%
Wear Common Protective or Safety Equip.	Work Context	1.27	-0.04	0.08	0.01	-0.02	-3%	10%	-7%
Exposed to High Places	Work Context	1.26	-0.12	0.07	-0.07	0.09	8%	-4%	-3%
Exposed to Hazardous Conditions	Work Context	1.25	-0.06	0.10	-0.02	0.02	5%	-2%	-3%
Exposed to Minor Burns, Cuts, Bites, etc.	Work Context	1.25	-0.10	0.08	-0.11	0.05	5%	-1%	-3%
Extremely Bright or Inadequate Lighting	Work Context	1.25	-0.11	0.07	-0.12	0.07	4%	-1%	-3%
Complex Problem Solving	Skill	1.25	-0.07	0.02	-0.04	-0.09	5%	-7%	2%
Troubleshooting	Skill	1.24	-0.11	0.05	-0.10	0.02	3%	0%	-4%
Installation	Skill	1.24	-0.19	-0.02	-0.09	-0.12	9%	-8%	-1%
Building and Construction	Knowledge	1.23	-0.07	0.08	-0.01	0.08	5%	-1%	-4%
Trunk Strength	Ability	1.23	-0.09	-0.09	0.05	0.01	5%	-5%	1%
Use of electronic mail	Work Context	1.23	-0.01	-0.08	0.07	0.00	2%	-5%	3%
Telecommunications	Knowledge	1.23	-0.14	0.01	-0.18	-0.18	9%	-7%	-1%
Manual Dexterity	Ability	1.23	-0.15	-0.10	0.01	0.02	6%	0%	-5%
Climbing Ladders, Scaffolds, or Poles	Work Context	1.23	-0.12	0.02	-0.10	-0.01	7%	-7%	0%
Making Repetitive Motions	Work Context	1.23	0.00	0.00	-0.01	-0.01	4%	-9%	5%
Repairing	Skill	1.22	-0.16	-0.03	-0.14	0.02	5%	-4%	-1%
Visual Color Discrimination	Ability	1.22	-0.01	-0.01	0.02	-0.01	-3%	8%	-4%
Static Strength	Ability	1.22	-0.06	-0.07	0.08	0.01	4%	-5%	1%
Quality Control Analysis	Skill	1.21	-0.05	0.08	-0.07	-0.05	0%	3%	-3%
Repairing/Maintaining Electronic Equip.	Work Activity	1.21	-0.11	0.02	-0.05	-0.07	1%	6%	-7%
Administration and Management	Knowledge	1.20	-0.11	0.05	-0.07	-0.02	3%	0%	-3%
Equipment Maintenance	Skill	1.20	-0.12	-0.05	-0.10	0.01	3%	-2%	-1%
Wear Specialized Protective Equip.	Work Context	1.20	-0.04	0.00	0.02	-0.03	5%	-7%	2%

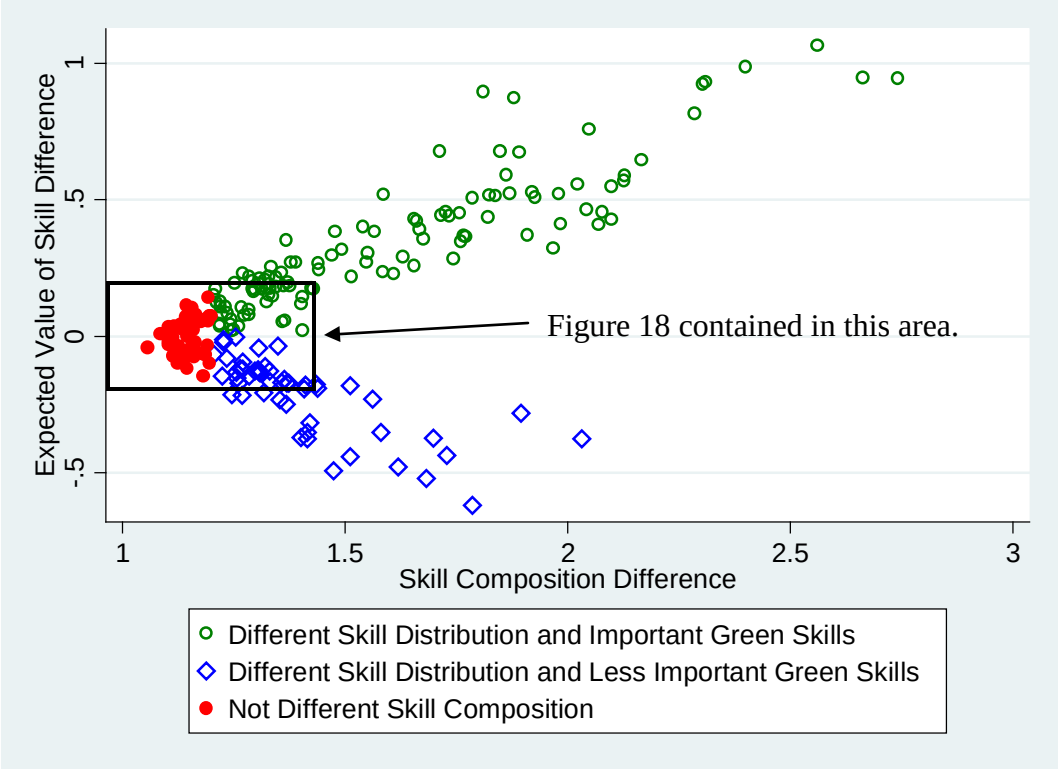
Like Table 10, Table 11 shows those skills that distinguish potentially green companies from green companies (blue dots in Figure 16). Technical design knowledge (blueprints, CAD systems, etc) tops this list, which is curious because such knowledge tends to require mathematical facility. Close inspection of these occupations reveals that high levels of design are in fact more common and important to green companies. In general, the table implies that green companies are less likely to employ workers where physical abilities and traditional blue collar skills are more common.[37]

It is difficult to get a sense of how different green and potentially green companies are to one another just using the numbers in Table 10 and Table 11. To get a sense of these magnitudes, we also compared the skills of green companies to the overall occupational mix in Delaware. The overall occupational profile was obtained from the 2009 Occupational Employment Statistics (OES) database.[38,39]

Figure 19 plots the measure of distributional similarity and difference in expected importance for each skill. The main result is that magnitude of skill differences between green businesses and Delaware's workforce is much larger than the differences between green and potentially green businesses. The rectangle overlaid in the figure indicates the maximum difference between green and potentially green businesses. We conclude that industry differences are nearly 5 times greater than differences resulting from the green/potentially green distinction.[40] This is important, because it points to less aggregation bias in the established industry-occupation classification. However, more research is needed to understand how the occupations differ within an industry.

[37] Readers interested in how the remaining skills (red dots in Figure 16) differ between green and potentially green companies will find these tables in the appendix.
[38] ftp://ftp.bls.gov/pub/special.requests/oes/oesm09st.zip
[39] In unreported results, we also compared the skills of green companies to the skills of all companies that responded to the survey. The results were very similar.
[40] Tables comparing skills in green companies to skills in the overall workforce are available upon request.

Figure 19 **Skill Comparison between Employees in Green Companies and the Delaware Workforce**



We caution the reader that the analysis in this section has limitations. First, the distributional differences are meant to characterize expected skill differences due to occupational classification. If there are differences within an occupation, this approach does not necessarily capture it. In addition, random error in occupational classification would cause random differences in the skill distribution.[41] Our discussion also has implicitly equated the frequency of a skill with the demand for that skill. Some occupations may be relatively infrequent, but still important to an organization (e.g. CEO's).[42]

[41] Standard tests of distributional equality seem not to apply (e.g. Kolmogorov-Smirnov) given that the distributions were constructed, not measured.

[42] Future research could easily incorporate wages to generate distributions based on the expected proportion of labor costs for each occupation.

Most Requested Green Skills

The previous section indicates how green and potentially green companies differ in the skills they employ. While the characterization is useful, the skills are too broadly defined for policy. For example, mathematical skills are clearly more common to green companies, but we do not know what kind of math (algebra, geometry, calculus, statistics, real analysis, etc.) is useful. In addition, we do not know which programs are desired most by Delaware businesses. To answer these more detailed policy questions, the survey included a list of environmentally relevant academic degrees and technical training programs offered by various educational institutions in Delaware.

The survey divided academic degrees into three sub-groups: Vo-tech high school degrees, Associates degrees, and Baccalaureate degrees or higher. The technical training programs were divided into residential and commercial construction technology, specialized construction training, industrial technology training, and other technical training. Each subsection included multiple programs, and respondents were asked to mark which degrees or programs were both relevant and desirable to their current or future employees.[43]

Table 12 shows how green companies responded to the prospect that their employees would have a background with a vo-tech high school degree. Approximately 50% of the green industry indicated that vo-tech high school students with a general construction background were desirable and relevant. Nearly 30% of those businesses indicated a desire for vo-tech students with a background in HVAC, electricity, or just a basic awareness of environmental conservation.

[43] See the appendix for a copy of the survey instrument.

Table 12 Desirable and Relevant Vo-Tech High School Degrees

Vo-Tech High School Degree	Energy Efficiency	Renewable Energy	Natural Resource Conservation	Pollution Reduction	Total Green
General Construction	54% (0.16)	55% (0.31)	39% (0.31)	46% (0.18)	50% (0.13)
HVAC	42% (0.16)	46% (0.31)	0% n.a.	9% (0.09)	32% (0.12)
Electrical	33% (0.15)	53% (0.33)	4% (0.06)	15% (0.09)	29% (0.11)
Conservation Principles (Behavior)	29% (0.15)	37% (0.33)	36% (0.31)	26% (0.13)	29% (0.11)
Plumbing	25% (0.13)	14% (0.14)	3% (0.04)	11% (0.08)	23% (0.10)
Drywall and Painting	13% (0.12)	12% (0.13)	0% n.a.	17% (0.19)	12% (0.09)
Landscaping	6% (0.04)	11% (0.12)	17% (0.15)	14% (0.09)	11% (0.05)
Cement and Masonry	8% (0.05)	12% (0.13)	5% (0.10)	7% (0.06)	9% (0.04)
Roofing	8% (0.04)	13% (0.13)	0% n.a.	3% (0.04)	7% (0.03)
Siding	7% (0.04)	13% (0.13)	0% n.a.	3% (0.04)	7% (0.03)
Automotive	4% (0.03)	1% (0.03)	2% (0.03)	11% (0.08)	5% (0.03)

- 95% Margin of Error in parentheses

Table 12 also shows how companies in the four green sectors responded to the prospect that their employees would have a vo-tech high school background. Companies in the energy efficiency and renewable energy sectors reported a strong preference for vo-tech backgrounds in construction, electrical, and HVAC related training. Companies in the natural resource conservation sector believe that landscaping and general construction were important skills for employees to possess.

Table 13 Desirable and Relevant Associates Degrees

Associate Degrees	Energy Efficiency	Renewable Energy	Natural Resource Conservation	Pollution Reduction	Total Green
Energy Management	43% (0.17)	68% (0.29)	25% (0.31)	11% (0.09)	34% (0.13)
Environmental Technology	27% (0.14)	44% (0.32)	43% (0.30)	22% (0.12)	29% (0.11)
Mechanical Engineering	37% (0.16)	33% (0.28)	2% (0.03)	12% (0.09)	28% (0.12)
Civil Engineering	21% (0.12)	35% (0.33)	34% (0.31)	27% (0.16)	22% (0.10)
Architectural Engineering	16% (0.08)	7% (0.08)	1% (0.01)	19% (0.11)	15% (0.06)
Electrical Engineering	16% (0.09)	25% (0.20)	0% n.a.	6% (0.06)	13% (0.07)
Survey and Geomatics Engineering	11% (0.09)	9% (0.11)	10% (0.12)	22% (0.16)	13% (0.08)
Electromechanical Engineering	7% (0.06)	8% (0.09)	0% n.a.	3% (0.05)	5% (0.04)
Chemistry Technology	6% (0.10)	4% (0.06)	1% (0.01)	2% (0.03)	5% (0.07)
Biotechnology	0% (0.00)	1% (0.02)	0% n.a.	6% (0.06)	2% (0.02)

- 95% Margin of Error in parentheses

Table 13 shows the interest in a variety of degree programs at the Associate's level. Green companies seem most interested in the Energy Management (34%) program. All four sectors regard environmental technology and civil engineering as desirable, while a two-year degree in mechanical engineering is primarily relevant to the energy efficiency and renewable energy sectors. Survey and geomatics engineering ranks particularly low in all sectors except the pollution reduction and recycling sector (10%). Green companies reported the least interest in the chemistry, biotechnology, and electromechanical engineering (8%) degree programs.

