

Energy, the Environment, and Delaware Jobs: An Analysis of Delaware's Green Educational Pipeline

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by

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Edward C. Ratledge

May 31, 2011

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This is the third in a series of reports titled “Energy, the Environment, and Delaware Jobs”. The entire series is comprised of the following five titles:

Energy Efficiency and the Manufacturing Sector

Defining and Describing Green Businesses

An Analysis of Delaware's Green Educational Pipeline

Households and Energy Efficiency

The Economic Impact of Delaware's Green Business

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Executive Summary

The Center for Applied Demography & Survey Research at the University of Delaware conducted this study to explore Delaware's green educational pipeline. 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.

The green education pipeline refers to those academic and vocational instructional programs that teach skills and concepts relevant to energy efficiency, renewable energy, natural resources, pollution control or remediation. The main objective in this report was to identify that pipeline in Delaware and provide pertinent information for those programs involved. A secondary objective of the report was to understand the career outcomes of persons exiting the pipeline. The report also was an opportunity to provide context and commentary on other important issues related to education and the green economy in Delaware.

Below is a brief summary of the most important facts and findings discussed in the report.

Overview of Important Trends in Postsecondary Education

- In Delaware's adult (19 years and older) labor force,
 - 29% have attained a bachelor's degree or higher level of education
 - 26% have attained an associate's degree or some other college experience less than the bachelor level
 - 33% have a high school diploma or equivalent
 - 11% do not have a high school diploma or equivalent
- The severity of the recession is closely tied to educational attainment. People with higher levels of education have lower levels of unemployment. For those who are employed, people with less education are more likely to be working part time despite being available for full time employment.
- Delaware's postsecondary academic schools conferred the following degrees in 2010:
 - 1,822 certificate degrees
 - 1,733 associate's degrees
 - 5,505 bachelor's degrees
 - 2,465 master's degrees
 - 528 doctoral degrees
- The University of Delaware, Wilmington University, and Delaware Technical and Community College (DelTech) award the most academic degrees in the state. In addition, DelTech, the adult education division in each county's adult vocational school district, local trade unions, and other private organizations provide technical, non academic training after high school.

- The type of degrees awarded by Delaware institutions has undergone a transition over the last 10 years. Degrees in engineering and engineering technologies, construction, beauty, personal service, education, business, nursing, accounting, economics, finance, physical fitness, and sports management have been on the rise. Degrees in history, consumer economics, and fashion have been declining.

Overview of Green Programs

- Majors in the following categories were identified as important to the green economy
 - agriculture
 - engineering and engineering technologies
 - wildlife, earth, and environmental science
 - chemistry and biochemistry
 - natural resource economics, operations research, and logistics
 - public policy & environmental law
 - construction and trades (mostly vocational)
- In terms of enrollment, engineering and engineering technologies was the largest component in Delaware's educational pipeline (2900 students). The next largest component are those majors related to the wildlife, earth, and environmental sciences (1000 students), followed by majors in chemistry and biochemistry (950 students) and agriculture (600 students).
- In terms of in-state student enrollment, engineering and engineering technologies was still the largest program in Delaware's educational pipeline (1350 students), followed by chemistry and biochemistry (600 students), and wildlife, earth, and environmental sciences (350 students).

- Students enrolled in a green academic degree had the following characteristics:
 - Associate: 92% in-state, 25.0 years old, 81% male
 - Bachelor: 37% in-state, 20.4 years old, 59% male
 - Master: 31% in-state, 28.8 years old, 52% male
 - Doctoral: 8% in-state, 28.0 years old, 67% male
- Students with a degree in chemistry and biochemistry or an associate's degree in agriculture reported the most success in finding a full time job or a job in a related field. Students graduating with an associate's degree in engineering technology had the least success in finding a job in a related field. Those graduating with a bachelor's or master's degree reported the least success in finding full time employment if that degree was related to agriculture, wildlife, earth, and the environment
- According the 2009 American Community Survey, career outcomes varied greatly for subjects within the green pipeline. Persons with bachelor's degrees in agriculture were paid the lowest wages (\$49,100), and persons receiving bachelor's degrees in engineering were paid the highest wages (\$80,200).
- For areas within the construction and trades, we estimated that those pursuing their journey papers were most commonly working towards becoming electricians (300), plumbers or pipefitters (220), or HVAC repairmen (120). Apprentices in these trades and those taking technical training often develop the skills taught in the more familiar stand-alone green courses.
- Enrollment in workforce training tied to more singular green issues, such as auditing a building for energy performance (45) and solar panel installation (15) is much smaller compared to those learning a broader set of trade skills. Programs in weatherization have attracted more applicants (estimated between 120-150), but these programs are not much different from introductory training in the construction crafts.

The Effects of the Recession

- The recession has had profound effects on occupations related to the green sector, and no single explanation seems to describe those changes. Traditional trades, like plumbers, electricians, and carpenters, as well as some types of engineering technicians show clear evidence of a decline in demand (falling wages and falling employment). However, for most occupations that can be obtained with a green education, employment fell while wages may have increased.
- Multiple reasons are offered to explain rising wages and falling employment.
 - Discouraged workers or skill atrophy among the unemployed.
 - Businesses may discriminate among job applicants.
 - Fewer applicants in the workforce have the skills desired by businesses. Those who possess such skills are relatively more valuable and are paid accordingly.
- Occupations requiring bachelor's degrees or higher levels of education in green majors had unemployment rates better than or equal to those in other disciplines. Occupations available to people with associate's degrees or lower levels of education in green related fields have substantially higher rates of unemployment. This is largely the result of these majors and training programs being in construction and manufacturing.

Opinions from Businesses and Educators

- Academic educators cited analytical thinking and mathematical ability as being the most crucial to student success in green-oriented majors, and high school mathematical attainment is an indicator of whether people enter a postsecondary academic program and which field they choose if they enter. The 2010 SAT10 mathematical performance scores indicate that 43% of 10th grade public school students did not meet the expected levels.
- Job readiness and mechanical aptitude are crucial to the non-academic green pipeline. While vocational educators agree that mathematical ability is also important and lacking in the workforce, they submit that such knowledge is easy to teach at the necessary level of rigor. Mechanical skills, on the other hand, take a long time to develop, and persons entering construction or the trades are most strongly deficient in these skills. Mechanical deficiencies are blamed on policies that encourage academic over vocational education.
- Green businesses in Delaware most frequently mentioned that skilled employees with construction and trade skills were desirable and relevant. The most commonly requested worker was a person with general construction skills from a vocational high school. Other construction related skills were rated highly among green businesses.
- Green businesses cited that associate degree programs in HVAC, energy management, environmental technology, and mechanical engineering technology were very relevant to their business. At the bachelor's degree or higher, the degrees found to be most relevant are environmental engineering and mechanical engineering.
- Businesses also expressed interest in LEED certification. These standards are introduced at the associate level, but are developed more thoroughly at the bachelor's level. Some trade unions offer LEED certification to their journeymen.

Introduction

Education is a critical component to jobs, productivity, and the strength of our state's economy. If the economy moves towards a more environmentally sustainable path, the workforce needs to possess certain skills, and Delaware's educational system will play a pivotal role. This report evaluates the contribution of the postsecondary instructional programs of the green educational pipeline. We uncover pertinent information about those programs and give them context within the broader educational system.

This report is the third in a series of reports that the Center for Applied Demography & Survey Research (the Center) is releasing about jobs and Delaware's green economy. The research was funded through the American Recovery and Reinvestment Act and performed in collaboration with the Delaware Department of Labor.

Students, educators and policy makers all want to know what training will be needed for the green jobs of tomorrow. Like any other forecast, the answer depends fundamentally on events that have not happened. Fundamentally, which green jobs are needed will depend on which green products and services are demanded by households, businesses, and the government. In turn, that demand depends on future energy prices, household income and consumption habits, competing budget priorities, and politicking in the midst of an anemic recovery. Despite this uncertainty, it is probable that the educational system in the foreseeable future will resemble that of today. Policies designed to influence the educational institutions, either directly or indirectly, should understand that system. To assist in that regard, this report provides an in depth review of Delaware's green educational pipeline.

There are two main components in that pipeline; an academic one and a nonacademic one. The academic component is mainly concentrated between two institutions, Delaware Technical and Community College (DelTech) and the University of Delaware (UD). DelTech is the state's only community college and has a campus in each county. The college has an open admissions policy, so anyone who applies will be accepted. Nearly 95% of DelTech's students are Delaware residents.

UD is the state's flagship university. The main campus in Newark offers a diverse array of programs and majors. Satellite campuses in Wilmington, Dover, Lewes, and Georgetown offer more specialized curricula. UD is considered a "more selective" institution by the US News and World Report (*Best Colleges 2011*), and enrolled over 8,300 Delaware residents (37% of total enrollment) in 2010 (*Facts and Figures, Enrollment by Resident Status*).

Other institutions like Wilmington University, Delaware State University, Wesley College, and Widener School of Law also offer academic programs relevant to the green economy, but the enrollment in those programs is considerably much lower compared to DelTech and UD.

The academic pipeline begins with relevant diploma and certificate degree programs offered mainly at DelTech. The programs require less than two years of full-time study to complete, and are typically stripped down versions of a similar associate degree program. All relevant associate degree programs in the pipeline are also offered by DelTech. These programs mainly reflect engineering technologies, but they also include degrees in agriculture, chemistry, and biochemistry.

Bachelor degree programs make up the next stage of the academic pipeline. Although Delaware State University (DelState) and Wesley College offer relevant bachelor's degrees in green related fields, UD's scale is so large that it represents almost all of the green related bachelor's degrees. Bachelor programs with the greatest enrollment included majors in the natural sciences, engineering, agriculture, chemistry, biochemistry, wildlife, earth sciences, and the environment.

Master's and doctoral degrees are available for students that pursue the academic pipeline to its conclusion. UD and DelState offer graduate degrees in chemistry and biochemistry. These two institutions along with Wesley College also offer graduate degrees in natural resources, wildlife, earth, and the environment. UD also offers graduate degrees in agriculture, engineering, and public policy. Wilmington University provides graduate degrees in public policy, transportation and logistics, and even has an MBA program specializing in green business. For students interested in practicing environmental law, the Widener School of Law prepares students for such careers.

The other component of Delaware's green educational pipeline is vocational instruction. This is largely concentrated in careers in the construction industry. That training primarily refers to the electrical, plumbing, heating, ventilation, and air conditioning (HVAC), industrial maintenance, and general construction trades. Because the nature of this training is vocational, the size and scope of the nonacademic pipeline is especially influenced by the immediate business environment.

No one or two institutions dominate the vocational component of the green pipeline. DelTech offers a few associate degree programs related to HVAC technology, but mainly has specialized courses through its Corporate and Community Program. The adult education divisions within Delaware's vocational school districts¹ also offer technical training and coursework to persons interested in learning a trade. Trade unions also train workers with these skills. The Delaware Skills Center is the only nonprofit organization in the pipeline, and a handful of private businesses constitute the remainder. Vocational training is not as formalized as the academic degree sequences and can take anywhere from one day to five years to complete.

We do not consider two other areas where vocational skills are learned. The first is the non-adult divisions of Delaware's vocational high schools. These institutions fell outside the scope of this report, which was intended to focus primarily on postsecondary instruction. The second area excluded from the report is training that happens within businesses themselves. Although we expect that most vocational training occurs on the job, we do not have much information about this type of training.

The main objective in this report is to detail the educational system described above with a strong emphasis of the career implications. The report also adds context by discussing broader trends in the state, highlighting important concepts for consideration, and conveying the opinions of our educators to the public.

¹ The three districts include New Castle County Vocational Education School District, PolyTech School District, and Sussex Technical School District.

The report begins with a broad overview of the educational system in Delaware. In that review, we show up-to-date labor market conditions for persons of different educational backgrounds and review what is being taught in the state's postsecondary academic institutions. We detail the specializations of each institution, and explore trends in degree conferral over the last ten years.

In the second section, we describe the selection process used to label a particular academic degree as 'green'. Briefly, that process involved identifying green occupations and then referencing those occupations to existing educational programs in the state's pipeline. Further considerations were made for each program that narrowed down the list of instructional programs we included. While we are confident that the programs chosen represent the core skills discussed in the green literature, the list is not definitive. Different subjective interpretations could change which programs are considered.

Detailed information in each green area is presented in the third section of the report. We present information including enrollment size, degree conferral, the proportion of in-state students, gender composition, and the job placement success of recent graduates. We also report recent wage and employment patterns in Delaware for occupations that could be obtained with different types of instruction. The section finishes with a discussion of the wage differentials across different academic majors.

In the fourth section, we remark on important complementary topics. First, we discuss the effects that the recession has had on selected green occupations. Then we present the opinions of green businesses concerning which employee skills they thought were most relevant. Next, we present the opinions of academic and vocational instructors in the pipeline. Finally, we discuss the role of mathematics for students entering the pipeline.

The final section summarizes and concludes.

This report details the educational pipeline in Delaware as it relates to the green economy and green jobs. Every student who receives such training or a degree will not necessarily have a green job by conventional definitions. On the contrary, most vocational and academic programs discussed in this report prepare students for green and non-green jobs. However the programs detailed herein stood out as developing the core skills envisioned by the green literature to be important in the future. There is much uncertainty in that future, and this report intends to provide useful information in an area where facts are often lacking.

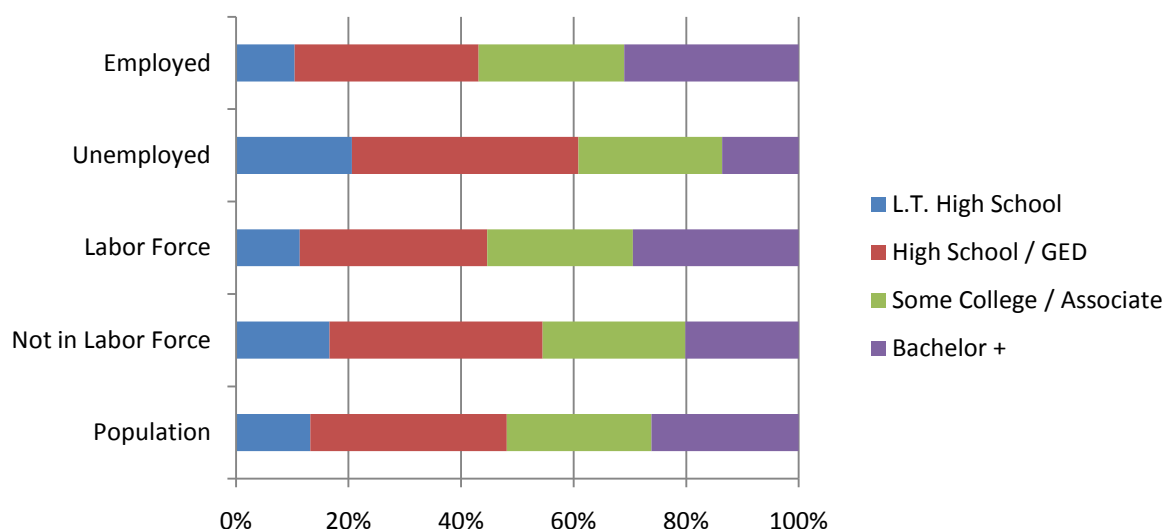
Overview of Important Trends in Delaware

We begin our analysis with an overview of important concepts and trends related to education and the Delaware economy. That information provides a useful context for considering programs in the green economy. First, we provide up-to-date statistics concerning the labor market conditions for persons with different educational backgrounds. Then we evaluate the trends and specializations of academic institutions in the state.

Labor Market Trends

In this section we briefly detail some of the major trends happening in Delaware's labor market for groups of people with similar levels of academic attainment. The trends reveal that economic conditions are generally worse for people with less education, and the current situation has made those conditions worse. We also show breakdowns of Delaware's industries and occupations by academic attainment.

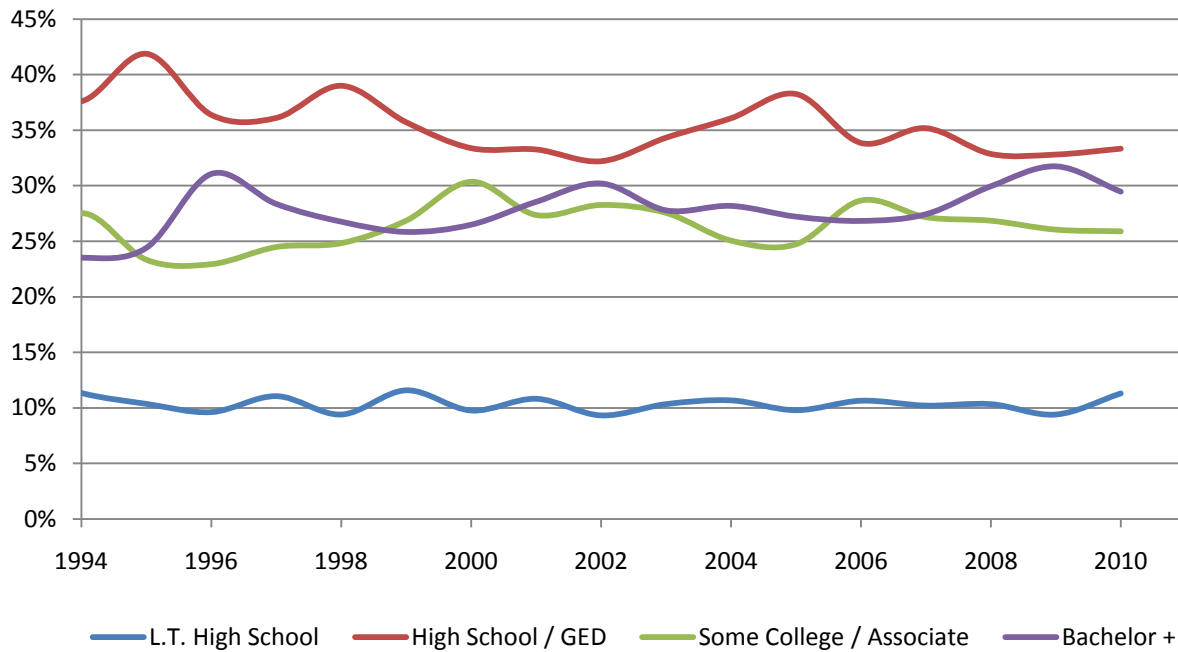
Figure 1 Composition of Delaware's Adult Population by Educational Attainment, March 2010



Source: 2010 Current Population Survey, March Supplement

Figure 1 indicates the educational backgrounds of Delawareans 19 years of age or older. The population is sorted into the employed, unemployed, those in the labor force, those not in the labor force, and the total population. Approximately 35% of Delaware's adults have a high school degree or equivalent degree, and 26% have a bachelor's degree or higher. Those without a high school degree make up 13% of the population and 11% of the labor force. As conventional wisdom tells us, the unemployed are overrepresented by persons who did not go to college, and the employed are overrepresented by persons with a bachelor's degree or higher level of attainment.

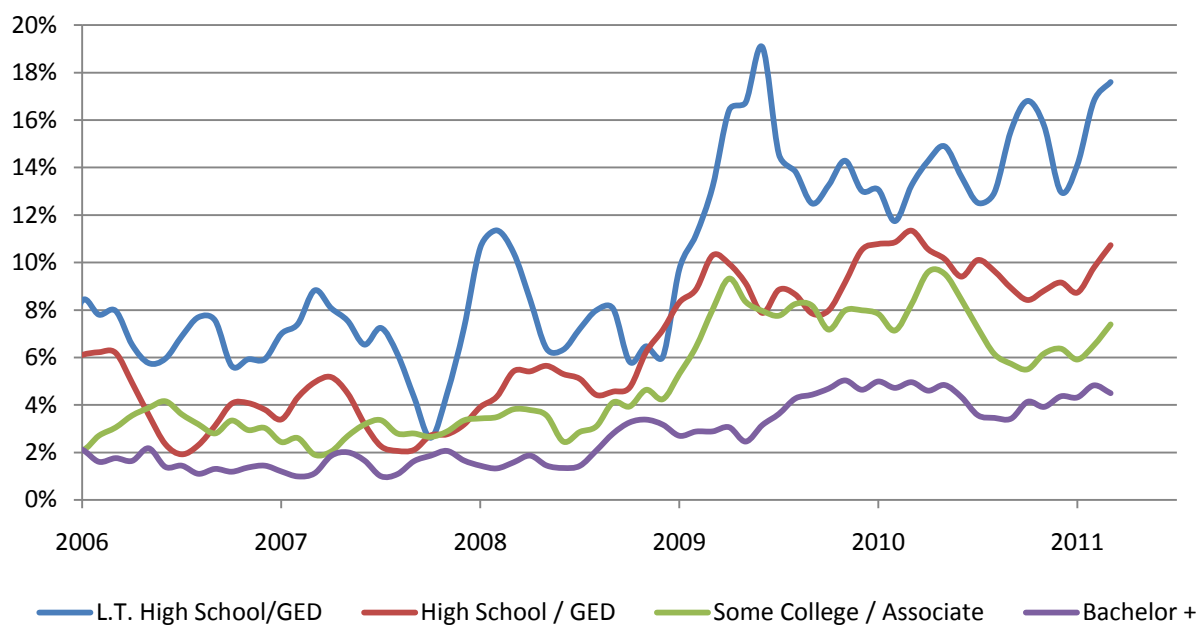
Figure 2 Percent of Delaware's Adults Labor Force Population by Educational Attainment, 1995-2010



Source: Current Population Survey, March Supplements, (1994-2010)

Figure 2 shows the trends in the composition of the adult labor force with respect to education. The number of people in the labor force with a high school education has fallen over time, while the number with some type of college degree has increased. Persons without a high school degree constitute a steady 10% to 11% of the labor force.

Figure 3 Unemployment Rate in Delaware by Educational Attainment, January 2006- March 2011

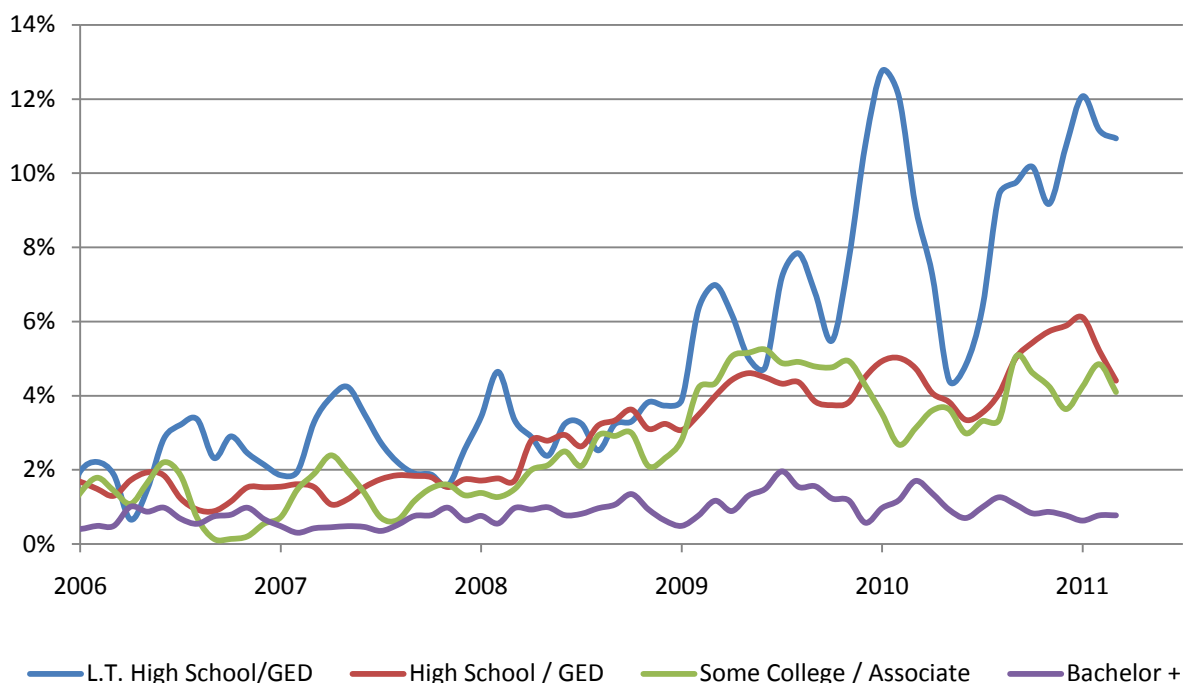


Source: Current Population Survey, Basic Monthly, (2006-2011)

The unemployment rate is calculated for persons with different levels of education in Figure 3.² The graph indicates that more educated persons are less likely to be unemployed. The graph also indicates just how severe the effects of the recession have been, particularly for those without a high school degree or equivalent. For these individuals, the unemployment rate is between 15% and 16%. Those with a bachelor's degree or graduate degree face rates below 5%.