Table 14 Desirable and Relevant Baccalaureate Degrees or Higher

Baccalaureate Degrees or Higher	Energy Efficiency	Renewable Energy	Natural Resource Conservation	Pollution Reduction	Total Green
Environmental Engineering	25% (0.13)	57% (0.31)	45% (0.31)	26% (0.13)	28% (0.10)
Mechanical Engineering	27% (0.15)	51% (0.32)	17% (0.26)	19% (0.14)	24% (0.11)
Civil Engineering	19% (0.12)	35% (0.33)	34% (0.31)	32% (0.17)	22% (0.10)
Soil / Environmental Science	13% (0.12)	32% (0.34)	50% (0.31)	32% (0.16)	20% (0.10)
Energy & Enviro. Policy, Laws, & Reg.	21% (0.12)	28% (0.27)	10% (0.12)	22% (0.15)	19% (0.09)
Natural Resource / Agricultural Economics	10% (0.09)	32% (0.33)	52% (0.30)	11% (0.09)	13% (0.08)
Electrical and Computer Engineering	15% (0.10)	37% (0.30)	16% (0.26)	12% (0.12)	13% (0.07)
Materials Science	14% (0.12)	33% (0.33)	25% (0.32)	16% (0.15)	11% (0.09)
Chemical Engineering	13% (0.12)	22% (0.28)	16% (0.26)	14% (0.13)	10% (0.09)
Plant Science	5% (0.05)	3% (0.06)	26% (0.22)	13% (0.10)	9% (0.05)
Ecology	4% (0.05)	3% (0.06)	19% (0.20)	8% (0.08)	7% (0.05)
Wildlife Management / Conservation	1% (0.01)	3% (0.06)	8% (0.08)	6% (0.07)	4% (0.03)
Chemistry / Biochemistry	0% (0.01)	2% (0.03)	9% (0.16)	4% (0.04)	3% (0.03)
Agribusiness Management	1% (0.01)	4% (0.06)	11% (0.12)	1% (0.01)	3% (0.02)
Animal Science	1% (0.01)	3% (0.06)	12% (0.17)	1% (0.02)	2% (0.03)
Bioengineering / Bioinformatics	0% n.a.	0% n.a.	0% n.a.	1% (0.01)	0% (0.01)
Marine Science	0% (0.00)	0% n.a.	0% n.a.	0% (0.00)	0% (0.01)
Cellular Biology / Biosciences	0% n.a.	0% n.a.	0% n.a.	0% n.a.	0% n.a.
Fisheries Management	0% n.a.	0% n.a.	0% n.a.	0% n.a.	0% n.a.

- 95% Margin of Error in parentheses

Table 14 indicates the relevance of various Baccalaureate level (or higher) degrees to Delaware's green businesses. Similar to Associate's degrees, we find that green companies express a preference primarily for engineers, specifically environmental (28%), mechanical (24%), and civil engineers (22%). Green companies also think that degrees in soil science, environmental science, or energy and environmental policy, law, and regulations are desirable. The table indicates again that the natural resource conservation sector of Delaware's economy has relatively unique demands for their employees, such as ecology, plant science, and agricultural economics. Again, we caution that our results have a large amount of uncertainty given the small number of natural resource conservation companies in the state.

Table 15 Desirable and Relevant Specialized Green Training Programs

Specialized Green Training	Energy Efficiency	Renewable Energy	Natural Resource Conservation	Pollution Reduction	Total Green
Green Building Design / Construction (LEED certification)	45% (0.17)	65% (0.30)	32% (0.31)	29% (0.19)	37% (0.13)
Geothermal Systems	37% (0.16)	54% (0.32)	25% (0.32)	7% (0.06)	30% (0.12)
Weatherization	34% (0.18)	19% (0.16)	0% n.a.	20% (0.19)	26% (0.14)
Green Building / Energy Auditing (BPI cert)	30% (0.13)	71% (0.29)	25% (0.31)	19% (0.11)	26% (0.10)
Solar Heat / Hot Water	27% (0.14)	31% (0.23)	2% (0.03)	7% (0.08)	22% (0.10)
Solar Panel / PV	17% (0.08)	30% (0.22)	6% (0.07)	11% (0.09)	16% (0.06)
Wind Turbine Systems	6% (0.03)	14% (0.12)	2% (0.03)	5% (0.05)	6% (0.03)

- 95% Margin of Error in parentheses

Table 15 indicates those specialized training programs commonly referred to as “green training”. Green design skills, such as the Leadership in Energy and Environmental Design (LEED), is the specialized criteria most often cited by green businesses as desirable and relevant (37%). The next highest training cited by green businesses as being relevant was Geothermal Systems (30%), followed closely by weatherization (26%) and green building auditing (26%). Solar heat and hot water systems as well as solar photovoltaic systems were cited as desirable skills in 22% and 16% of the green sector. A relatively small proportion of the green industry cited wind turbine systems (6%).

Table 16 Desirable and Relevant Types Training in Construction

General Construction Training	Energy Efficiency	Renewable Energy	Natural Resource Conservation	Pollution Reduction	Total Green
HVAC	43% (0.16)	46% (0.31)	0% n.a.	14% (0.10)	33% (0.12)
Lead Abatement / Awareness	31% (0.18)	32% (0.33)	22% (0.32)	20% (0.12)	27% (0.13)
Plumbing	29% (0.14)	14% (0.14)	3% (0.04)	14% (0.09)	26% (0.10)
Electrical Wiring	28% (0.14)	35% (0.25)	4% (0.06)	16% (0.10)	26% (0.10)
Carpentry	32% (0.18)	14% (0.14)	0% n.a.	18% (0.19)	25% (0.14)
Water Management / Run-off	23% (0.13)	32% (0.33)	38% (0.31)	29% (0.16)	23% (0.10)
Other Hazardous Waste Removal	19% (0.12)	30% (0.34)	25% (0.32)	29% (0.16)	19% (0.09)
Refrigeration	24% (0.13)	18% (0.16)	0% n.a.	6% (0.06)	19% (0.10)
Asbestos Safety & Disposal	18% (0.11)	30% (0.34)	22% (0.32)	19% (0.11)	18% (0.08)
Wastewater Treatment	16% (0.10)	28% (0.34)	22% (0.32)	16% (0.11)	14% (0.08)
Roofing	12% (0.06)	13% (0.13)	0% n.a.	6% (0.06)	10% (0.05)

- 95% Margin of Error in parentheses

Table 16 shows the interest in residential and commercial construction training, and Table 17 shows the training programs in industrial technology. Three of the top four skills identified in the residential and commercial construction training are HVAC, plumbing, and electric. The top three skills identified in the industrial technology sector are HVAC, steam, hot water and piping systems, and combustion systems.

Table 17 Desirable and Relevant Types of Training in Industrial Technology

Industrial Technology Training	Energy Efficiency	Renewable Energy	Natural Resource Conservation	Pollution Reduction	Total Green
Industrial HVAC / Ventilation / Air Quality	34% (0.15)	41% (0.30)	0% n.a.	11% (0.09)	25% (0.11)
Steam, Hot Water, Piping Systems	31% (0.15)	18% (0.16)	0% n.a.	6% (0.06)	24% (0.12)
Combustion Sys. (Boilers, Furnaces, etc.)	30% (0.15)	18% (0.15)	3% (0.06)	21% (0.16)	23% (0.11)
Electrical Sys. / Power Gen. and Control	26% (0.14)	45% (0.31)	0% n.a.	13% (0.09)	22% (0.10)
Cooling Tower and Water Treatment	26% (0.15)	13% (0.13)	1% (0.02)	15% (0.11)	22% (0.11)
Motors & Mechanical Systems	23% (0.14)	14% (0.12)	5% (0.07)	23% (0.15)	20% (0.11)
Lighting Systems	23% (0.14)	24% (0.20)	5% (0.10)	9% (0.09)	19% (0.10)
Compressed Air Systems	25% (0.15)	25% (0.27)	1% (0.01)	16% (0.14)	19% (0.11)
Piping, Machine, Equipment Insulation	18% (0.13)	14% (0.14)	4% (0.06)	14% (0.10)	19% (0.10)
Heat Recovery	24% (0.14)	19% (0.16)	3% (0.06)	5% (0.06)	19% (0.10)
Cogeneration (Combined Heat and Power)	18% (0.13)	29% (0.27)	9% (0.11)	4% (0.05)	15% (0.10)
Refrigeration Systems	18% (0.13)	17% (0.15)	0% n.a.	4% (0.05)	13% (0.09)
Heat Treating Sys. (Ovens, Die-Cast, etc)	3% (0.03)	10% (0.10)	0% n.a.	1% (0.01)	2% (0.02)

- 95% Margin of Error in parentheses

Table 18 Other Types of Desirable and Relevant Training Programs

Other Training	Energy Efficiency	Renewable Energy	Natural Resource Conservation	Pollution Reduction	Total Green
Geographic Information Systems (GIS)	9% (0.09)	27% (0.34)	62% (0.28)	13% (0.10)	15% (0.09)
Soil Remediation	11% (0.10)	27% (0.34)	42% (0.30)	23% (0.12)	15% (0.08)
Landscape and Turf Management	4% (0.03)	11% (0.12)	21% (0.17)	14% (0.10)	10% (0.05)
Agricultural Production	1% (0.01)	3% (0.06)	21% (0.20)	2% (0.02)	4% (0.03)
Hybrid or Electric Automotive Technology	1% (0.01)	4% (0.06)	1% (0.01)	4% (0.04)	2% (0.02)
Chemical Process Operator	0% n.a.	1% (0.02)	0% n.a.	0% (0.01)	0% (0.00)

- 95% Margin of Error in parentheses

Table 18 includes technical training that did not fall easily into the classification. Knowledge of Geographical Information Systems (62%) and soil remediation (42%) was cited frequently by natural resource conservation companies.

Table 19 summarizes the results by ranking the top 20 programs most frequently cited in each green sector. Vo-tech high school students with general construction skills are most frequently cited by companies in the energy efficiency sector. Environmental design, as recognized by LEED certification, an Associate's degree in Energy Management, and HVAC related training are reported to be the next most relevant and desirable skills in this sector. These companies report that highly skilled, but not necessarily highly educated, employees are desirable. In fact, with the exception of mechanical engineering (#20), no other baccalaureate degrees fall in the energy efficiency sector's top 20 list of relevant programs.