² The graphs have been smoothed with a 3-month moving average. Most of the volatility reflects statistical uncertainty due to small sample sizes rather than actual swings in the labor market.

Figure 4 Working Part Time but Available Full Time: Percent of Employed Persons, Jan 2006- Mar 2011



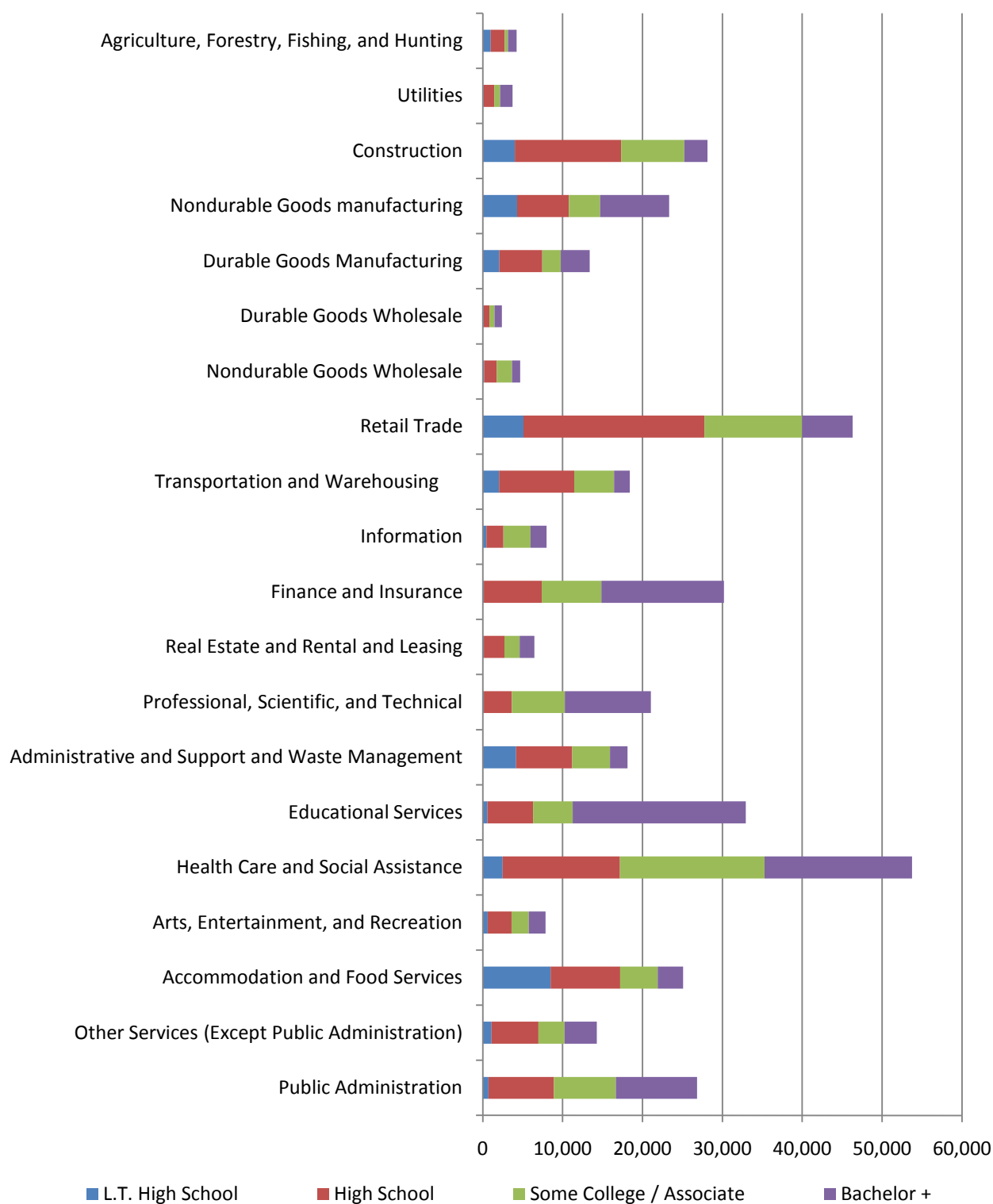
Source: Current Population Survey, Basic Monthly, (2006-2011)

For persons who were working in Delaware, Figure 4 shows the percent that were available for full time work but worked part time instead.³ Since the recession, persons with less than a high school education have had the least success in finding full time employment. Prior to the recession, 3% to 4% of employed people with less than a high school diploma worked part time but wanted full time work. More recently that figure is closer to 11%. Similarly, approximately 4% to 5% of employed persons with a high school degree or an associate's degree want to work full time, but can only find part-time employment. This is more than double since before the recession. Employed persons with a bachelor's degree or higher level of education have not been seriously affected in this regard.

³ The graphs have been smoothed with a 3-month moving average.

An Analysis of Delaware's Green Educational Pipeline

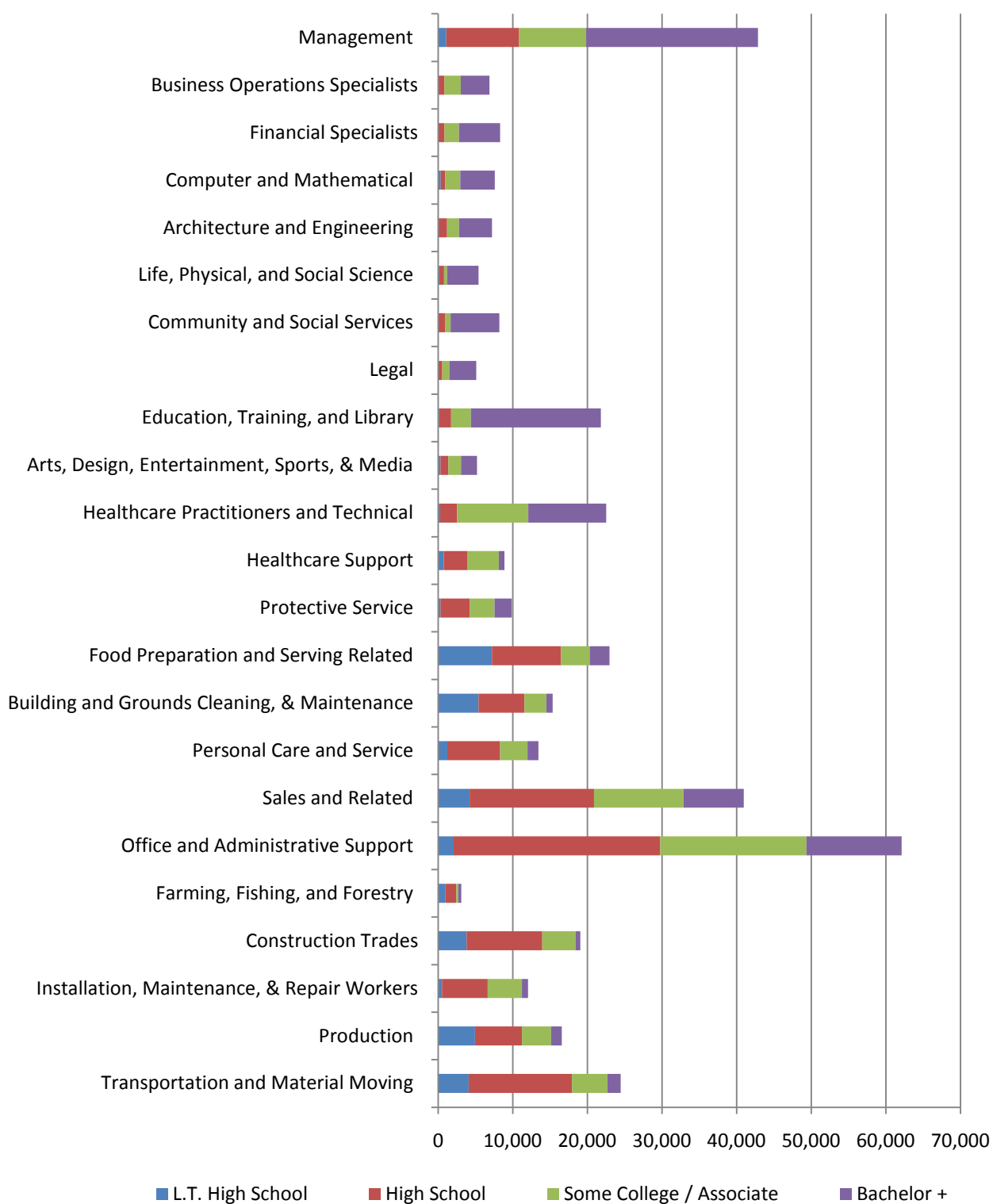
Figure 5 Delaware Employment Composition by Industry and Education, 2010



Source: 2010 Current Population Survey, Monthly Outgoing Rotation Groups

An Analysis of Delaware's Green Educational Pipeline

Figure 6 Delaware Employment Composition by Occupation and Education, 2010



Source: 2010 Current Population Survey, Monthly Outgoing Rotation Groups

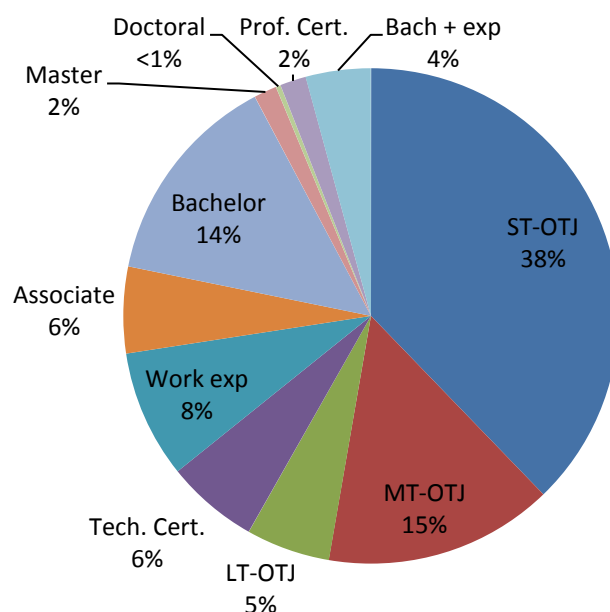
Figure 5 shows how industries in Delaware employ persons with differing levels of education. Persons not receiving a high school degree are concentrated in construction, manufacturing, retail trade, administrative support and waste management, and accommodation and food services. Persons with high school degrees, some college experience, or associate's degrees are more evenly distributed throughout industries in Delaware. Persons who attained bachelor's or graduate degrees tend to be concentrated in finance and insurance, professional, scientific, and technical services, educational services, and health care and social assistance.

Figure 6 decomposes Delaware employment by education and the type of occupation. Persons without a high school diploma are most likely to be in the production and support occupations in the bottom half of the figure. Those with a high school diploma, some college experience or an associate's degree also tend to be in these occupations. Persons with a bachelor's degree or graduate degree tend to be in managerial and technical occupations listed in the upper half of the figure.

Using a previous survey of Delaware businesses, we identified that most of the green businesses were in the construction, professional, scientific, and technical services, and administrative and support and waste management industries. In addition, most of the occupations were in the construction trades, architecture and engineering, office and administrative support, and installation, maintenance, and repair occupations.

Based on this decomposition, we conclude that green businesses employing persons with less than high school educations will most likely be in construction or waste remediation. Persons who work in green businesses and have high school degrees or higher level of education could find employment in a wider set of industries. Persons with bachelor's degrees working for green businesses will most likely find work in engineering or related occupations.

Figure 7 Composition of Minimum Educational Requirements for Delaware Occupations, 2010



Source: Delaware Occupational Employment Statistics, 2010 and Bureau of Labor Statistics Employment Projections, 2008: Table 1.11

Figure 7 shows what type of occupations exist in Delaware based on the minimum expected level of education or training. Occupations requiring short term or medium-term on-the-job training constitute just over half (53%) of Delaware's employment, and 22% of employed Delawareans are in occupations that require four year bachelor's degrees or higher level of education.

Next, we turn our attention to describing the trends occurring within Delaware's academic institutions. As in this section, the goal is to give context to those programs and degrees to be discussed later in the report.

Educational Trends for Academic Degrees

This section establishes a baseline of educational activity and reveals important trends about the kind of degrees coming out of Delaware academic institutions. The analysis shows how the educational pipeline is changing, what topics are attracting students, and in what areas Delaware institutions specialize. Owing to the distributed and diverse nature of on-the-job training and non-degree certification, we could not find data compiled for non-academic instruction.

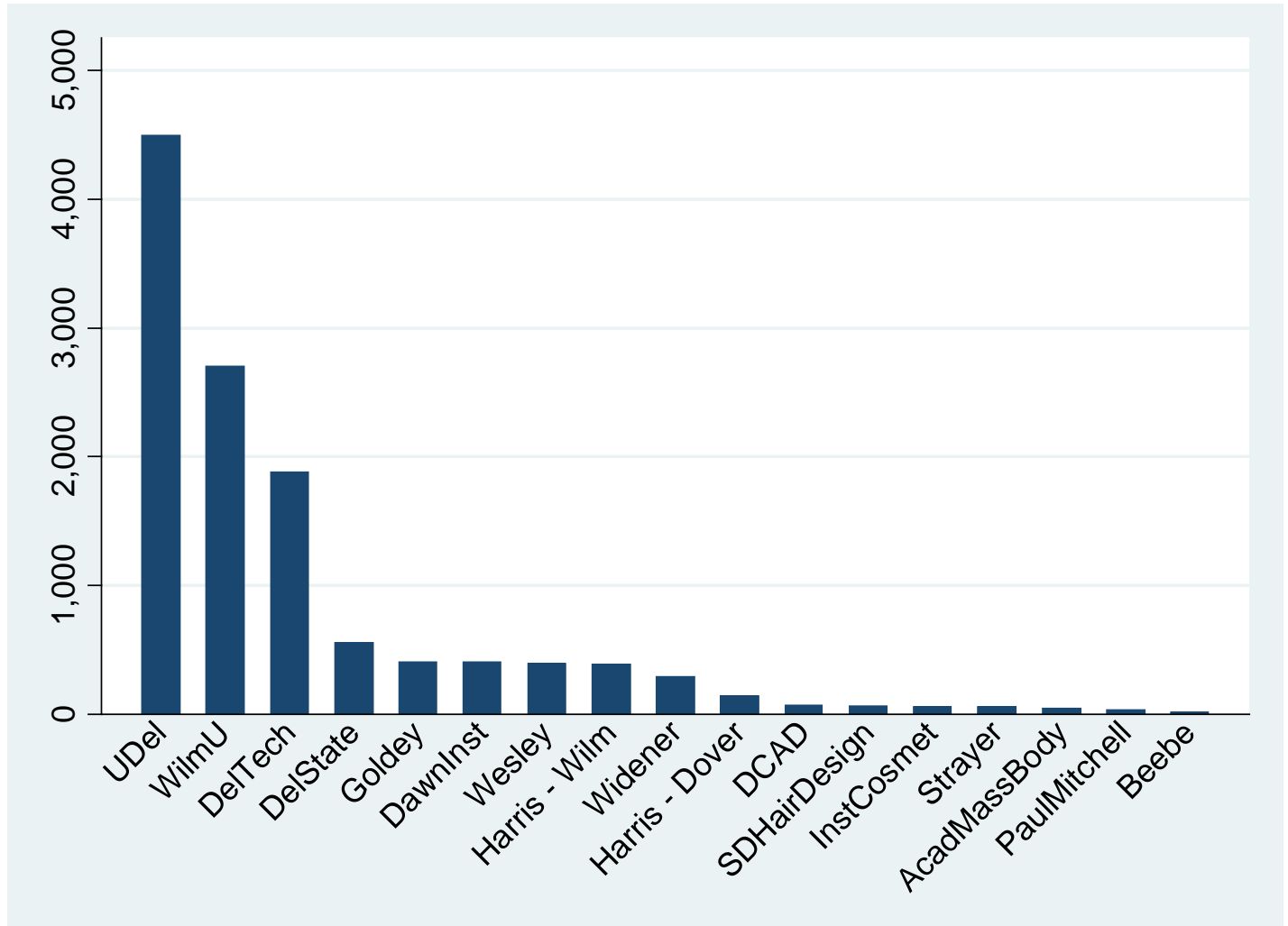
The analysis in this section uses data obtained from the Integrated Postsecondary Educational Data System (IPEDS) database. The database collects institutional characteristics, including student enrollment, graduation rates, tuition, student aid, faculty salaries, etc. All educational institutions eligible to receive federal assistance for student aid are required to submit such information annually.

Figure 8 shows the total number of degrees awarded by Delaware's postsecondary educational institutions.⁴ In 2010, these institutions granted 12,053 degrees. The University of Delaware (UDel), Wilmington University (WilmU) and the three Delaware Technical and Community College campuses (DelTech) awarded approximately 75% of those degrees. Delaware State University (DelState), Goldey Beacom College, the Dawn Institute of Technology, Wesley College, the Harris School of Business – Wilmington Campus, and Widener University School of Law comprise the next 20% of degrees awarded.

⁴ Degree completions apply to the 2009-2010 academic year and are for first majors only.

An Analysis of Delaware's Green Educational Pipeline

Figure 8 Total Number of Degree Completions by Delaware's Postsecondary Educational Institutions: 2009-2010



• Source: Integrated Postsecondary Data System (IPEDS), National Center for Education Statistics

Table 1 further classifies each degree into the following categories.

1. Certificates requiring less than one year of training
2. Certificates requiring more than one but less than two years of training
3. Associate degrees
4. Bachelor degrees
5. Master degrees
6. Doctoral degrees

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Table 1 Vocational/Educational Degrees Completions by Delaware's Postsecondary Institutions: 2009-2010

Postsecondary Educational Institution	Type	Certificate less than 1 year	Certificate more than 1 and less than 2 years	Associate* degree	Bachelor degree	Master Degree	Doctoral** degree
University of Delaware	1			254	3,361	652	230
Wilmington University	1			73	1,276	1,321	37
Delaware State University	1				436	116	7
Goldey Beacom College	1			26	139	242	
Wesley College	1			52	263	82	
Widener University - Delaware	1			3	17	22	254
Strayer University - Delaware	1			16	13	30	
Beebe Hospital School of Nursing	2			21			
Delaware Technical and Community College - Owens	2	183	305	421			
Delaware Technical and Community College - Terry	2	11	75	285			
Delaware Technical and Community College - Stanton/Wilm.	2	48	34	522			
Delaware College of Art and Design	2	10		60			
Harris School of Business - Wilmington	3	16	373				
Harris School of Business - Dover	3	114	31				
Delaware Learning Institute of Cosmetology	3	35	27				
Schiller Douglas School of Hair Design	3	6	63				
Academy of Massage and Bodywork	3	46					
Dawn Career Institute, Inc	3	407					
Delaware Academy - Paul Mitchell Partner School	3		38				
Total	n.a.	876	946	1,733	5,505	2,465	528

Source: Integrated Postsecondary Data System (IPEDS), National Center for Education Statistics

* includes certificates of more than two years and less than four years of education

** includes professional certificates

Based on the decomposition in Table 1, we group Delaware's postsecondary institutions into three types of schools: those that award associate or higher degree levels (type 1), those that award certificates requiring less than two years of training and associate degrees (type 2), and those that only award certificate degrees requiring less than two years of training (type 3).

Type 1 institutions award the largest number of degrees in the state. The University of Delaware awards the most, followed by Wilmington University, and then Delaware State University. Type 2 institutions are dominated by the three Delaware Technical and Community College campuses (Owens, Terry, and Stanton/Wilmington). The largest type 3 institutions include the two Harris School of Business campuses (Wilmington and Dover) and the Dawn Career Institute.

The IPEDS database also lists the total degree completions by the Classification of Instructional Programs (CIP). The CIP is an index of academic, vocational and technical instructional programs with more than 1,800 categories. Delaware institutions reported 463 different CIP codes (at varying level of awards) which we organized into 32 categories. Our organization was chosen to group similar fields together as well as single out potentially green fields of study. For example, our organization of the CIP classification differentiated natural resource economics from general economics, logistics from business management, and biotechnology from biomedical technology.

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Table 2 Degree Completions by Award Level and Field: 2009-2010

	Pot. Green	Cert. <1 year	Cert. < 2 years	AA/AS*	BA/BS	MA/MS**	PhD / JD
Accounting/Finance/Economics			25	60	541	209	2
Agriculture	Y			15	105	20	1
Arts and Theatre		4		76	92	19	3
Aviation					15		
Business Mgmt & Logistics		2	64	228	563	479	
Chemistry, Biology, Biochemistry	Y		3	23	228	21	32
Administrative / Medical Records		304	288	9	1		
Communication				21	201	5	
Computer Sci. / Info Mgmt		7		42	149	104	6
Consumer Econ / Fashion					87	1	
Criminal Justice		1		77	211	55	2
Cultural Studies					44		
Education		2	13	97	329	855	75
Engineering & Engineering Tech.	Y	4	22	130	232	66	48
Food & Nutrition					74	8	
History					161	25	3
Hotel/Hospitality				23	83	4	
Language & Literature		82			235	34	4
Legal	Y	24		14	64	22	254
Marketing			21	11	267	57	
Mathematics / Physics				4	62	17	9
Music					60	6	
Nat Resource Econ / Op Research	Y			7	16	24	
Nursing & Health		155	301	413	433	182	
Other Social Sciences				303	257	12	16
Physical Ed. / Sports		11		36	205	18	30
Wildlife, Earth, Environment	Y			3	78	24	17
Policy & Administration	Y				7	66	11
Political Sci. and Intn'l Relations					183	9	5
Psychology / Development		5	27	81	522	121	10
Construction	Y	118	29	60			
Beauty / Personal Service		157	153				
Total		876	946	1,733	5,505	2,465	528

Source: Integrated Postsecondary Data System (IPEDS), National Center for Education Statistics

* includes certificates of more than two years and less than four years of education

** includes professional certificates

Table 2 shows the results of that categorization and how many degrees had been completed in the 2009/2010 academic year.⁵ Certificate programs requiring less than two years of training are generally confined to nursing and health, administrative assistance and medical billing, construction, and beauty and personal services areas. Degrees awarded at the associate, bachelor, and master levels are more distributed. There are large concentrations in accounting, finance, and economics, business management, education, engineering, nursing and health, psychology, and other social sciences. Doctoral degrees are concentrated in chemistry, biology, and biochemistry, engineering, education, physical education/athletic therapy, and law.

Figure 9 shows the trends in degree conferral over the last decade for the certificate degrees.⁶ There has been strong growth in certificate completions related to nursing and health care, beauty and personal service, administration and medical records, and construction. Fewer certificate programs are being completed in agriculture, education, and information management than in 2000.