Table 19 Top 20 Most Cited Relevant and Desirable Technical Training / Academic Programs in Delaware's Green Sector

Skill Rank	Energy Efficiency	Renewable Energy	Natural Resource Conservation	Pollution Reduction	Overall Green Sector
1	Construction (Vo-Tech)	Energy Auditing (BPI cert)	Geog. Info. Systems	Construction (Vo-Tech)	Construction (Vo-Tech)
2	Green Design (LEED cert)	Energy Mgmt (Assoc)	Agric. Economics (BA+)	Soil / Enviro. Science (BA+)	Green Design (LEED cert)
3	HVAC	Green Design (LEED cert)	Soil / Enviro. Science (BA+)	Civil Engineering (BA+)	Energy Mgmt (Assoc)
4	Energy Mgmt (Assoc)	Enviro. Engineering (BA+)	Enviro. Engineering (BA+)	Green Design (LEED cert)	HVAC
5	HVAC (Vo-Tech)	Construction (Vo-Tech)	Enviro. Technology (Assoc)	Water Mgmt / Run-Off	HVAC (Vo-Tech)
6	Geothermal	Geothermal	Soil Remediation	Other Hazardous Waste	Geothermal
7	Mech. Engineering (Assoc)	Electrical (Vo-Tech)	Construction (Vo-Tech)	Civil Engineering (Assoc)	Electrical (Vo-Tech)
8	Industrial HVAC	Mech. Engineering (BA+)	Water Mgmt / Run-Off	Conservation (Vo-Tech)	Conservation (Vo-Tech)
9	Weatherization	HVAC (Vo-Tech)	Conservation (Vo-Tech)	Enviro. Engineering (BA+)	Enviro. Tech (Assoc.)
10	Electrical (Vo-Tech)	HVAC	Civil Engineering (Assoc)	Industrial Motors	Enviro. Engineering (BA+)
11	Carpentry	Industrial Power/Electric	Civil Engineering (BA+)	Soil Remediation	Mech. Engineering (Assoc)
12	Industrial Steam/Piping	Enviro. Tech (Assoc.)	Green Design (LEED cert)	Energy & Enviro. Policy, Laws, & Regulation (BA+)	Lead Abatement
13	Lead Abatement	Industrial HVAC	Plant Science (BA+)	Survey & Geomatic (Assoc)	Plumbing
14	Industrial Combustion Sys.	Conservation (Vo-Tech)	Energy Mgmt (Assoc)	Enviro. Tech (Assoc.)	Weatherization
15	Energy Auditing (BPI cert)	Elec. / Comp. Engin (BA+)	Energy Auditing (BPI cert)	Industrial Combustion Sys.	Electrical Wiring
16	Plumbing	Electrical Wiring	Materials Science (BA+)	Weatherization	Energy Auditing (BPI cert)
17	Conservation (Vo-Tech)	Civil Engineering (Assoc)	Other Hazardous Waste	Lead Abatement	Industrial HVAC
18	Electrical Wiring	Civil Engineering (BA+)	Geothermal Systems	Architect. Engineer. (BA+)	Carpentry
19	Enviro. Tech (Assoc.)	Mech. Engineering (Assoc)	Lead Abatement	Mech. Engineering (BA+)	Industrial Steam/Piping
20	Mech. Engineering (BA+)	Materials Science (BA+)	Asbestos Safety	Asbestos Safety	Mech. Engineering (BA+)

- Academic programs are noted in parentheses. All other skills are technical training programs.

The second column of Table 19 shows the skills most often cited by companies in Delaware's renewable energy sector. Energy auditing, as recognized by BPI certification, is the skill most cited by renewable energy firms. Associate's degrees in energy management and in environmental design (e.g. LEED certification) are cited as the second and third most relevant skill to have in the energy efficiency sector. Vo-tech training in electrical trades is the 7th most important program mentioned, just behind geothermal systems.

The third column reports the relevant and desirable skills for those companies in the natural resource conservation sector. This sector frequently cited training in geographical information systems (GIS) as relevant and desirable, followed by agricultural economics, and soil and environmental science.

The pollution reduction and recycling sector most frequently cited vo-tech high school graduates with construction backgrounds. The next two most relevant programs include a baccalaureate degree in soil and environmental science and a baccalaureate degree in civil engineering. Programs intended to mitigate pollution directly, such as soil remediation, asbestos safety, treating wastewater, and lead abatement are ranked lower.

In the final column of Table 19, all of Delaware's green businesses are evaluated as one group. Vo-tech high school degrees are cited in four of the top 10 types of training that green employers find relevant and desirable. Green design, energy management, and HVAC training are also very important skills to the state's green economy.

Table 20 Most Important Skills Specifically Mentioned by Green Businesses, Disaggregated Categories

Rank	Energy Efficiency	Renewable Energy	Natural Resource Conservation	Pollution Reduction	Total Green Industry
1	Gen. Construction & Trades	Green Design & Practice	Gen. Science	Gen. Business Skills	Gen. Construction & Trades
2	Basic Skills (Read, Write, Math)	Gen. Science	Real Estate	Cement & Masonry	Basic Skills (Read, Write, Math)
3	Gen. Mathematics	Solar PV	Landscaping	Automotive Trades	General Mathematics
4	Green Design & Practice	Alt. Energy Engineering	Horticulture	Welding & Sheet Metal	Green Design & Practice
5	Construction Management	Marketing	Architectural Engineering	Soil Science	Construction Management

Next we asked respondents to write down which specific training, degree, or certification programs would most help their businesses. The free-response nature of this question allowed companies to mention programs not listed on the survey and also identify which skills were considered most important. Unfortunately, the question had a higher non-response, and because responses are unstructured, they had to be organized manually. We grouped the responses into 15 broad categories and 109 more specific categories. Table 20 reports the top 5 responses of the more specific categories.

Companies in the energy efficient sector reported that training programs in the general construction and trade fields would be most helpful to their business. These companies also thought that the elementary skills of Delaware's workforce (i.e. reading, writing, and math) needed to be substantially improved. Green design and building practices as well as construction management were also frequently cited. Since the energy efficiency sector constitutes so much of the green economy, the top 5 most important skills in this sector matched the top 5 skills in Delaware's overall green economy.

Table 21 Frequency of Important Skills Mentioned by Businesses, Aggregated Categories

	Actual Green Industry		Possible Green Industry		All Industry	
Skill Group	Response	MoE	Response	MoE	Response	MoE
Agriculture	1.0%	(0.011)	0.8%	(0.007)	3.6%	0.055
Applied Training	1.2%	(0.011)	0.5%	(0.008)	3.4%	0.038
Business and Administrative	16.0%	(0.116)	9.6%	(0.054)	11.8%	0.081
Basics (read, write, math, basic computers & behavior)	11.5%	(0.129)	3.7%	(0.037)	12.7%	0.124
Advanced Computer	1.8%	(0.025)	1.1%	(0.010)	0.6%	0.004
Construction & Trades	36.8%	(0.129)	19.2%	(0.096)	11.7%	0.082
Other Technical Training	5.1%	(0.039)	6.7%	(0.044)	4.1%	0.024
Science and Math (nonbasic)	16.0%	(0.097)	9.1%	(0.075)	5.1%	0.031
Law and Policy	0.5%	(0.007)	7.3%	(0.037)	5.8%	0.068
Waste and Remediation	0.8%	(0.011)	n.a.	n.a.	0.8%	0.011
Arts	n.a.	n.a.	0.2%	(0.003)	0.4%	0.005
Educator Training	n.a.	n.a.	0.3%	(0.004)	6.7%	0.061
Medical Training	n.a.	n.a.	0.5%	(0.006)	8.3%	0.107
Service / Accommodation	n.a.	n.a.	0.3%	(0.005)	5.0%	0.055

- 95% Margin of Error in parentheses

Table 21 lists the 15 primary categories of our organization. The numbers in each column represent the proportion of respondents indicating a preference for at least one training program in that category. Overall, nearly 37% of the green industry indicated that their business would benefit most if the Delaware workforce were trained in some kind of construction or trade. Approximately 16% mentioned that business/administrative skills were critical and another 16% mentioned some type of skill in mathematics or science as being critical.

The second column of the table indicates all the potentially green firms not producing green output. These businesses reported a preference for construction and trades, business skills, and science and math. However, these companies also were more likely to request law, policy, and other training programs.

The final column in Table 21 shows the results for all survey respondents, irrespective of the goods and services they produce. Overall, Delaware businesses think that training programs which teach basic skills to the workforce would be most helpful for their businesses. The next most important skills were in business and administration, and the construction and trades.

Comments on the Specific Green Skills

One implication from this section is that companies in the renewable energy sector tend to cite training programs that focus more on energy efficiency than renewable energy.[44] This may reflect the fact that reducing energy use is more affordable to the average household than alternative energy. Studies have found that these "negawatts" obtained via energy efficiency are much cheaper investments offering higher returns than what can be obtained via renewable energy sources (Energy Efficiency and Renewable Energy, 2010).

Green design was mentioned very frequently in this survey. As of July 2010, the Green Building Certification Institute listed 205 LEED-certified professionals practicing in Delaware.[45] The states with the highest number of LEED certified professionals relative to the size of the construction sector are in Massachusetts, Colorado, and California.[46] Delaware ranks 43rd among all 50 states and last in our region. Pennsylvania, New Jersey, Maryland, Virginia, and New York are ranked 27th, 18th, 15th, 13th, and 11th on this criterion, respectively. Future research should explore why Delaware has so few LEED certified practitioners.

[44] Recall that only 13% of the renewable sector was not also in the energy efficiency sector.
[45] http://www.usgbc.org/LEED/AP/LEEDProfessionalDirectory.aspx
[46] The ratios are calculated as total LEED certified professionals divided by the sum of private sector employment in the construction sector (NAICS 23) as of June 2010. Employment data was obtained from the Quarterly Census of Employment and Wages program administered by the Bureau of Labor Statistics. http://www.bls.gov/cew/

Other Topics of Interest

Green Marketing

As explained earlier in this report, the definition of green is based on perceptions of environmental benefits. Since marketing's intention is to influence perceptions, we sought to understand more about green marketing and its relationship with the green definition. To get a sense of what the term green means to businesses, we asked survey recipients whether they marketed themselves as being green, why they made such claims, and how they made them.

Table 22 indicates that companies not producing green output commonly market their businesses as "being green". In Delaware, nearly 1,869 businesses made these marketing claims, but only 538 businesses met BLS's criteria of producing green output. Thus, for every business that makes green output and markets itself as green, there are 2.5 other businesses making green claims.

Such a stark ratio could be explained if businesses adhere to a more liberal interpretation of green output than the BLS. However, Table 22 shows that only 592 companies believed they made green output. In other words, 32% of businesses marketing themselves as "being green" do not claim to make green output.

Table 22 Green Marketing Decisions among Delaware Establishments

	No Green Marketing		Green Marketing	
	Establishments	MoE	Establishments	MoE
No Green Output	12,451	(587)	1,330	(513)
Actual Green Output	742	(226)	538	(190)
No Green Output Claims	12,135	(634)	1,277	(503)
Green Output Claims	1,057	(353)	592	(222)

- 95% Margin of Error in parentheses

Another explanation is that companies view their production methods as being green, not necessarily their output. For example, banks may market themselves as being green if they encourage their customers to use online statements. Under this explanation, being green may be unrelated to output. A third explanation is that companies engage in "greenwashing", a term meaning that a company falsely makes green claims in order to increase sales or otherwise benefit from that status.

Unfortunately, there is no clear way of distinguishing between the latter two explanations until criteria identify green production practices from non-green production practices. The BLS process-approach could make a contribution to this area.

We asked businesses to rank how important different factors were in their companies' marketing decision. Factors were rated on scale from 1 through 5, where 1 indicates a factor that was not important at all and 5 represents those factors that are extremely important. Table 23 lists the results.

Table 23 Important Factors behind Green Marketing

	No Green Output Claim		Claiming Green Output	
	Average	MoE	Average	MoE
Increase Customer Satisfaction / Sales	4.1	(0.6)	4.4	(0.4)
Spread Information on Best Practices	3.8	(0.6)	4.3	(0.3)
Influence Customers to Use Cheaper Services	2.7	(0.7)	3.3	(0.5)
Affect Employee Behavior/Attract Job Applicants	2.6	(0.6)	3.0	(0.3)
Response to Competitor's Marketing Campaign	2.3	(0.6)	2.7	(0.4)
Collect Third-Party Funding	2.3	(0.6)	2.6	(0.4)

- 95% Margin of Error in parentheses

The column on the left represents those companies that marketed themselves as green, but did not claim to make green output. The column on the right represents those companies that claim to be green and also claimed that their output was green. Increasing customer satisfaction or sales is the main reason companies said that they marketed themselves as being green. The second largest justification was that companies wanted to spread information on best practices. The least altruistic reason behind green marketing, that marketing was intended to collect third-party funds, was cited as the least important factor overall. We found that 24% of companies engaged in green marketing claimed that third-party funds were somewhat important or very important in their marketing decision.

Finally, survey respondents were asked what kind of marketing had been used to make their green claims. The overwhelming majority of companies used websites (56%) or mail (28%). Newspapers and public events were also frequently mentioned.

Table 24 Type of Marketing by Establishments that Market Themselves as Being Green

Type of Marketing	Percent of Establishments	MoE
TV	5%	(0.06)
Radio	7%	(0.06)
Newspaper	18%	(0.12)
Billboard	2%	(0.01)
Website	56%	(0.15)
Mail	28%	(0.13)
Events	18%	(0.09)

- 95% Margin of Error in parentheses

The Role of Government

All industries are influenced by the government. However, certain elements in the green economy seem especially influenced by policy. Governments create environmental regulations, monitor and enforce business compliance, fund the remediation of contaminated land, and maintain parks and nature preserves. Governments also fund the research and development for alternative energy supplies. They require, negotiate, and enforce long-term purchasing commitments, while creating and subsidizing the current demand for these technologies. From a labor perspective, government policy is fundamentally connected to the future of green jobs.

Of course, the green economy is not entirely dependent on government policy. Companies and households have a private incentive to conserve energy. Waste management is a basic need of our society. Certain recycled metals yield the same value as virgin metal, but at a lower cost. Some households gain pleasure by living the "green lifestyle". Conventional hydroelectricity is competitive with other forms of energy supply.

Table 25 How Important Government Programs are in Generating Consumer Demand, as a Percent of Green Sector Employment

	Somewhat / Very Important	
Green Sector	Percent	MoE
All Green Businesses	70%	(0.12)
Energy Efficiency	68%	(0.15)
Renewable Energy	93%	(0.08)
Natural Resource Cons.	88%	(0.13)
Pollution & Recycling	60%	(0.18)

- 95% Margin of Error in parentheses

In order to understand which components of the green economy are at risk to policy change, we asked respondents how important government-sponsored programs were in generating the demand for their output.[47] Approximately 93% of the renewable energy establishments and 88% of the establishments in the natural resource conservation sector said that government programs were either somewhat important or very important in generating customer demand (Table 25). These results may reflect the fact that natural resources are often public goods and most renewable energy technology is heavily subsidized.

Overall, nearly 70% of Delaware's green sector believes the government to be somewhat or very important in generating demand for green goods and services. Existing methods of forecasting employment should consider both political and market factors.

[47] Government programs were explicitly referred to as "regulations, tax credits, or other incentives" in the survey.

The Role of Businesses as a Consumer of Energy Efficiency

A secondary objective of the survey was to understand the role that businesses might play as consumers of green products. In particular, we asked businesses how important energy costs were to their companies' profitability, and followed this question by asking how likely the company would consider making energy efficient investments in the next two years. Both questions were on a scale from 1 to 5, where 1 was not important / not likely and 5 was very important/very likely.

Table 26 shows the survey results for these two questions, adjusted for the employment in each company. Overall, companies indicated that energy costs were very important (mean 4.36) to their profitability, but that energy efficient investments were neither likely nor unlikely to occur (mean 3.34). Construction firms were not substantially different from the average firm, but manufacturers indicated that energy was slightly more important and that they were more likely to consider investing in energy efficiency. Green companies also seemed very willing to invest in energy efficiency, while potentially green companies were less likely to make that investment. Companies outside the green universe gave opinions between these two views.

Table 26 Survey Responses to Opinions on Energy Efficiency

	Energy Cost		Energy Invest	
Type of Business	Mean	MoE	Mean	MoE
All Companies	4.36	0.22	3.34	0.35
Construction	4.34	0.15	3.36	0.30
Manufacturing	4.60	0.40	4.21	0.67
Actually Green	4.53	0.21	3.81	0.31
Potentially Green, but not Actually Green	3.87	0.16	2.90	0.35
Not Potentially Green	4.33	0.23	3.28	0.37
Owns Buildings in DE	4.46	0.30	3.63	0.48
Does Not Own Buildings in DE	4.19	0.33	2.88	0.47
No Establishments in DE	3.54	1.37	2.62	1.14
One Establishment in DE	4.20	0.30	3.02	0.45
Two or More Establishments	4.53	0.29	3.71	0.43

- 95% Margin of Error in parentheses

Other results in the table were consistent with prior expectations. Businesses that own buildings in Delaware believed energy to be more important to profits than companies that do not own any buildings. The same was true for businesses with multiple establishments in the state.[48]

According to conventional wisdom, energy efficiency is one of the lowest hanging fruits of the green industry. From an economic lens, profit maximizing companies are supposed to use inputs efficiently, so the decision to conserve energy is financial in nature. However, companies often do not adopt energy efficient investments that appear to have high returns. This lack of demand has been called the implementation gap (Wright et al., 2009). To better understand the implementation gap, we asked companies what the major concerns were with investing in energy efficiency.

[48] We expected all surveyed to have at least one establishment in DE. The few recipients that claimed to have no establishments usually offered services that required travelling to their customers.

Energy efficiency concerns fall into three categories: personnel, financial, and technical. Personnel concerns include the difficulty of changing employee behavior and finding qualified new employees. Financial concerns include having to pay large, up-front costs, obtaining financing only at high interest rates, the risk that future savings will be less than expected, and waiting a long time before investment pays for itself. Technical concerns include whether the investment would impose delays or changes in operations and the risk that the energy efficient improvement might be installed improperly.

Financial issues were the overwhelming concern raised by businesses in our survey. Overall the two most important factors preventing businesses from making energy efficient investments are large, up-front implementation costs and having to wait a long time before recovering that cost. Obtaining credit at high interest rates and the risk of operational delay were also important concerns. The businesses were least concerned with the roles that their current or future employees would have in energy efficiency. These results suggest it is unlikely that skill constraints in the labor market are deterring companies from making investments in energy efficiency.[49]

This survey corroborates the findings of Anderson and Newell [2004] which focused just on manufacturing facilities. The results imply that manufacturers' sentiments on energy efficiency may be generalizable to all businesses.

[49] Of course, the financial cost of energy investments could be reduced if a greater labor supply drove down labor costs, but such savings are not explored in this report.

Table 27 Importance of the Concerns for Investing in Energy Efficiency

	Personnel Issues				Financial Issues								Technical Issues			
	Make Current Employees Change Behavior		Finding Qualified New Employees		Large, Up-Front Installation Costs		Obtaining Credit only at High Interest Rates		Future Savings on Energy Bills May be Less Than Expected		Wait a Long Time Before Recovering Cost		Change / Delay in Operations		Risk of Incorrect Installation	
	Mean	MoE	Mean	MoE	Mean	MoE	Mean	MoE	Mean	MoE	Mean	MoE	Mean	MoE	Mean	MoE
All Companies	2.99	0.28	3.46	0.44	4.14	0.28	4.02	0.33	3.71	0.25	4.18	0.26	3.96	0.27	3.72	0.29
Construction	3.06	0.26	3.75	0.30	4.20	0.16	4.13	0.27	3.95	0.16	4.32	0.17	4.01	0.22	3.92	0.20
Manufacturing	2.66	0.63	3.68	0.43	4.74	0.25	4.43	0.61	3.02	0.89	4.66	0.34	4.32	0.35	3.02	0.92
Actually Green	3.18	0.28	3.81	0.30	4.21	0.31	4.09	0.31	3.75	0.21	4.17	0.31	3.94	0.27	3.70	0.28
Potentially Green, but Not	2.88	0.32	3.11	0.32	3.93	0.28	4.05	0.22	3.81	0.18	4.10	0.19	3.91	0.23	3.78	0.22
Not Potentially Green	2.98	0.30	3.40	0.48	4.17	0.30	4.00	0.35	3.70	0.27	4.24	0.25	3.94	0.29	3.69	0.30
Owns Buildings in DE	2.95	0.34	3.46	0.59	4.23	0.37	4.02	0.45	3.64	0.37	4.23	0.33	3.98	0.40	3.69	0.42
Does Not Own Buildings in DE	3.05	0.45	3.46	0.65	3.99	0.46	4.04	0.44	3.84	0.23	4.11	0.41	3.92	0.24	3.77	0.27
No Establishments in DE	2.18	1.27	3.01	1.96	2.05	1.15	1.95	1.15	2.05	1.15	2.05	1.15	2.26	1.42	2.20	1.36
One Establishment in DE	3.03	0.36	3.17	0.62	4.29	0.27	4.14	0.29	3.91	0.15	4.27	0.28	4.11	0.21	3.87	0.22
Two or More Establishments	2.94	0.42	3.80	0.58	3.98	0.51	3.90	0.62	3.47	0.52	4.09	0.44	3.79	0.51	3.55	0.56

- 95% Margin of Error in parentheses

Table 28 Proportion of Establishments that Employs Persons to Monitor Energy Use

Type of Business	Mean	MoE
All Companies	14%	0.04
Construction	22%	0.10
Manufacturing	16%	0.05
Actually Green	24%	0.08
Potentially Green, but not Actually Green	12%	0.03
Not Potentially Green	13%	0.04
Owns Buildings in DE	19%	0.07
Does Not Own Buildings in DE	10%	0.04
No Establishments in DE	5%	0.10
One Establishment in DE	13%	0.04
Two or More Establishments	17%	0.10

- 95% Margin of Error in parentheses

Finally, we asked whether the business currently had anyone on staff to monitor energy use and reinforce best practices. The average business in Delaware has approximately a 14% chance of having someone on staff that performs these duties. For the average construction company or manufacturing plant, this statistic is 22% and 16%, respectively. Green companies, companies that own their own building, and companies with multiple establishments are more likely to employ such persons than their respective counterparts.

Summary and Conclusion

Scientists tell us that the world faces difficult tradeoffs between the economy and the environment. Some believe that the worst of these decisions are avoidable if the economy is transformed in a way so that painful environmental sacrifice is not a precondition for growth. That transformation, however defined, is referred to as the green economy. The term loosely refers to those economic elements perceived to be environmentally beneficial.

The green economy has received substantial attention of late, spurred on by rising energy prices, looming environmental threats, and political interest. This report's objective was to assemble important facts for businesses that comprise Delaware's green economy. The report surveyed businesses and used supplemental labor market information to understand its scale and scope, the relevant workforce skills and training programs, and other issues.

Assembling this information was not straightforward, not least because the perceptions of "environmentally beneficial" differ so much within the nascent literature. We adopted the Bureau of Labor Statistic's definition of green goods and services. For practical reasons, we excluded companies offering green education, training, compliance, awareness, and mass transit.

Our survey found that nearly 11.0% of companies claim to make green goods and services, but only 8.5% actually do according to the BLS definition. In addition, if companies are classified by their industry and not their output, 24% of green employment may be missed. Those businesses that make green goods and services employ approximately 16,250 persons. Each business was assumed to fall into at least one of four green sectors, and some businesses fell into multiple sectors.

Energy efficiency is the largest green sector in Delaware, employing 11,714 workers. These companies supply the materials for sustainable construction. They also design, construct, perform energy audits and retrofit buildings. They service and redesign vehicles as well as industrial processes.

The second largest sector in the green economy is the pollution reduction and recycling sector. Employing 6,466 persons, this sector manages, recycles and treats waste and wastewater. Companies in this sector use recycled materials as production inputs, service vehicles to reduce emissions, and remediate toxic substances.

The third largest sector produces goods and services that are intended to conserve natural resources. Businesses in this sector produce organic agriculture, manage stormwater, parks, and nature preserves, and also promote wildlife conservation. There are an estimated 2,544 employees in this green sector.

The renewable energy sector is the smallest green sector in Delaware with an estimated employment of 2,280 persons. This sector produces the inputs and specialty services necessary for wind and solar power. The sector also is involved in geothermal HVAC, solar heat and hot water systems, and biofuels.