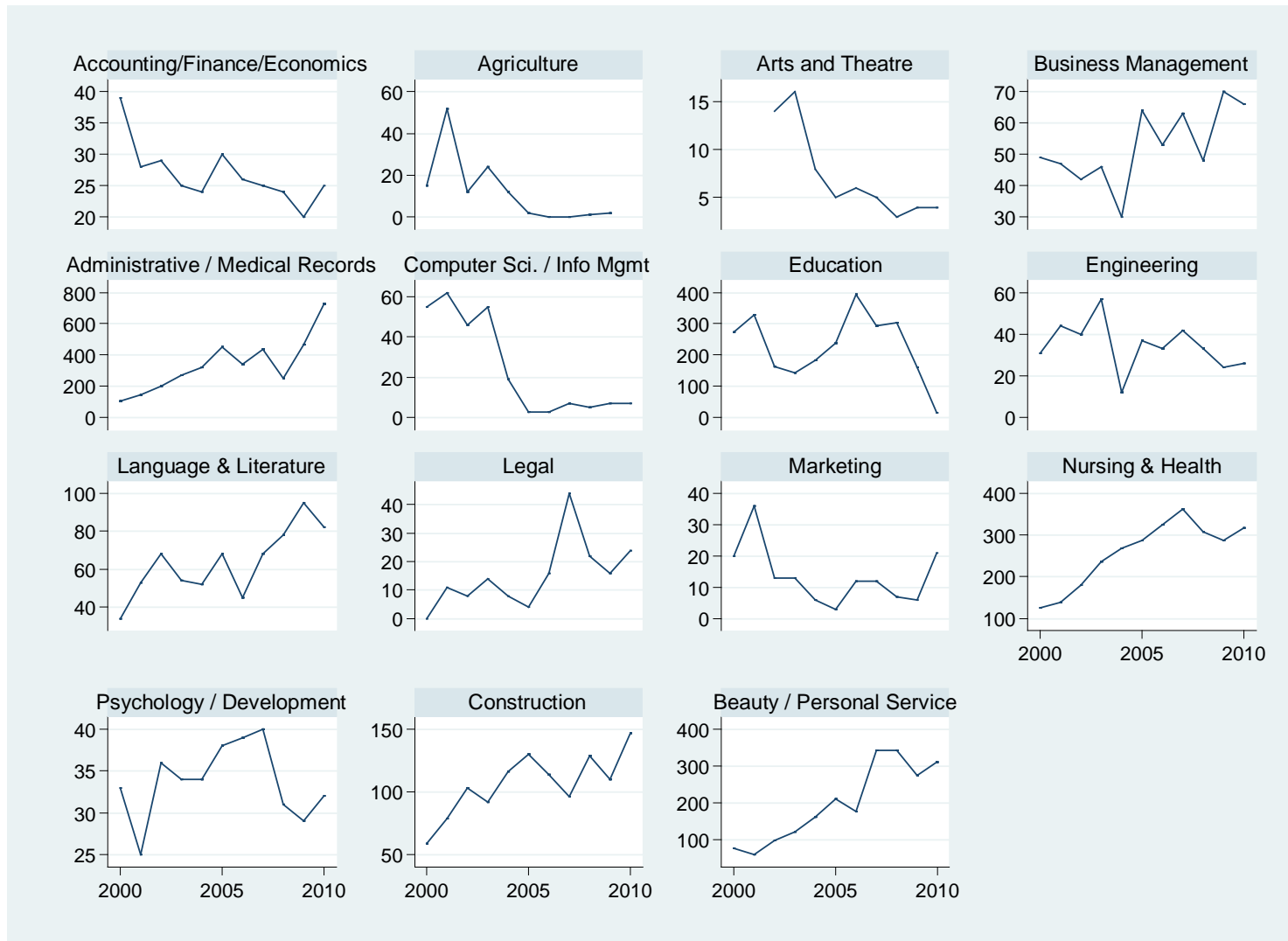
Figure 10 shows the trends of associate degrees awarded over the last 10 years. Areas with the strongest growth are in business management, education, nursing and health, and other social sciences (general liberal arts). Associate degrees in criminal justice, computer science, and marketing have been declining over the last decade.

⁵ First majors only

⁶ Universities occasionally change the CIP codes that they report over time leading to the possibility of artificial swings in degree conferral. While some of this undoubtedly remains, care was taken to minimize such swings.

An Analysis of Delaware's Green Educational Pipeline

Figure 9 Certificate (< 2 years) Degree Completions Awarded by Delawarean Postsecondary Institutions, 2000-2010



Source: Integrated Postsecondary Data System (IPEDS), National Center for Education Statistics

An Analysis of Delaware's Green Educational Pipeline

Figure 10 Associate Degree Completions Awarded by Delawarean Postsecondary Institutions, 2000-2010



Source: Integrated Postsecondary Data System (IPEDS), National Center for Education Statistics

The trends in Delaware's bachelor degree completions can be seen in Figure 11. There is widespread growth in most fields. However, degrees in consumer economics and fashion, as well as agriculture, wildlife, earth, and environmental science have been in decline over the last ten years. These latter two fields are quintessentially green.

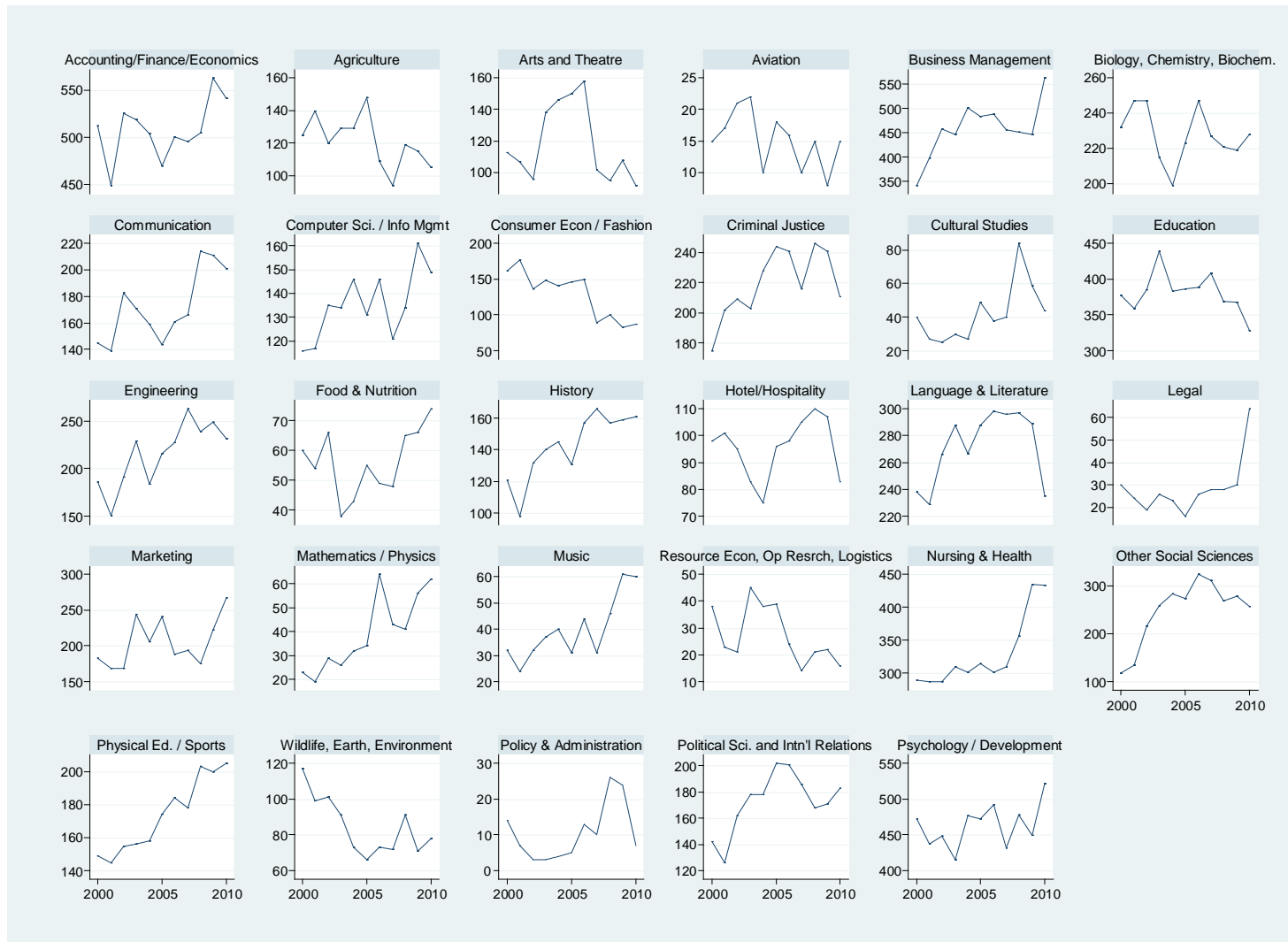
Figure 12 plots the number of master degree completions. There is more volatility from one year to the next indicating the relatively smaller number of graduate students. There has generally been strong growth across many of these categories; history being the only field clearly experiencing declines. Degrees in education are the most common graduate degrees awarded in Delaware, and their growth has been quite rapid over the last decade. Master's degrees in accounting, finance, and economics, computer science and information management, business management, nursing and health, and psychology have also shown positive trends over the past decade.

Finally, Figure 13 shows the trends of doctoral level degrees by category.⁷ Legal degrees are clearly the most common type. However, doctoral degrees in education have increased sharply since 2005. At the doctoral level, degrees in biology, chemistry and biochemistry and engineering have steadily increased between 2000 and 2010.

⁷ Professional certificates are included in this category, primarily capturing J.D. degrees.

An Analysis of Delaware's Green Educational Pipeline

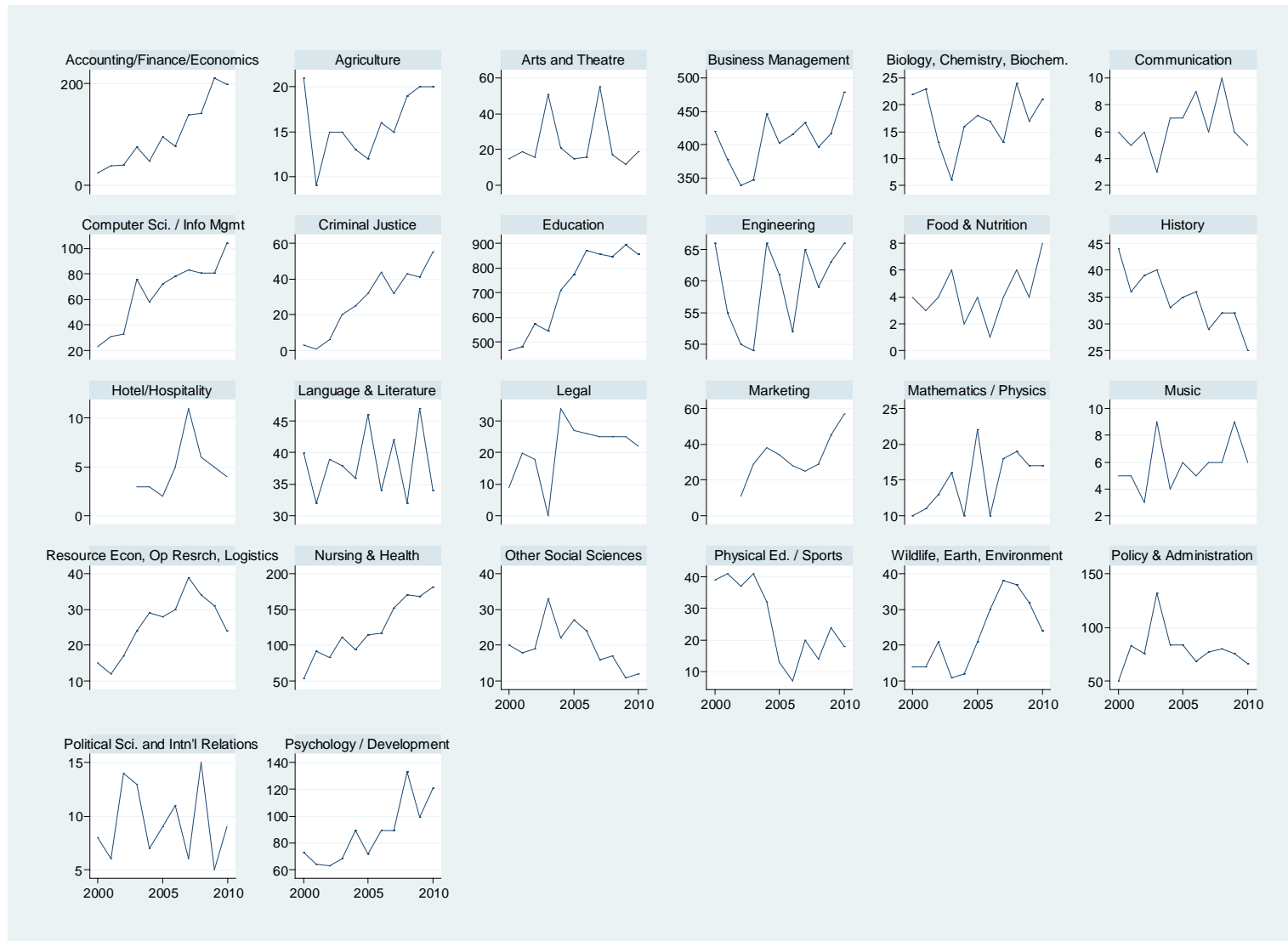
Figure 11 Bachelor Degree Completions Awarded by Delawarean Postsecondary Institutions, 2000-2010



Source: Integrated Postsecondary Data System (IPEDS), National Center for Education Statistics