Overall, we found that although companies from many different industries make up the green economy, they primarily come from the construction sector (which includes specialized trade contractors) and the professional and technical services industry.

We also evaluated the historical employment patterns for companies that were either green or potentially green as of 2010. Caution should be taken when interpreting such trends, because the historical trends of firms that exist today do not necessarily represent firms that existed in the past. With this technical caveat in mind, the trends show that both green and potentially green businesses decreased employment during the recession, but firms selling green products experienced stronger real wage growth than their non-green counterparts.

We exploited occupational data provided by the Delaware Department of Labor to assess whether green firms and potentially green firms had different occupational compositions. Plumbers, pipefitters, and steam fitters are widely employed by both green and potentially green businesses, while civil engineers and HVAC workers were mostly employed by just green companies.

These occupational differences imply that green businesses tend to use more science, math, and communication skills from their employees, while their non-green counterparts tend to emphasize mechanical, repairing, and installation skills. The skill sets of green businesses have much more in common with potentially green businesses than they do with the Delaware workforce. We interpret this result to mean that industry differences are paramount.

When asked what kind of training or educational programs would be most relevant and desirable for their business, green companies overwhelmingly responded with a vo-tech high school degree with a background in general construction. Green design, as exemplified with LEED certification, and energy management degrees were also cited frequently. HVAC related training was also among the most frequently mentioned skills, along with geothermal technology.

When given the opportunity to list which programs would be most important to their business, green companies specifically mentioned that construction and trade skills were most helpful, followed by the basic skills (reading, writing, and arithmetic). As a whole, Delaware businesses recommended that these basic skills, along with changes in attitude, were the most important types of training that could be performed. Green companies also emphasized science and mathematics.

Our survey reveals that many companies market themselves as green, which makes it difficult to conclude which businesses actually are green according to any one standard. For every company making green output that marketed itself as being green, 2.5 other companies not making green output also claim to be green. The primary intention behind this marketing is to increase sales or improve customer satisfaction.

Approximately 70% of green businesses reported that the government was somewhat important or very important to stimulating the private demand. Jobs in the renewable energy and natural resource conservation sectors seem especially linked to policy, while those in the energy efficiency and pollution reduction and recycling sector are less susceptible to future regulatory uncertainty.

With respect to Delaware businesses making energy efficient investments, the results were mixed. Though the average business stated that energy costs were very important, it was also indifferent to investing in energy efficiency. Manufacturers claimed to be most interested in investing in energy efficiency, as did businesses with multiple establishments and businesses that owned their own buildings. The primary concerns of businesses are the perceived large up-front costs and corresponding time it takes the investment to pay off. Financing costs and future benefit risks were of less concern.

This report examines the output generated by Delaware's green economy, and it explored what jobs produce those goods and services. The results should be viewed as descriptive, not prescriptive. One must consider that an economy is more complex than just what gets made and how it is produced. The demand for green goods and services depends on the number of consumers, their incomes and preferences, prices of related goods, government policy, etc, while supply depends on wages, material costs, the degree of competition, and other issues. So far, we have just begun the process of identifying what is meant by green, and we do not yet understand these other important issues. Future research should explore them.

The intention of this report was to provide descriptive facts concerning the green economy in Delaware. Given the paucity of historical data on this topic, the task was daunting. We hope that readers use the information contained in this report to better understand what the green economy means to Delaware. An informed citizenry is crucial for innovative policies.

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Appendix

Sample Design, Response, and Weighting

The survey was designed using a list of establishments from the first quarter of 2010. The initial focus of the survey was to be on those businesses that the BLS classified as potentially green from their 6-digit NAICS code. However, a secondary focus was on the construction and manufacturing sectors, since other surveys have found many potential green jobs in these industries. Educational institutions were initially omitted from the universe, since the green jobs available at these places are very likely to require advanced degrees beyond the reach of most unemployed Delawareans and because the employment measures would be too lumpy to use statistically in a small state.[50] We also omitted establishments that employed fewer than 2 employees due to the high financial costs and low statistical benefits.[51]

We stratified establishments based on which industries the BLS classified as potentially green and which it did not. The frame was also separated into whether the businesses were in construction, manufacturing, or some other sector. Finally, establishments were stratified on their employment size. Establishments with at least 2 but less than 5 employees were one group, and establishments with more than 5 employees were another group.[52] Table 29 decomposes the population of Delaware establishments into these strata.

[50] We feel it is better to treat educational institutions as suppliers of human capital, instead of labor demand. We will be gathering information from Delaware's educational facilities in this respect.
[51] These small businesses represent more than 45% of establishments in Delaware and employ less than 2% of the state's labor force. Since we often weight the survey responses based on the employment size of each respondent, the weights placed on these observations would be relatively low.
[52] Given Delaware's relatively small size and the typically low response rates of voluntary business surveys conducted through the mail, we decided it was better not to divide establishments with more than 5 employees into separate strata.

Table 29 Universe of Establishments

Potentially Green

	0 ≤ Emp < 2	2 ≤ Emp < 5	5 ≤ Emp	Total
Construction	1611	716	797	3124
Manufacturing	43	33	80	156
Other	2035	904	1075	4014
Total	3689	1653	1952	7294

Not Potentially Green

	0 ≤ Emp < 2	2 ≤ Emp < 5	5 ≤ Emp	Total
Construction	23	8	35	66
Manufacturing	165	91	242	498
Other	8886	4140	7079	20105
Total	9074	4239	7356	20669

Table 30 Sampling of Universe

Potentially Green

	0 ≤ Emp < 2	2 ≤ Emp < 5	5 ≤ Emp	Total
Construction	0	413	783	1196
Manufacturing	0	19	80	99
Other	0	509	1058	1215
Total	0	941	1921	2862

Not Potentially Green

	0 ≤ Emp < 2	2 ≤ Emp < 5	5 ≤ Emp	Total
Construction	0	5	35	40
Manufacturing	0	52	241	293
Other	0	376	839	1215
Total	0	433	1115	1548

Table 31 Responses Received

Potentially Green

	0 ≤ Emp < 2	2 ≤ Emp < 5	5 ≤ Emp	Total
Construction	0	54	149	203
Manufacturing	0	6	12	18
Other	0	86	189	275
Total	0	146	350	496

Not Potentially Green

	0 ≤ Emp < 2	2 ≤ Emp < 5	5 ≤ Emp	Total
Construction	0	0	6	6
Manufacturing	0	7	39	46
Other	0	43	120	163
Total	0	50	165	215

Establishments with at least 2 but less than 5 employees were administered surveys randomly. The 1,653 potentially green establishments as well as the 99 non-green establishments in construction and manufacturing were randomly administered 998 surveys (sampling rate of 57%). Almost all potentially green establishments with 5 or more employees as well as non-green establishments in construction and manufacturing were sent a survey (2197 surveys).[53] In order to make comparisons between potentially green and non-green industries, we also administered 1,215 surveys to other, not potentially green establishments. These were divided such that 839 surveys went to establishments with 5 or more employees and 376 went to the remaining establishments.

In all, the Delaware Environmental Business Survey was given to 4,410 establishments, stratified by employee size, industry type, and green vs. non-green classifications (BLS). We received 711 responses, which corresponds to an overall response rate of 16.1%. Table 3 indicates the total number of responses (returned / administered). Because we received a relatively small number of responses in certain cells, we collapsed the manufacturing and construction sectors across the green/non-green stratification. Table 32 lists the strata size and sample used for calculating various survey statistics.

[53] Establishments that were included in a pilot survey did not receive the main survey.

Table 32 Responses Received, Classified by Strata

Potentially Green

	0 ≤ Emp < 2	2 ≤ Emp < 5	5 ≤ Emp	Total
Construction	0	54	155	209
Manufacturing	0	13	51	64
Other – Potentially Green	0	86	189	275
Other – Not Potentially Green	0	43	120	163
Total	0	196	515	711

A recurring question in all surveys is whether the responses represent a random sample of the underlying population of businesses for the parameters under investigation. Although a researcher can never answer this question definitively (unless all survey recipients respond), we can inspect the responses to test how close our sample is to being random. We assumed that 711 surveys were randomly drawn from the 4,410 surveyed establishments. The resulting count of responses in each of the 8 strata was recorded, and this procedure was replicated 10,000 times. The 2nd, 5th, 95th and 98th percentiles were calculated across all simulations for each stratum. The results are shown in Table 33.

Comparing the actual results with the hypothetical results indicates that fewer small establishments in “Construction” and “Other – Potentially Green” responded to the survey than what was expected from a random sample. However, Table 33 also implies that there were relatively more responses in these two categories for establishments with five or more employees. Thus, based on a strict count of responses in each stratum, the survey could have nonrandom selection due to the employment size of the respondents.

Table 33 Response Percentiles of Random Draws from Surveyed Establishments

Sector	Employee Size	2nd Pct	5th Pct	95th Pct	98th Pct
Construction	2 - 5	53	56	79	82
Manufacturing	2 - 5	5.5	7	16	18
Other – Potentially Green	2 - 5	66	69	95	98
Other – Not Potentially Green	2 - 5	47	50	72	75
Construction	5+	113	116	148	152
Manufacturing	5+	39	41	63	65
Other – Potentially Green	5+	150	154	188	192
Other – Not Potentially Green	5+	116	120	151	155

We also tested whether the employment and average wage per worker differed between establishments that responded to the survey and those that did not. Table 34 shows the average employment and wage per employee for each stratum, as well as the p-value from a two-tailed t-test of equality assuming unequal variances. The tests indicate that for the most part, there is no discernable difference in employment and average wages for establishments with less than 5 employees. For establishments with 5 or more employees, there is evidence that respondents in the "Other - Green" strata employ significantly fewer persons than similar businesses that did not respond. The statistical test also implied that for all but construction firms, respondents paid employees less wages than nonrespondents.

As stated earlier, we do not know whether or how these differences bias the answers. Because we have no prior expectation as to how these factors correlate with employment, wages, and industry, we do not control for nonreponse bias, but we acknowledge that such bias could exist. The establishment weights are calculated as:

$$W_{i,h} = \frac{N_h}{n_h}$$

Where 'h' represents a particular stratum, $W_{i,h}$ represents the weight of an individual establishment i, N_h represents the total establishments in each stratum, and n_h represents the total responses in each stratum.