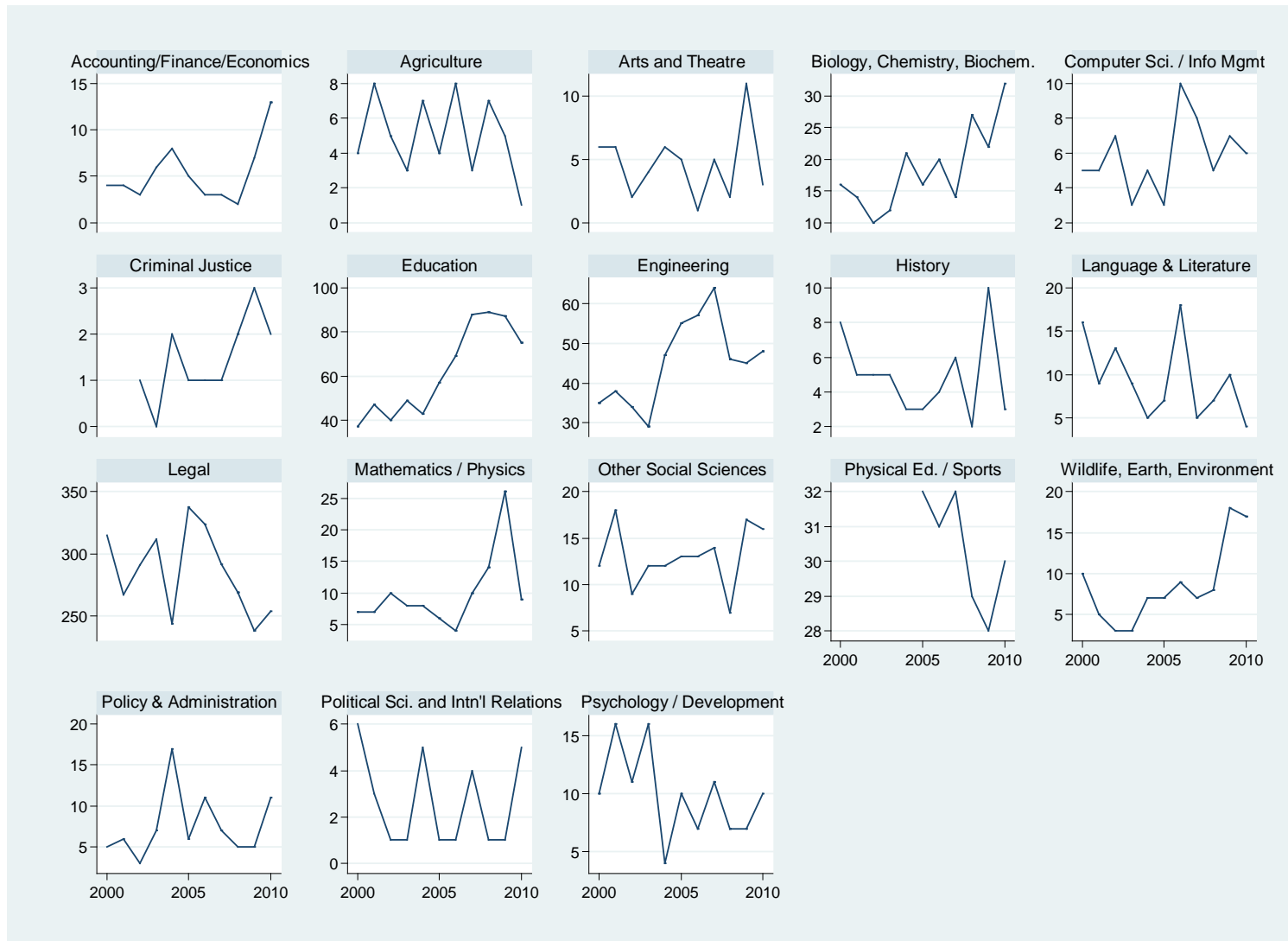
An Analysis of Delaware's Green Educational Pipeline

Figure 12 Master Degree Completions Awarded by Delawarean Postsecondary Institutions, 2000-2010



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Figure 13 Doctoral Degree Completions Awarded by Delawarean Postsecondary Institutions, 2000-2010



Source: Integrated Postsecondary Data System (IPEDS), National Center for Education Statistics

To summarize, the type of educational degrees being conferred by Delaware institutions is transforming. More students are receiving certificate degrees in beauty and personal services, administrative assistance and medical records, and nursing and healthcare than in the past. Business management and nursing and health care dominate the growth in associate degree programs, while degrees in computer science have been declining. At the bachelor's level, nursing, business management, and other social sciences (e.g. liberal arts) have grown the most since 2000. The rapid growth of master and doctoral degrees in education is clearly the biggest change affecting graduate studies in Delaware.

Changes are also underway for green related areas. Degrees in construction and engineering technology have been on the rise in the certificate and associate degree levels. Engineering degree conferral has also been increasing at both the bachelor and doctoral levels. Conference of bachelor degrees related to wildlife, earth, and the environment is actually lower than in 2000, but more graduate degrees are being conferred today than in the past.

Table 32 through Table 37 in the appendix show how many of each type of degree were awarded in 2010 at each institution.

Degrees Relevant to Green Occupations

In the previous section, we alluded to some educational categories as being green. In this section, we describe how and why we identified certain programs in the green pipeline.

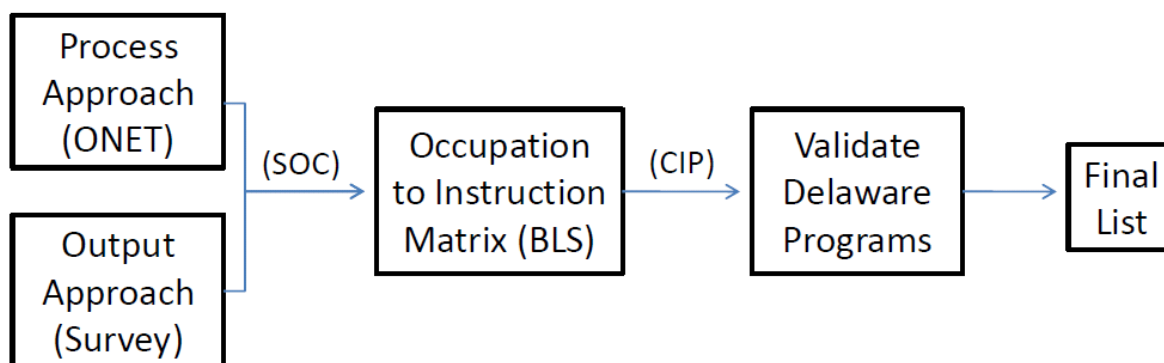
Figure 14 is a diagram outlining the process used to identify a green degree. That process begins by identifying a set of occupations previously labeled as green. Research conducted by ONET Online provided one list of green occupations, and a survey that our Center conducted of green businesses in Delaware provided the other list. These occupations (SOC code) were then cross-listed with instructional programs (CIP codes) using a referencing matrix developed by the Bureau of Labor Statistics and the Department of Education's National Center for Education Statistics.⁸

Next, that list of implied instructional programs was validated for Delaware's educational system. Our validation process involved a number of decisions. First, at least one Delaware institution had to offer the instructional program and at least one student had to be enrolled in it. Instructional programs were identified in academic postsecondary institutions, adult education divisions of vocational schools districts, trade unions, and other training institutions accredited by Delaware's Workforce Investment Board. In addition, the level of instruction had to be at a level that was in range of the respective green occupation's minimum requirements.⁹

⁸ See "SOC 2010 to CIP 2010 Crosswalk" at <<http://nces.ed.gov/ipeds/cipcode/resources.aspx?y=55>>.

⁹ Requirements were obtained from the Bureau of Labor Statistics' Employment Projections. <http://www.bls.gov/emp/ep_table_111.htm>.

Figure 14 Process Used to Identify Green Programs



Once that list of instructional programs was in place, we used website searches and surveys to determine whether the type of instruction should be considered green. The decision whether to include or exclude a CIP code applied to all institutions. For example, if three separate departments offered a degree in the same major, either all or none of the departments were considered green. That decision was made to avoid singling out particular departments or programs as green in one college, but not in another.

Ultimately the selection process was subjective and influenced by what is perceived to be green. In general, no report that assigns green labels can escape that criticism. However, the following three factors increased the chances that a field would be labeled as green:

- 1) Many green occupations mapped to a program in that field.
- 2) Curriculum or faculty research focused on energy-efficiency, renewable energy, natural resource conservation, recycling and pollution reduction, control, or remediation.¹⁰
- 3) Promotional material related to green careers/skills aligned with established green literature.¹¹

¹⁰ The Bureau of Labor Statistics' green definition defined these categories. (see *Measuring Green Jobs*, 2011)

¹¹ See Brown and Ratledge (2011) for a discussion of green literature.

It was often difficult to decide whether an instructional code was “green enough” to merit that notation. For example, many green occupations referenced degrees in business management, and one Delaware institution even offered a master’s of business administration in environmental stewardship.¹² However, business management degrees were fairly ubiquitous among Delaware institutions, ranging from certificates that took less than one year to complete through doctoral programs. In addition, no other institutions in Delaware offered such a specialized degree sequence.

The tradeoff described in the previous paragraph is referred to as ‘aggregation bias’, a problem arising when the system used to identify something specific is too broad. Examples of aggregation bias can be found in other areas of the green jobs literature, not just the instructional programs. If future research into “green” education is desired, then a new system of classifying programs based on green characteristics needs to be developed and put into practice.¹³

Identifying Instructional Programs Available for Green Jobs

Green jobs are most often defined in the literature using either a “process approach” or an “output approach”. Under the process approach, occupational experts label work activities as being green. Under the output approach, goods and services are either green or not. As an example of this difference, an energy auditor is always considered green in the process approach, since performing energy audits is a green work activity. However, under the output approach, the auditor would only be classified as green if the company he worked for sold green goods or services. In the latter interpretation, green is defined by the output that is made, not the work that is done.

¹² http://www.wilmu.edu/business/mba_concentration_environmental.aspx

¹³ Alternatively, that aggregation bias can be reduced if it can somehow be measured.

The Process Approach

O*NET Online (ONET) is a quasi-governmental organization funded through the U.S. Department of Labor's Employment and Training Administration. ONET collects occupationally related information, including which knowledge, skills, and abilities are important to different occupations and what work activities each performs (*O*NET Resource Center*).¹⁴ Occupations are codified using an extension of the standard 6-digit SOC system.

In a 2009 report ONET provides a nuanced definition of a green job (Dierdorff et al., 2009). Instead of classifying an occupation as either green or non-green, ONET classifies occupations as “greening”. Their distinction highlights the fact that work activities change over time, and that the types of work activities envisioned for the future green economy may not be properly defined by existing occupations.

According to ONET,

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

¹⁴ Though ONET is a private organization, it receives its funding by the Department of Labor and the Employment Training Administration.

In short, ONET classifies green occupations into three groups. The first group includes occupations that exist today and are thought to be relevant to a greener economy in the future. The second group includes those occupations that will need to update their skill sets in order to perform green work activities in that future. The remaining green occupations are anticipated to be so different from today's workers that a new occupation needs to be defined to properly characterize their role.

Table 38 in the appendix shows which green occupations are attainable from Delaware's existing educational pipeline. The first column indicates the minimum education or training needed for that job type. The second column lists the occupation deemed green by ONET. The terms in parentheses indicate whether the occupation was classified as "increased demand" (ID), "enhanced skills" (ES), or "new and emerging" (NE). The third column lists what vocational or academic field contains the instructional programs.

Green jobs requiring on-the-job training or technical certification are mostly found in the construction and trades. These are also the most recognizable green jobs.¹⁵ For example, solar panel installers, wind turbine maintenance technicians, and weatherization installers are included in this list. So too are the standard trade occupations, such as electricians, carpenters, plumbers, and HVAC technicians. Most of the green occupations requiring an associate's degree are technicians or technologists requiring a background in chemistry, biochemistry, or engineering.

For green jobs requiring a bachelor's or graduate degree, fields in engineering, wildlife, earth and the environment were most common in the process approach. Economics, accounting, and finance, as well as natural resource economics, operations research, and logistics were also common areas to find more academic green jobs.

¹⁵ ST-OTJ: short term on-the job training; MT-OTJ: medium term on-the-job training; LT-OTJ: long term on-the-job training

The top five most common educational areas in Delaware for green occupations are:

- 1) Engineering and engineering technology
- 2) Construction and trades
- 3) Wildlife, earth, and environmental science
- 4) Business management
- 5) Chemistry and biochemistry

The Output-Approach

Under the output approach, a list of green occupations was obtained from an earlier survey performed by our Center. In that survey, businesses were identified as green based on the output they sold. Supplemental information on those businesses' occupational profiles was used to identify the most common jobs among Delaware's green businesses (Brown and Ratledge, 2011). Occupations employed by Delaware's green companies were cross referenced with the technical training or academic degrees available in Delaware.

Table 39 in the appendix lists those occupations that mapped to an instructional program offered in Delaware's pipeline. The minimum required level of education and the rank of how common each occupation was among Delaware's green businesses is included. The final column indicates which type of instructional program offered in Delaware could prepare workers for those occupations.

The most common subject areas that prepare workers for green jobs requiring on-the-job training or technical certification are in construction, engineering technology, and administrative fields. Green occupations that are attainable with an associate's degree are primarily in the engineering technology. Common occupations requiring a higher degree were most often found in engineering, wildlife, earth, and environmental science as well as business management, accounting, finance, and economics.

Those educational backgrounds that prepare workers for green occupations according to the output-approach are most commonly found in:

- 1) Engineering and engineering technology
- 2) Construction and trade
- 3) Business management
- 4) Wildlife, earth, and the environment
- 5) Natural Resource Economics, Operations Research, and Logistics (tied)
- 5) Chemistry and Biochemistry (tied)

Selection of Green Academic Programs

Once the initial list of green CIP codes was developed, we conducted a search of academic program curricula, faculty research, student career paths, and descriptions of academic majors and minors to validate whether a particular type of instructional program should receive the green label. We specifically looked for connections with energy efficiency, renewable energy, environmental processes, pollution remediation and control, recycling, or natural resource conservation. Such distinctions were often evident through a program's curriculum or were explicitly touted on websites.

Based on our review, we identified many different instructional programs in engineering, agriculture, chemistry, biochemistry, public policy, natural resource economics, and wildlife, earth, and environmental sciences that seemed particularly relevant.

Ultimately, our definition of the green pipeline did not include programs in accounting, general economics, finance, marketing, and communication because we could not find evidence that the curricula or faculty research was explicitly tied to one of the aforementioned green areas. In addition, many of the occupations that linked to these fields required work experience on top of a college degree, so it was difficult to say how or where these green skills developed. For these reasons and because of the perceived degree of aggregation bias that would result, we also decided not to label business management as a green field.¹⁶

We also debated whether programs in operational efficiencies should be classified as 'green'. On the one hand, enhanced productivity is something sought by all businesses in pursuit of profits, and so was not particularly green. On the other hand, eliminating inefficiencies means that more output can be produced with fewer resources, and using fewer resources is a central tenant of 'going green'.¹⁷ In addition, courses in operations research were taught by the same faculty who were involved in natural resource economics. Consequently, we included degree programs in supply chain management, logistics, operations research/management, and statistics.

¹⁶ This decision eliminated two potential business management programs from our consideration. Wilmington University offered an MBA program in environmental stewardship and the University of Delaware's MBA program offered an elective course in sustainability and green business.

¹⁷ There is dispute as to whether efficiencies reduce input use. Known as the 'output effect', increased efficiencies could cause businesses to use more inputs in order to produce more output and sell it in the market.

Next we detail which instructional programs and CIP codes were included in Delaware's green educational pipeline. A brief explanation details why these programs were perceived as green. The 'Available Degrees' sections in the following tables signify programs where students are enrolled.

For shorthand notation, the tables refer to the following

N - Non-Degree Certificate

C - Certificate/Diploma Degree

A - Associate's Degree

B - Bachelor's Degree

M - Master's Degree

P - Doctoral Degree

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Agriculture

Besides mining and energy, agriculture is the only other industry that directly uses natural resources. Because both crops and wildlife compete for the same resources, agricultural degrees implicitly teach how natural resources should be managed. Specialized curricula teaching alternative (e.g. organic) production methods are cited as justifications for being green.

Table 3 Relevant CIP Codes Available from Delaware Institutions: Agriculture

01.0000	Agriculture, General	01.0605	Landscaping and Groundskeeping
01.0101	Agricultural Business and Management, General	01.0607	Turf and Turfgrass Management
01.0301	Agricultural Production Operations, General	01.1105	Plant Protection & Integrated Pest Management
01.0401	Agricultural and Food Products Processing	04.0601	Landscape Architecture
01.0601	Applied Horticulture/Horticulture Ops, Gen	01.1101	Plant Sciences, General.
01.0901	Animal Sciences, General.	01.1199	Plant Sciences, Other.

Table 4 Relevant Degrees Available from Delaware Institutions: Agriculture

Institution	Department	Major / Concentration	Available Degrees			
			A	B	M	P
DelState	Agriculture & Natural Resources Dept	General Agriculture		x		
		Plant Science			x	
DelTech	Agribusiness Management Program	Agribusiness Management	x			
		Landscape/Ornamental Horticulture	x			
		Production	x			
		Turf Management	x			
UDEL	Animal and Food Science Department	Animal and Food Sciences		x		
		Animal Science		x	x	x
	Dept of Entomology and Wildlife Ecology	Plant Protection		x		
	Food and Resource Economics Dept	Agricultural & Technology Education		x	x	
		Agricultural Education		x	x	
		Food & Agribusiness Mktg & Mgt		x		
	College of Agriculture & Natural Resources	Agriculture & Natural Resources		x		
	Plant and Soil Sciences Department	Landscape Horticulture / Hort.& Design		x		
		Plant Science & Plant and Soil Sciences		x	x	x
		Public Horticulture			x	

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Chemistry and Biochemistry

Chemistry and biochemistry are often considered green for their role in advancing green technologies, including biofuels, fuel cells, energy efficiency, and recycling processes. Chemists and biochemists are instrumental to the research and development of these technologies. Fields in biology and anatomical sciences were not given a green label, as these curricula tended to focus on health, medicinal, epidemiological and pharmaceutical related issues.

Table 5 Relevant CIP Codes Available from Delaware Institutions: Chemistry and Biochemistry

26-0202	Biochemistry	41-0101	Biology Technician/Biotechnology Laboratory Tech.
40-0501	Chemistry, General	41-0301	Chemical Technology/Technician
40-0599	Chemistry, Other	41-9999	Science Technologies/Technicians, Other

Table 6 Relevant Degrees Available from Delaware Institutions: Chemistry and Biochemistry

Institution	Department	Major / Concentration	Available Degrees			
			A	B	M	P
DelState	Department of Biological Sciences	Biotechnology		x		
	Department of Chemistry	Applied Chemistry			x	x
		Chemistry		x	x	
		Chemistry Education		x		
		Chemistry/Pre-Professional		x		
DelTech	Department of Biology and Chemistry	Biotechnology	x			
		Biotechnology - Biological Science Option	x			
		Chemical Process Operator	x			
		Chemistry	x			
		Chemistry/Math Concentration	x			
	Medical Laboratory Technology Dept	Biotechnology	x			
		Biological Sciences	x			
UDEL	Dept of Chemistry and Biochemistry	Biochemistry		x		
		Chemistry		x		
		Chemistry and Biochemistry			x	x
		Chemistry Education		x		
Wesley	Science Department	Biology & Biological Chemistry		x		

Engineering & Engineering Technologies

Engineering and engineering technology departments have the greatest number of instructional codes. Electrical, civil, mechanical, and chemical engineering play a critical role in developing and implementing new green technology. As examples, electrical engineers work on smart grid technologies, civil engineers design sustainable buildings and construction projects, mechanical engineers design and implement energy-saving recommendations in the industrial sector, and chemical engineers and material scientists find processes that improve the efficiency of photovoltaic solar panels. Engineering technicians and technologists implement these technologies in an industrial or construction setting.

Table 7 Relevant CIP Codes Available from Delaware Institutions: Engineering and Engineering Technologies

14-0101	Engineering, General	40-1001	Materials Science
14-0701	Chemical Engineering	15-0499	Electromechanical and Instrumentation and Maintenance Technologies, Other
14-0801	Civil Engineering, General	15-0805	Mechanical Engineering/Mechanical Technology
14-1001	Electrical and Electronics Engineering	15-1201	Computer Engineering Technology
14-1901	Mechanical Engineering	15-1301	Drafting and Design Technology, General
15-1001	Construction Engineering Technology	15-1302	CAD/CADD Drafting and/or Design Technology
15-0101	Architectural Engineering Technology	15-1304	Civil Drafting and Civil Engineering CAD/CADD
15-0303	Electrical, Electronic and Communications Engineering Technology	15-1306	Mechanical Drafting and Mechanical Drafting CAD/CADD
15-0201	Civil Engineering Technology	40-0899	Physics, Other
15-0399	Electrical and Electronic Engineering Technologies, Other	15-0403	Electromechanical Technology/Electromechanical Engineering Tech

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Table 8 Relevant Degrees Available from Delaware Institutions: Engineering and Engineering Technologies

			Available Degrees					
Institution	Department	Major / Concentration	N	C	A	B	M	P
DelState	Dept of Physics & Pre-Engineering	Physics/Pre-Civil Engineering Dual				x		
		Physics/Pre-Elect Engineering Dual				x		
		Pre-Civil Engineering				x		
		Pre-Electrical Engineering				x		
		Physics (Engineering)				x		
DelTech	Electronics & Computer Engineering Technology Dept	Electrical Engineering				x		
		Electronics Engineering				x		
		Engineering Math Option				x		
		Instrumentation Engineering				x		
	Engineering Technology Dept	Architectural Engineering				x		
		Civil Engineering Technology				x		
		Computer Aided Draft/Design & Study	x		x			
		Design Engineering (Mechanical)				x		
		Electrical Engineering				x		
		Electromechanical Engineering				x		
		Electronics Engineering				x		
		Engineering Drafting				x		
		Engineering Math Option				x		
		Mechanical Engineering				x		
		Survey/Materials/Geomatics Eng Tech				x		
UDel	Bioresources Engineering Dept	Engineering Technology				x		
	Chemical Engineering Dept	Chemical Engineering				x	x	x
	Civil & Environmental Engineering	Civil Engineering				x	x	x
	Dept of Mechanical Engineering	Mechanical Engineering				x	x	x
	Electrical & Computer Engineering	Electrical & Computer Engineering					x	x
		Electrical Engineering				x		x
	Materials Science & Engineering	Materials Science & Engineering					x	x
	College of Engineering	Engineering - Non-Degree		x				
		Engineering - Undeclared				x		
		Engineering Outreach		x				
DEMEP*	n/a	Energy Savings Analysis and Audit	x					
CDM**	n/a	AutoCad Drafting	x					

* Delaware Manufacturing Extension Partnership,

** CDM Institute

Natural Resource Economics, Operations Research, and Logistics

The instructional programs in this category explicitly focus on natural resource economics and operational efficiency. Natural resource economics studies how society values its resources and quantifies the tradeoffs inherent to environmental policy. Operations research studies how operational efficiency can be maximized so that resources do not go to waste. Similarly, logistics studies the operational efficiency in the organization of a company's supply chain.

Table 9 Relevant CIP Codes Available from Delaware Institutions: Natural Resource Economics, Operations Research, and Logistics

03-0204	Natural Resource Economics	52-0203	Logistics, Materials, and Supply Chain Management
14-3701	Operations Research	52-0205	Operations Management and Supervision
27-0501	Statistics, General		

Table 10 Relevant Degrees Available from Delaware Institutions: Natural Resource Economics, Operations Research, and Logistics

Institution	Department	Major / Concentration	Available Degrees				
			N	A	B	M	P
DelTech	Department of Business Technologies	Operations Management	x				
DEMEP*	n/a	Six Sigma Green Belt Certificate	x				
UDEL	Professional and Continuing Studies	Six Sigma Green Belt Certificate	x				
	Food and Resource Economics Department	Agricultural & Resource Econ				x	
		Operations Research				x	x
		Resource Economics			x		
		Statistics			x	x	
	Operations Management Dept	Operations Management	x				
WilmU	College of Business	Transportation and Business Logistics	x				

* Delaware Manufacturing Extension Partnership

Earth, Wildlife, and Environmental Science

This category includes those majors explicitly focused on nature and the natural sciences. For example, wildlife ecology studies the ecosystem and humanity's impact, and climatology focuses on the causes and consequences of a changing climate. Fields in this list also study remediation technology and the effects of pollution.