Table 34 Employment and Quarterly Wage per Employee for Responding and Non-Responding Establishments

	Employee Size: 2 - 5			Employee Size: 5+		
	Non-Response	Response	P-Value	Non-Response	Response	P-Value
Construction	2.8	3.0	0.135	19.6	20.3	0.759
Manufacturing	2.8	3.1	0.305	83.4	59.5	0.407
Other – Green	2.8	2.9	0.852	34.3	23.7	0.011
Other – Not Green	3.0	3.0	0.780	38.5	25.0	0.101

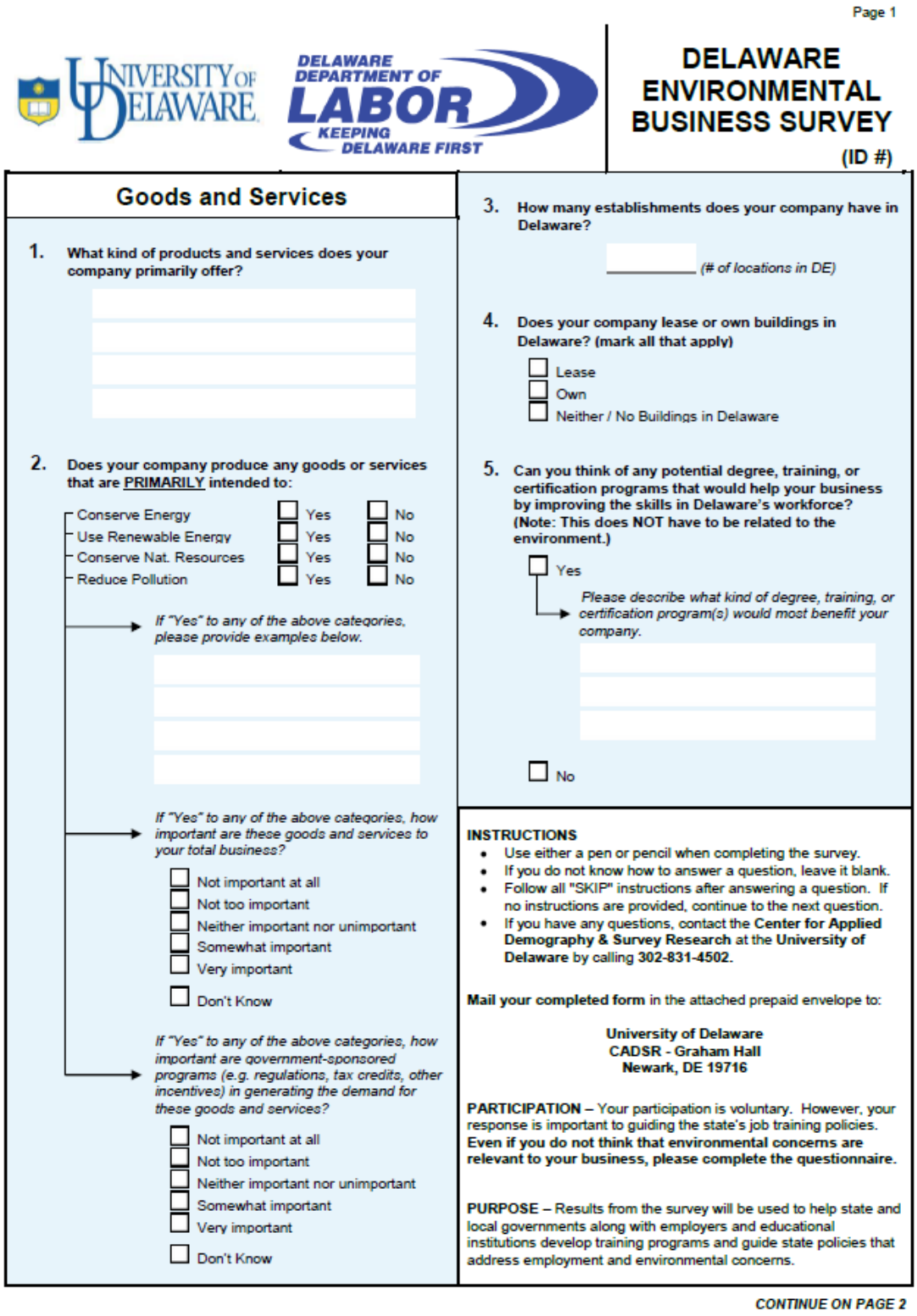
	Employee Size: 2 - 5			Employee Size: 5+		
	Non-Response	Response	P-Value	Non-Response	Response	P-Value
Construction	$8,833	$8,071	0.345	$10,118	$12,056	0.116
Manufacturing	$11,874	$10,968	0.702	$12,362	$10,406	0.026
Other – Green	$10,872	$9,344	0.368	$14,512	$10,269	0.036
Other – Not Green	$8,857	$8,014	0.058	$9,626	$8,135	0.000

Although the survey samples establishments in Delaware, most questions of interest are adjusted by the relative weights of each establishment's employment. In effect, these questions weigh the responses of larger establishments more heavily than the responses of smaller establishments. Weights of each respondent in the strata were calculated by the following equation:

$$\widehat{W}_{i,h} = \frac{N_h}{n_h} \cdot E_{i,h} \cdot \left(\frac{\sum_{g=1}^{N_h} E_{g,h}}{\sum_{j=1}^{n_h} \frac{N_h}{n_h} E_{j,h}} \right)$$

Where $E_{i,h}$ represents employment of those establishments. The above equation effectively normalizes the weights to be proportional to employment within each stratum and to sum to that stratum's total employment level.

Template of Survey Instrument



Page 1

UNIVERSITY OF DELAWARE

DELAWARE DEPARTMENT OF LABOR
KEEPING DELAWARE FIRST

DELAWARE ENVIRONMENTAL BUSINESS SURVEY

(ID #)

Goods and Services

1. **What kind of products and services does your company primarily offer?**

2. **Does your company produce any goods or services that are PRIMARILY intended to:**

Conserve Energy	☐ Yes	☐ No
Use Renewable Energy	☐ Yes	☐ No
Conserve Nat. Resources	☐ Yes	☐ No
Reduce Pollution	☐ Yes	☐ No

If "Yes" to any of the above categories, please provide examples below.

If "Yes" to any of the above categories, how important are these goods and services to your total business?

- ☐ Not important at all
- ☐ Not too important
- ☐ Neither important nor unimportant
- ☐ Somewhat important
- ☐ Very important
- ☐ Don't Know

If "Yes" to any of the above categories, how important are government-sponsored programs (e.g. regulations, tax credits, other incentives) in generating the demand for these goods and services?

- ☐ Not important at all
- ☐ Not too important
- ☐ Neither important nor unimportant
- ☐ Somewhat important
- ☐ Very important
- ☐ Don't Know

3. **How many establishments does your company have in Delaware?**

_____ *(# of locations in DE)*

4. **Does your company lease or own buildings in Delaware? (mark all that apply)**

- ☐ Lease
- ☐ Own
- ☐ Neither / No Buildings in Delaware

5. **Can you think of any potential degree, training, or certification programs that would help your business by improving the skills in Delaware's workforce? (Note: This does NOT have to be related to the environment.)**

- ☐ Yes
  - *Please describe what kind of degree, training, or certification program(s) would most benefit your company.*
- ☐ No

INSTRUCTIONS

- Use either a pen or pencil when completing the survey.
- If you do not know how to answer a question, leave it blank.
- Follow all "SKIP" instructions after answering a question. If no instructions are provided, continue to the next question.
- If you have any questions, contact the **Center for Applied Demography & Survey Research** at the **University of Delaware** by calling **302-831-4502.**

Mail your completed form in the attached prepaid envelope to:

University of Delaware
CADSR - Graham Hall
Newark, DE 19716

PARTICIPATION – Your participation is voluntary. However, your response is important to guiding the state's job training policies. **Even if you do not think that environmental concerns are relevant to your business, please complete the questionnaire.**

PURPOSE – Results from the survey will be used to help state and local governments along with employers and educational institutions develop training programs and guide state policies that address employment and environmental concerns.

CONTINUE ON PAGE 2

Education and Training

6. The following list shows different EDUCATIONAL degrees that could play a role in energy efficiency, renewable energy, natural resource conservation, or pollution reduction. Please mark those degrees that would be both desirable and relevant to your current or future employees.

Vo-Tech High School Degree

- ☐ Conservation Principles (Behavioral / Motivational)
- ☐ General Construction
- ☐ Roofing
- ☐ Cement and Masonry
- ☐ Landscaping
- ☐ Drywall and Painting
- ☐ Siding
- ☐ HVAC
- ☐ Plumbing
- ☐ Electrical
- ☐ Automotive
- ☐ Other

Associate Degree

- ☐ Environmental Technology
- ☐ Energy Management
- ☐ Civil Engineering
- ☐ Architectural Engineering
- ☐ Electromechanical Engineering
- ☐ Electrical Engineering
- ☐ Mechanical Engineering
- ☐ Survey & Geomatics Engineering
- ☐ Chemistry Technology
- ☐ Biotechnology
- ☐ Other

Baccalaureate Degree or Higher

- ☐ Plant Science
- ☐ Animal Science
- ☐ Wildlife Management / Conservation
- ☐ Fisheries Management
- ☐ Marine Science
- ☐ Ecology
- ☐ Soil / Environmental Science
- ☐ Cellular Biology / Biosciences
- ☐ Chemistry / Biochemistry
- ☐ Bioengineering / Bioinformatics
- ☐ Environmental Engineering
- ☐ Chemical Engineering
- ☐ Electrical & Computer Engineering
- ☐ Civil Engineering
- ☐ Mechanical Engineering
- ☐ Materials Science
- ☐ Natural Resource / Agricultural Economics
- ☐ Agribusiness Management
- ☐ Energy & Environmental Policy, Laws & Regulation
- ☐ Other

7. The following list shows different TECHNICAL TRAINING programs that could play a role in energy efficiency, renewable energy, natural resource conservation, or pollution reduction. Please mark those programs that would be both desirable and relevant to your current or future employees.

Construction Training (Residential & Commercial)

- ☐ Asbestos Safety & Disposal
- ☐ Lead Abatement / Awareness
- ☐ Other Hazardous Waste Removal
- ☐ Wastewater Treatment
- ☐ Water Management / Water Run-off
- ☐ HVAC
- ☐ Refrigeration
- ☐ Electrical Wiring / NEC Standards
- ☐ Plumbing
- ☐ Carpentry
- ☐ Roofing
- ☐ Other

Specialized Construction Technology

- ☐ Weatherization (Insulation, Caulk, Windows, and Doors)
- ☐ Solar Panel / Photovoltaic Systems
- ☐ Solar Heat & Hot Water Systems
- ☐ Green Building / Energy Auditing (BPI certification)
- ☐ Green Building Design / Construction (LEED certification)
- ☐ Geothermal Systems
- ☐ Wind Turbine Systems
- ☐ Other

Industrial Technology Training

- ☐ Piping / Machine / Equipment Insulation
- ☐ Steam / Hot Water / Piping Systems
- ☐ Motors & Mechanical Systems
- ☐ Compressed Air Systems
- ☐ Electrical Systems / Power Generation and Control
- ☐ Industrial HVAC / Indoor Ventilation / Air Quality
- ☐ Cogeneration (Combined Heat and Power) Technology
- ☐ Combustion Systems (Boilers, Furnaces, etc.)
- ☐ Heat Treating Systems (Ovens, Die-Casting, etc.)
- ☐ Heat Recovery (Design & Implementation)
- ☐ Refrigeration Systems
- ☐ Lighting Systems
- ☐ Water Treatment / Cooling Tower Treatment
- ☐ Other

Other Technical Training

- ☐ Landscape / Turf Management
- ☐ Soil Remediation
- ☐ Agricultural Production
- ☐ Hybrid or Electric Automotive Technology
- ☐ Geographic Information Systems (GIS)
- ☐ Chemical Process Operator
- ☐ Other

CONTINUE ON PAGE 3

Opinions on Energy Efficiency

8. **Please mark any of the following sources of energy that your company purchases for any reason:**

- ☐ Electricity
- ☐ Natural Gas
- ☐ Oil (Residual or Distillate)
- ☐ Gasoline
- ☐ Propane / LPG
- ☐ Steam
- ☐ Coal
- ☐ Wood
- ☐ Other

9. **How important are energy costs to your company's profitability?**

- ☐ Not important at all
- ☐ Not too important
- ☐ Neither important nor unimportant
- ☐ Somewhat important
- ☐ Very important
- ☐ Don't Know

10. **How likely is it that your company would consider investing in energy-saving technologies in the next two years?**

- ☐ Very unlikely
- ☐ Somewhat unlikely
- ☐ Neither likely nor unlikely
- ☐ Somewhat likely
- ☐ Very likely
- ☐ Don't Know

11. **Using a scale of 1 through 5, please indicate how concerned your company would be to each of the following potential deterrents to energy-saving investments.**

1 = not concerned at all
2 = not too concerned
3 = neither concerned nor unconcerned
4 = somewhat concerned
5 = very concerned

Making current employees change behavior
Finding qualified new employees
Large up-front installation costs
Waiting a long time before recovering investment costs
Obtaining credit only at high interest rates
Change / delays in operations
Risk of incorrect installation
Risk that future savings on energy bills will be less than expected

12. **Does your company evaluate any specific criteria (e.g. up-front costs, time to recoup investment, return-on-investment, etc.) when deciding whether an energy-saving investment is worth pursuing?**

- ☐ Yes
  - *Please describe the criteria being used.*
- ☐ No
- ☐ Don't Know

13. **Does your company currently have anyone on staff to monitor energy use and reinforce energy-efficient best-practices?**

- ☐ Yes
- ☐ No
- ☐ Don't Know

Opinions on Green Marketing

14. **Has your company marketed itself as being "green"?**

- ☐ Yes
  - *What methods were used to communicate that message? (mark all that apply)*
    - ☐ Television
    - ☐ Radio
    - ☐ Newspaper
    - ☐ Billboards
    - ☐ Website / Social Networking Sites
    - ☐ Mail / Flyers
    - ☐ Events / Conferences
    - ☐ Other *(specify)*
  - *Using a scale of 1 through 5, please indicate how important each of the following factors was to your company's decision to market itself as being "green".*

1 = not important at all
2 = not too important
3 = neither important nor unimportant
4 = somewhat important
5 = extremely important

Your company wanted to affect employee behavior or attract job applicants.
Your company wanted to increase customer satisfaction / sales.
Your company wanted to spread information on best practices.
Your company wanted third-party funds that support green products and services.
Your company was responding to marketing campaigns from competitors.
Your company wanted to influence customers to use less expensive services.

- ☐ No
- ☐ Don't Know

CONTINUE ON PAGE 4

If you have any comments, please feel free to include them in the space provided below.

Thank you for completing the Delaware Environmental Business Survey.

Please return the completed form to:

University of Delaware
CADSR – Graham Hall
Newark, DE 19716

Table 35 Skill Comparison between Green and Potentially Green Companies: Distributions with Less Difference

Description	Type	Distribution Difference	Expected Value Diff.	Cond'l Expected Value Diff. Low	Medium	High	Cond'l Probability Mass Diff. Low	Medium	High
History and Archeology	Knowledge	1.19	0.03	0.04	-0.14	0.01	0%	0%	0%
Philosophy and Theology	Knowledge	1.19	0.04	0.04	-0.14	0.05	0%	0%	0%
Gross Body Equilibrium	Ability	1.19	-0.14	-0.04	-0.05	-0.05	6%	-6%	-1%
Inductive Reasoning	Ability	1.19	0.01	-0.04	-0.05	0.02	0%	-6%	6%
Originality	Ability	1.19	0.02	0.02	0.03	0.01	2%	-4%	1%
Competitive pressures	Work Context	1.19	-0.10	-0.03	-0.07	0.02	2%	2%	-4%
Negotiation	Skill	1.19	-0.01	-0.04	-0.04	0.00	-5%	5%	0%
Exposed to Whole Body Vibration	Work Context	1.19	-0.12	0.01	0.04	-0.14	7%	-5%	-2%
Rate Control	Ability	1.19	-0.01	-0.07	0.07	0.04	0%	-2%	2%
Work in an open vehicle or equipment	Work Context	1.18	-0.05	0.06	0.04	-0.07	6%	-6%	0%
Drafting / Specifying Tech Devices, Equip.	Work Activity	1.18	0.18	0.02	0.03	0.14	-3%	-5%	8%
Reaction Time	Ability	1.18	-0.05	-0.10	0.01	-0.05	1%	-1%	0%
Fluency of Ideas	Ability	1.18	-0.01	0.01	0.00	0.03	2%	-3%	1%
Outdoors, Exposed to Weather	Work Context	1.18	-0.02	0.01	-0.07	-0.06	0%	0%	0%
Arm-Hand Steadiness	Ability	1.18	-0.13	-0.13	-0.02	-0.01	3%	-1%	-3%
Stamina	Ability	1.18	-0.06	-0.10	0.04	-0.03	2%	-1%	0%
Public Safety and Security	Knowledge	1.18	0.13	0.03	0.04	-0.02	-7%	5%	2%
Physics	Knowledge	1.17	0.07	0.00	0.04	0.08	0%	-5%	5%
Telephone conversations	Work Context	1.17	-0.12	0.06	-0.10	0.04	3%	3%	-6%
Spend Time Standing	Work Context	1.17	-0.13	0.03	-0.09	-0.02	5%	-1%	-4%
Visualization	Ability	1.17	0.04	-0.02	-0.02	0.03	-3%	-1%	4%
Working outdoors, under cover	Work Context	1.17	-0.06	0.05	-0.09	0.02	4%	-3%	0%
Science	Skill	1.17	0.12	0.02	0.27	-0.12	-3%	1%	2%
Contact With Others	Work Context	1.17	0.04	0.00	0.03	0.00	0%	-3%	3%
Staffing Organizational Units	Work Activity	1.17	0.05	0.00	-0.03	-0.09	-5%	5%	0%
Use of Hands to Handle/Control Objects	Work Context	1.16	-0.15	0.01	-0.05	-0.03	5%	-1%	-4%
Interacting With Computers	Work Activity	1.16	0.11	0.03	-0.02	-0.04	-3%	-2%	5%

Table 35 Skill Comparison between Green and Potentially Green Companies: Distributions with Less Difference (cont)

Description	Type	Distribution Difference	Expected Value Diff.	Cond'l Expected Value Diff. Low	Medium	High	Cond'l Probability Mass Diff. Low	Medium	High
Multilimb Coordination	Ability	1.16	-0.05	0.03	0.00	0.02	5%	-6%	2%
Psychology	Knowledge	1.16	-0.06	0.02	-0.07	-0.03	5%	-5%	-1%
Response Orientation	Ability	1.16	-0.06	-0.06	0.00	-0.01	3%	-4%	1%
Selling or Influencing Others	Work Activity	1.16	0.05	0.01	0.05	-0.05	-5%	7%	-1%
Operations Analysis	Skill	1.16	-0.02	-0.01	0.06	-0.11	4%	-6%	2%
Working in a closed vehicle or equipment	Work Context	1.16	0.01	0.06	-0.01	0.07	3%	-3%	0%
Spend Time Bending or Twisting the Body	Work Context	1.16	-0.03	-0.01	0.02	-0.04	4%	-6%	2%
Written Expression	Ability	1.16	0.09	-0.02	0.03	0.00	-3%	-3%	5%
Deductive Reasoning	Ability	1.16	-0.01	-0.01	-0.04	0.01	0%	-2%	2%
Mathematics	Knowledge	1.16	-0.03	-0.05	-0.04	0.08	2%	-1%	-1%
Spend Time Walking and Running	Work Context	1.16	-0.04	0.02	0.01	-0.06	5%	-5%	0%
Reading Comprehension	Skill	1.16	0.01	-0.01	-0.02	-0.03	0%	-3%	3%
Very Hot or Cold Temperatures	Work Context	1.16	0.02	0.05	-0.10	-0.01	-1%	-1%	2%
Indoors, Environmentally Controlled	Work Context	1.16	-0.04	0.04	-0.08	0.00	3%	-4%	1%
Writing letters and memos	Work Context	1.16	0.03	0.03	0.00	-0.01	2%	-6%	4%
Documenting/Recording Information	Work Activity	1.15	0.08	0.05	0.01	-0.05	-4%	1%	3%
Writing	Skill	1.15	0.04	0.02	-0.03	0.03	-5%	3%	2%
Spatial Orientation	Ability	1.15	0.06	0.04	0.09	0.00	1%	-2%	1%
Face-to-face discussions	Work Context	1.15	-0.06	-0.01	-0.01	-0.04	0%	2%	-2%
Kneeling, Crouching, Stooping or Crawling	Work Context	1.15	-0.07	0.01	0.00	-0.05	6%	-6%	0%
Judgment and Decision	Skill	1.15	0.00	0.00	-0.03	-0.03	1%	-4%	3%
Finger Dexterity	Ability	1.15	-0.06	-0.01	-0.04	0.04	1%	2%	-2%
Inspecting Equip., Structures, or Material	Work Activity	1.15	0.05	0.00	0.02	-0.04	-4%	3%	1%
Instructing	Skill	1.15	-0.02	-0.01	-0.03	-0.01	-2%	3%	-1%
Operation and Control	Skill	1.15	-0.03	-0.01	-0.02	0.03	3%	-6%	3%
Making Decisions and Solving Problems	Work Activity	1.15	0.01	0.08	0.05	-0.02	0%	1%	-1%
Provide Consultation and Advice to Others	Work Activity	1.15	0.06	-0.03	0.06	0.02	-2%	0%	2%

Table 35 Skill Comparison between Green and Potentially Green Companies: Distributions with Less Difference (cont)

Description	Type	Distribution Difference	Expected Value Diff.	Cond'l Expected Value Diff. Low	Medium	High	Cond'l Probability Mass Diff. Low	Medium	High
Developing Objectives and Strategies	Work Activity	1.15	0.05	0.02	0.01	-0.04	-6%	7%	-1%
Cramped Work Space, Awkward Positions	Work Context	1.15	-0.10	0.03	-0.03	0.08	4%	0%	-4%
Tasks in close physical proximity to people	Work Context	1.15	-0.07	-0.03	-0.05	0.00	2%	-1%	-2%
Dynamic Strength	Ability	1.14	-0.04	-0.06	0.04	-0.01	2%	-2%	0%
Management of Financial Resources	Skill	1.14	-0.05	-0.07	0.02	0.02	1%	0%	-1%
Extent Flexibility	Ability	1.14	-0.10	-0.05	-0.01	0.05	5%	-5%	0%
Education and Training	Knowledge	1.14	-0.05	0.03	-0.05	-0.06	0%	1%	-2%
Dynamic Flexibility	Ability	1.14	-0.04	-0.04	-0.07	-0.05	0%	0%	0%
Management of Personnel Resources	Skill	1.14	-0.08	-0.03	-0.01	0.02	6%	-5%	-1%
Operating Vehicles, Mech. Devices, Equip.	Work Activity	1.14	0.00	0.04	-0.06	0.02	1%	-3%	2%
Coordinating the Work Activities of Others	Work Activity	1.14	-0.01	-0.06	0.04	-0.03	4%	-4%	1%
Explosive Strength	Ability	1.14	-0.06	-0.05	0.02	0.02	1%	-1%	0%
Interpret Information for Others	Work Activity	1.14	-0.02	-0.07	0.04	-0.05	3%	-3%	0%
Thinking Creatively	Work Activity	1.14	0.01	0.06	-0.01	-0.05	0%	-2%	2%
Memorization	Ability	1.14	-0.05	0.02	-0.02	0.00	6%	-6%	0%
Control Precision	Ability	1.14	-0.04	-0.01	0.02	0.04	4%	-4%	1%
Establish and Maintain Relationships	Work Activity	1.14	-0.01	0.07	-0.03	-0.01	1%	-3%	2%
Gross Body Coordination	Ability	1.14	-0.07	-0.08	-0.01	0.00	1%	-1%	0%
Customer and Personal Service	Knowledge	1.14	-0.09	-0.05	-0.02	0.02	2%	4%	-6%
Oral Comprehension	Ability	1.14	-0.01	-0.01	-0.04	0.01	0%	-1%	1%
Computers and Electronics	Knowledge	1.14	-0.11	0.04	-0.01	-0.21	3%	1%	-5%
Coordinate or Lead Others	Work Context	1.13	-0.05	-0.02	-0.04	0.02	0%	2%	-3%
Depth Perception	Ability	1.13	0.08	0.00	-0.01	0.00	-6%	5%	1%
Management of Material Resources	Skill	1.13	-0.05	0.00	0.02	-0.01	5%	-5%	-1%
Written Comprehension	Ability	1.13	0.05	-0.03	0.00	0.01	0%	-5%	5%
Flexibility of Closure	Ability	1.13	0.06	0.00	0.02	0.00	-1%	-2%	3%
Glare Sensitivity	Ability	1.13	0.00	-0.03	0.11	0.00	-1%	1%	0%

Table 35 Skill Comparison between Green and Potentially Green Companies: Distributions with Less Difference (cont)

Description	Type	Distribution Difference	Expected Value Diff.	Cond'l Expected Value Diff. Low	Medium	High	Cond'l Probability Mass Diff. Low	Medium	High
Pace Determined by Speed of Equipment	Work Context	1.13	0.07	-0.02	0.06	0.00	-4%	3%	1%
Handling and Moving Objects	Work Activity	1.13	-0.04	0.03	0.01	0.00	4%	-5%	1%
Distracting or Uncomfortable Sounds	Work Context	1.13	-0.03	0.00	-0.02	0.04	-1%	4%	-4%
Controlling Machines and Processes	Work Activity	1.13	-0.03	0.00	-0.02	-0.01	3%	-5%	2%
Perceptual Speed	Ability	1.13	0.00	-0.01	0.01	0.00	2%	-4%	2%
Deal With External Customers	Work Context	1.13	-0.02	-0.04	0.04	-0.06	2%	-2%	0%
Developing and Building Teams	Work Activity	1.13	0.06	0.01	0.05	-0.04	-1%	0%	1%
Technology Design	Skill	1.12	-0.06	-0.02	-0.01	0.01	4%	-4%	0%
Updating and Using Relevant Knowledge	Work Activity	1.12	-0.05	0.01	0.00	-0.03	3%	-2%	0%
Critical Thinking	Skill	1.12	0.01	0.00	-0.02	0.02	0%	-3%	3%
Performing Administrative Activities	Work Activity	1.12	0.03	-0.02	0.04	-0.02	-2%	2%	0%
Performing General Physical Activities	Work Activity	1.12	-0.03	0.04	-0.01	0.02	4%	-4%	0%
Far Vision	Ability	1.12	0.04	-0.03	0.02	0.02	1%	-4%	4%
Frequency of Conflict Situations	Work Context	1.12	0.00	-0.05	0.00	-0.02	-2%	3%	-1%
Sales and Marketing	Knowledge	1.12	-0.07	0.01	-0.02	0.01	5%	-4%	-1%
Systems Analysis	Skill	1.12	-0.04	0.02	-0.03	0.03	1%	1%	-2%
Training and Teaching Others	Work Activity	1.12	0.01	-0.02	0.02	0.03	3%	-6%	3%
Biology	Knowledge	1.11	0.06	0.02	0.11	-0.38	-2%	1%	1%
Auditory Attention	Ability	1.11	0.03	0.05	0.00	0.02	-1%	1%	0%
Active Listening	Skill	1.11	-0.01	0.02	-0.04	0.00	0%	-2%	2%
Peripheral Vision	Ability	1.11	0.06	-0.02	0.17	-0.02	-4%	4%	0%
Speed of Limb Movement	Ability	1.11	-0.03	-0.02	0.03	0.00	2%	-2%	0%
Processing Information	Work Activity	1.11	0.07	-0.04	0.03	-0.01	-1%	-4%	5%
Service Orientation	Skill	1.11	-0.02	0.02	-0.03	-0.01	-1%	1%	0%
Speaking	Skill	1.11	0.01	0.00	-0.01	-0.02	0%	-2%	2%
Public Speaking	Work Context	1.11	0.04	0.04	-0.01	-0.02	-1%	1%	0%
Sociology and Anthropology	Knowledge	1.11	0.01	0.03	-0.15	-0.05	1%	-1%	0%

Table 35 Skill Comparison between Green and Potentially Green Companies: Distributions with Less Difference (cont)

Description	Type	Distribution Difference	Expected Value Diff.	Cond'l Expected Value Diff.			Cond'l Probability Mass Diff.		
				Low	Medium	High	Low	Medium	High
Organizing, Planning, and Prioritizing Work	Work Activity	1.11	0.04	0.04	0.03	-0.01	-2%	2%	0%
Selective Attention	Ability	1.11	0.01	0.00	0.00	0.00	0%	0%	0%
Active Learning	Skill	1.11	-0.01	0.01	-0.03	-0.05	0%	-1%	1%
Importance of Being Exact or Accurate	Work Context	1.11	0.00	0.00	0.04	-0.02	0%	-1%	1%
Spend Time Keeping or Regaining Balance	Work Context	1.10	-0.03	0.00	0.04	-0.05	3%	-3%	0%
Deal With Unpleasant or Angry People	Work Context	1.10	0.04	0.01	0.03	-0.06	-3%	3%	-1%
English Language	Knowledge	1.10	0.02	-0.07	0.00	0.03	1%	-5%	4%
Operation Monitoring	Skill	1.10	-0.04	-0.01	-0.03	0.03	3%	-3%	1%
Economics and Accounting	Knowledge	1.10	0.02	0.00	-0.03	0.00	-3%	4%	-1%
Scheduling Work and Activities	Work Activity	1.10	0.03	0.06	0.02	-0.05	-1%	0%	1%
Job structured for the worker	Work Context	1.10	-0.03	-0.01	0.01	0.02	0%	4%	-5%
Sound Localization	Ability	1.10	0.00	-0.02	0.09	0.01	-1%	0%	0%
Hearing Sensitivity	Ability	1.10	0.02	-0.01	0.05	-0.01	0%	0%	0%
Decisions affect people, finances, image	Work Context	1.10	-0.04	-0.01	0.00	-0.05	0%	1%	-1%
Category Flexibility	Ability	1.10	0.02	0.00	0.00	-0.01	0%	-2%	3%
Night Vision	Ability	1.10	0.05	-0.02	0.19	-0.01	-4%	4%	0%
Foreign Language	Knowledge	1.09	0.02	0.02	-0.03	-0.01	0%	0%	0%
Getting Information	Work Activity	1.09	0.02	0.03	-0.04	0.02	0%	-2%	2%
Freedom Making Decisions	Work Context	1.09	-0.02	-0.03	0.04	0.00	0%	3%	-3%
Oral Expression	Ability	1.09	0.00	0.00	-0.03	0.02	0%	-2%	2%
Repairing / Maintaining Mechanical Equip.	Work Activity	1.09	0.02	0.03	0.02	0.05	1%	-2%	1%
Degree of Automation	Work Context	1.09	0.04	0.04	0.00	-0.03	-2%	2%	0%
Communicate with Supervisors, Peers, etc.	Work Activity	1.09	-0.01	-0.03	0.02	-0.01	0%	1%	-1%
Information Ordering	Ability	1.09	0.03	-0.01	0.00	0.01	0%	-5%	5%
Systems Evaluation	Skill	1.09	0.01	0.05	0.00	0.03	0%	1%	-1%
Monitoring	Skill	1.09	0.01	-0.01	0.02	-0.01	0%	1%	-1%
Judging Qualities of Things, Services, etc.	Work Activity	1.09	-0.02	-0.02	0.00	-0.02	-1%	3%	-2%

Table 35 Skill Comparison between Green and Potentially Green Companies: Distributions with Less Difference (cont)

Description	Type	Distribution Difference	Expected Value Diff.	Cond'l Expected Value Diff. Low	Medium	High	Cond'l Probability Mass Diff. Low	Medium	High
Evaluating Info. to Comply with Standards	Work Activity	1.09	0.05	-0.01	0.02	0.01	-2%	0%	2%
Meet strict deadlines	Work Context	1.09	0.03	-0.01	0.00	0.03	0%	-1%	1%
Learning Strategies	Skill	1.09	0.00	0.00	-0.02	-0.09	-2%	2%	0%
Coaching and Developing Others	Work Activity	1.09	0.03	0.01	0.04	-0.06	-1%	2%	-1%
Responsibility for Outcomes and Results	Work Context	1.09	-0.03	0.00	0.02	-0.01	0%	3%	-3%
Exposed to Radiation	Work Context	1.08	0.00	0.01	-0.02	-0.05	1%	-1%	0%
Monitoring and Controlling Resources	Work Activity	1.08	0.05	0.01	0.03	0.00	-3%	3%	0%
Decisions impact coworkers, clients or firm	Work Context	1.08	-0.05	0.01	-0.03	-0.02	0%	3%	-3%
Analyzing Data or Information	Work Activity	1.08	0.05	-0.01	0.02	-0.01	-3%	2%	1%
Speed of Closure	Ability	1.08	0.00	0.00	0.01	0.01	2%	-2%	0%
Clerical	Knowledge	1.08	0.01	0.00	-0.02	-0.01	-2%	3%	0%
Programming	Skill	1.08	-0.09	0.00	-0.15	-0.12	3%	0%	-3%
Wrist-Finger Speed	Ability	1.08	-0.04	-0.03	0.01	-0.02	1%	-1%	0%
Resolving Conflicts / Negotiating	Work Activity	1.08	-0.01	0.02	-0.02	-0.03	-1%	1%	0%
Production and Processing	Knowledge	1.08	-0.02	0.03	-0.01	-0.02	2%	-2%	0%
Communications and Media	Knowledge	1.08	-0.01	0.01	-0.01	0.12	2%	-2%	0%
Guide, Direct, and Motivate Subordinates	Work Activity	1.07	0.01	-0.02	0.03	-0.04	0%	-1%	0%
Identifying Objects, Actions, and Events	Work Activity	1.07	-0.04	-0.04	0.00	-0.02	0%	4%	-4%
Time Management	Skill	1.07	0.02	-0.01	0.01	0.00	0%	-1%	1%
Social Perceptiveness	Skill	1.07	0.01	0.00	0.01	0.00	0%	1%	-1%
Estimate the Quantifiable Characteristics	Work Activity	1.07	0.02	-0.01	-0.01	0.03	-1%	0%	1%
Persuasion	Skill	1.07	-0.01	0.01	-0.01	-0.02	-1%	2%	-1%
Exposed to Disease or Infections	Work Context	1.07	-0.01	-0.02	0.09	-0.01	0%	0%	0%
Assisting and Caring for Others	Work Activity	1.07	-0.02	0.01	0.01	-0.09	3%	-3%	0%
Work with others in a group or team	Work Context	1.07	0.01	-0.04	0.02	0.01	0%	1%	-1%
Near Vision	Ability	1.06	0.03	-0.02	0.01	0.02	0%	-3%	3%
Responsible for Others' Health and Safety	Work Context	1.06	-0.01	-0.02	0.02	-0.02	1%	0%	0%

Table 35 Skill Comparison between Green and Potentially Green Companies: Distributions with Less Difference (cont)

Description	Type	Distribution Difference	Expected Value Diff.	Cond'l Expected Value Diff.			Cond'l Probability Mass Diff.		
				Low	Medium	High	Low	Medium	High
Speech Recognition	Ability	1.06	0.00	0.01	0.00	0.00	0%	-1%	1%
Coordination	Skill	1.06	-0.01	-0.09	-0.01	0.01	1%	-1%	1%
Consequence of Error	Work Context	1.06	0.03	0.00	0.00	0.01	-2%	2%	0%
Problem Sensitivity	Ability	1.06	0.01	-0.01	0.00	0.01	0%	0%	0%
Speech Clarity	Ability	1.06	0.00	-0.02	-0.01	0.00	0%	0%	0%
Medicine and Dentistry	Knowledge	1.05	-0.01	-0.01	0.02	-0.06	0%	0%	0%
Food Production	Knowledge	1.05	0.00	0.01	-0.04	-0.07	0%	0%	0%
Personnel and Human Resources	Knowledge	1.05	-0.01	0.00	0.00	-0.03	-1%	2%	-1%
Monitor Process, Material, or Surrounding	Work Activity	1.05	0.03	-0.01	0.01	0.03	0%	-1%	1%
Importance of Repeating Same Tasks	Work Context	1.05	-0.02	-0.01	-0.01	0.03	1%	-1%	0%
Fine Arts	Knowledge	1.05	0.00	0.00	-0.10	0.11	0%	0%	0%
Time Sharing	Ability	1.05	0.00	0.00	-0.01	0.02	-1%	1%	0%
Deal With Physically Aggressive People	Work Context	1.04	0.00	0.00	-0.06	-0.06	0%	0%	0%
Therapy and Counseling	Knowledge	1.03	-0.01	0.00	-0.18	-0.19	1%	-1%	0%