Table 11 Relevant CIP Codes Available from Delaware Institutions: Plants, Animals, and the Environment

03-0103	Environmental Studies	15-0507	Environmental Engineering Technology/Environmental Technology
03-0104	Environmental Science	51-1104	Pre-Veterinary Studies
03-0201	Natural Resource Management and Policy	26-1302	Marine Biology and Biological Oceanography
03-0299	Natural Resource Management and Policy, Other	40-0401	Atmospheric Sciences and Meteorology, General
03-0601	Wildlife, Fish and Wildlands Science and Mgmt	40-0601	Geology/Earth Science, General
13-1332	Geography Teacher Education	40-0607	Oceanography, Chemical and Physical
14-1401	Environmental/Environmental Health Engineering	45-0701	Geography
15-0506	Water Quality and Wastewater Treatment Management and Recycling Technology	45-0702	Geographic Information Science and Cartography
26-0702	Entomology	46-0599	Plumbing & Related Water Supply Services, Other

An Analysis of Delaware's Green Educational Pipeline

Table 12 Relevant Degrees Available from Delaware Institutions: Plants, Animals, and the Environment

Institution	Department	Major / Concentration	Available Degrees				
			C	A	B	M	P
DelState	Agriculture & Natural Resources Dept	Natural Resources			x	x	
DelTech	Engineering Technology Department	Water/Wastewater		x			
	Environmental Technology Dept	Environmental Technology		x			
UDEL	Food & Resource Economics Dept	Natural Resource Management			x		
	Animal and Food Sciences Dept	Pre-Vet Medicine & Animal Bioscience			x		
	Bioresources Engineering Dept	Bioresources Engineering				x	
	Center for Applied Coastal Research	Ocean Engineering				x	x
	Civil & Environmental Engineering Department	Environmental Engineering			x		
		Environmental Science			x		
	Department of Entomology and Wildlife Ecology	Entomology			x	x	
		Entomology & Wildlife Ecology					x
		Environmental Science			x		
		Wildlife Conservation			x		
UDEL	Geography Department	Wildlife Ecology				x	
		Climatology					x
		Environmental Studies / Science			x		
		Geographic Information Science	x				
		Geography			x	x	x
		Geography Education			x		
	Geology Department	Earth Science Education			x		
		Geology			x	x	x
UDeI	Plant and Soil Sciences Department	Environmental Soil Science			x		
		Environmental Studies			x		
	School of Marine Science and Policy	Marine Policy				x	
		Marine Studies	x			x	x
		Ocean Engineering				x	
Wesley	Science Department	Oceanography					x
		Environmental Studies / Science			x	x	

Public Policy & Law

Absent a green policy, decisions that society makes will mostly ignore the costs of environmental degradation. Green public policy is designed to make decisions better reflect those costs. Examples of green public policy include renewable energy incentives and portfolio standards. Green policies are rarely confined to single issues, and policy makers have to consider multiple tradeoffs in any decision. Environmental law is complementary to public policy.

Table 13 Relevant CIP Codes Available from Delaware Institutions: Public Policy

22-0207	Energy, Environment, and Natural Resources Law	22-0101	Law (LL.B., J.D.)
44-0401	Public Administration	45-1201	Urban Studies/Affairs

Table 14 Relevant Degrees Available from Delaware Institutions: Public Policy

			Available Degrees		
			B	M	P
UDEL	Center for Energy and Environmental Policy	Energy & Environmental Policy	x	x	x
	School of Public Policy and Administration	Urban Affairs & Public Policy	x	x	x
WilmU	College of Arts and Science	Government and Public Policy	x		
	College of Business	Public Administration		x	
Widener	School of Law	Environmental Law Center			x

Selection of Green Non-Academic Programs

The initial list of green occupations included many jobs that required construction, trade and industrial skills. These skills are usually obtained without a formal academic education. In fact, the output approach indicated that jobs in the construction and trades were the most numerous among green businesses in Delaware. Furthermore, those businesses overwhelmingly responded that technical and trade skills were more relevant and desirable than an academic education.

Both lists of green occupations included electricians, plumbers, pipefitters, steamfitters, heating, ventilation, and air conditioning (HVAC) mechanics and installers, industrial maintenance technicians, carpenters and construction workers. Each skilled trade is extremely relevant to the green economy. For example, electricians install solar panels, plumbers install solar thermal hot water heaters, HVAC mechanics replace older, energy intensive HVAC systems, and construction workers perform weatherization services. Industrial maintenance technicians are critical to saving energy at an industrial scale. Our survey implied that green businesses preferred training in these broader skills over stand-alone training in specific types of green technology.

Stand-alone training in specific green technologies also exists in Delaware's green pipeline. Delaware Technical and Community College offers non-degree instruction in weatherization and auditing a building's energy performance. Sussex Tech Adult Division offered classes on how to weatherize a home and install solar panels.¹⁸ In fact, the adult technical schools in each of the three counties offered an apprenticeship program in the construction crafts that integrated the skills needed to weatherize a home into the curriculum. The Delaware Skills Center also offers weatherization training. Some private organizations also offer technical training in various types of hazardous materials and remediation technology.

¹⁸ Bucks County Community College also offers stand alone courses on solar panel installation, but that program was excluded because it is not located in Delaware.

Labor unions make up the final part of Delaware's vocational green pipeline. Many labor unions in the state offer apprenticeships that integrate environmentally relevant skills into the curricula. Other than the four standard trades already mentioned are other crafts relevant to conserving energy and cleaning pollution. For example, heating and frost insulators perform energy efficient retrofits in industrial settings that create some of the fastest returns. In addition, millwrights and boilermakers provide the servicing that keeps large scale industrial processes operating at their most efficient.

We compose the nonacademic component of Delaware's green educational pipeline into trade apprenticeships and other training. The table uses the following shorthand notation,

N - Non-Degree Certificate Program

C - Certificate/Diploma Degree Program

A - Associate's Degree Program¹⁹

¹⁹ Engineering technology programs are a blend of academic and nonacademic education. While most engineering technologies are included in the previous section, a few were categorized in the construction and trades.

An Analysis of Delaware's Green Educational Pipeline

Construction and Trades

The construction and trades category was included as green primarily due to its role in the energy efficiency sector. Such skills are necessary to weatherize homes and businesses, install solar panels, perform energy audits, and replace energy-intensive industrial equipment. Workers with these skills are the most publicized kind of green worker.

Table 15 Relevant CIP Codes Available from Delaware Institutions: Construction and Trades

150501	Heating, Ventilation, Air Conditioning and Refrigeration Engineering Technology	460414	Insulator
150503	Energy Management and Systems Technology	460415	Building Construction Technology
150505	Solar Energy Technology	460503	Plumbing Technology/Plumber
150508	Hazardous Materials Management and Waste Technology	470201	Heating, Air Conditioning, Ventilation and Refrigeration Maintenance Technology
150701	Occupational Safety and Health Technology	470302	Heavy Equipment Maintenance Technology
460201	Carpentry/Carpenter	470303	Industrial Mechanics & Maintenance Tech
460301	Electrical & Power Transmission Installation, Gen	480506	Sheet Metal Technology/Sheetworking
460302	Electrician	480801	Boilermaking/Boilermaker
460401	Building/Property Maintenance	500408	Interior Design
460403	Building/Home/Construction Inspection	522001	Construction Management

Table 16 Relevant Construction and Trades Training/Degrees Available from Delaware Institutions

			Available Degrees		
			N	C	A
DelTech	Applied Energy Program	Energy Management / Facilities Mgmt	x	x	
	Engineering Technology Department	Construction Management Interior Design	x	x	x
	Mechanical Engineering Technology Department	HVAC Engineering & Design Refrigeration, Heating A/C			x x
	Refrigeration, Heating, and Air Conditioning Technology Department	Refrigeration, Heating A/C			x
Central DE Training Academy	n/a	Asbestos Abatement	x		
		Lead Safety	x		
		OSHA Safety	x		
DE Rural Water Assoc	n/a	Cross-Connection Control Training	x		

An Analysis of Delaware's Green Educational Pipeline

Table 17 Non-Academic Programs Available at Delaware Institutions

Institution	Area	Program Name	Program Length	Locations
Sussex Tech Adult Division	Weatherization, Energy Auditing, & Alternative Energy	Green Environment and Green Business Training	15 hrs	SSX
		Solar Panel Design and Installation	30 hrs	SSX
		Thermal Imaging Technology	12 hrs	SSX
		Weatherization Training	2 courses, 15 hrs each	SSX
Delaware Technical and Community College	Weatherization, Energy Auditing, & Alternative Energy	BPI Certified Building Analyst Training	52 hrs	SSX, NCC, KNT
		Introduction to Alternative Energy Sources	7 hrs	SSX
		Weatherization Training	2 courses, 42 hrs each	NCC
		Solar Photovoltaic Panel Installer (coming soon)	n/a	n/a
	Water Supply & Treatment	Base Level Water Operators Certification	57 hrs	SSX & NCC
		Chlorination/Chlorine Dioxide Disinfection	2 courses, 7 hrs each	KNT & SSX
		Inspection Onsite Waste Water Systems	7 hrs	SSX
		Review Stormwater Management Modeling	24 hrs	SSX
		Wastewater Operator Review & Certification	2 courses, 48 hrs each	SSX & NCC
		Water Supply Hydrology	7 hrs	SSX
	Construction, Safety & Hazmat	Basic Carpentry	40 hrs	KNT
		Asbestos Class A Supervisor Refresher	8 hrs	NCC
		HAZMAT Refresher	8 hrs	NCC
		Lead Safety Renov. Repair & Painting Refresher	8 hrs	NCC
		OSHA Construction Safety	12 hrs	SSX
	Electrical	Residential Wiring	2 courses, 42 hrs each	KNT & NCC
		Electrical Blueprint Reading/Operator Cert.	7 hrs	SSX
		Blueprint Reading	30 hrs	KNT
	HVAC	HVAC	38 hrs	KNT
		Blueprint Reading for HVAC	42 hrs	NCC
		Refrigeration & A/C	2 courses, 42 hrs each	NCC
	Plumbing	Basic Plumbing	40 hrs	KNT
Delaware Skills Center	Construction, Safety & Hazmat	Construction and Green Technology	18 weeks, 30 hrs/wk	NCC
	Electric	Electric	12 weeks, 30 hrs/wk	NCC
	HVAC	HVAC / Building Systems Maintenance	12 weeks, 30 hrs/wk	NCC
PolyTech Adult Education (KNT)	Electric	Electrical Standards & Certification	39 hrs	KNT
	HVAC	HVAC Trades/HVAC-R 1	36 hrs	KNT
	Plumbing	Basic Plumbing	36 hrs	KNT

An Analysis of Delaware's Green Educational Pipeline

Figure 15 Relevant Trade Apprenticeships in Delaware

Institution	Area	Program Name
New Castle County VoTech	Electric	Electrician Apprenticeship
	HVAC	HVAC Apprenticeship
	Plumbing	Plumbing / Pipefitter Apprenticeship
	Industrial	Industrial Maintenance Mechanic Apprenticeship
	Construction, Safety & Hazmat	Roofing/Carpentry Apprenticeship
Sussex Tech Adult Division	Electric	Electrician Apprenticeship
	HVAC	HVAC Apprenticeship
	Plumbing	Plumbing and Pipefitter Apprenticeship
	Industrial	Industrial Maintenance Apprenticeship
PolyTech Adult Education (KNT)	Electric	Electrician Apprenticeship
	HVAC	HVAC Apprenticeship
	Plumbing	Plumbing Apprenticeship
	Industrial	Industrial Maintenance Apprenticeship
International Brotherhood of Electrical Workers	Electric	Trade Union Apprenticeship: Local 313, 1238
Plumbers and Pipefitters United Association	Plumbing	Trade Union Apprenticeship: Local 74, 782
Sheet Metal Workers	HVAC	Trade Union Apprenticeship: Local 19
Heat and Frost Insulated and Allied Workers	Industrial	Trade Union Apprenticeship: Local 42
International Brotherhood Of Boilermakers	Industrial	Trade Union Apprenticeship: Local 13, 193
Millwright and Machinery Erectors	Industrial	Trade Union Apprenticeship: Local 1906
United Brotherhood of Carpenters and Joiners	Construction, Safety & Hazmat	Trade Union Apprenticeship: Local 2012, 626
Laborers International Union of North America	Construction, Safety & Hazmat	Trade Union Apprenticeship: Local 199, 55

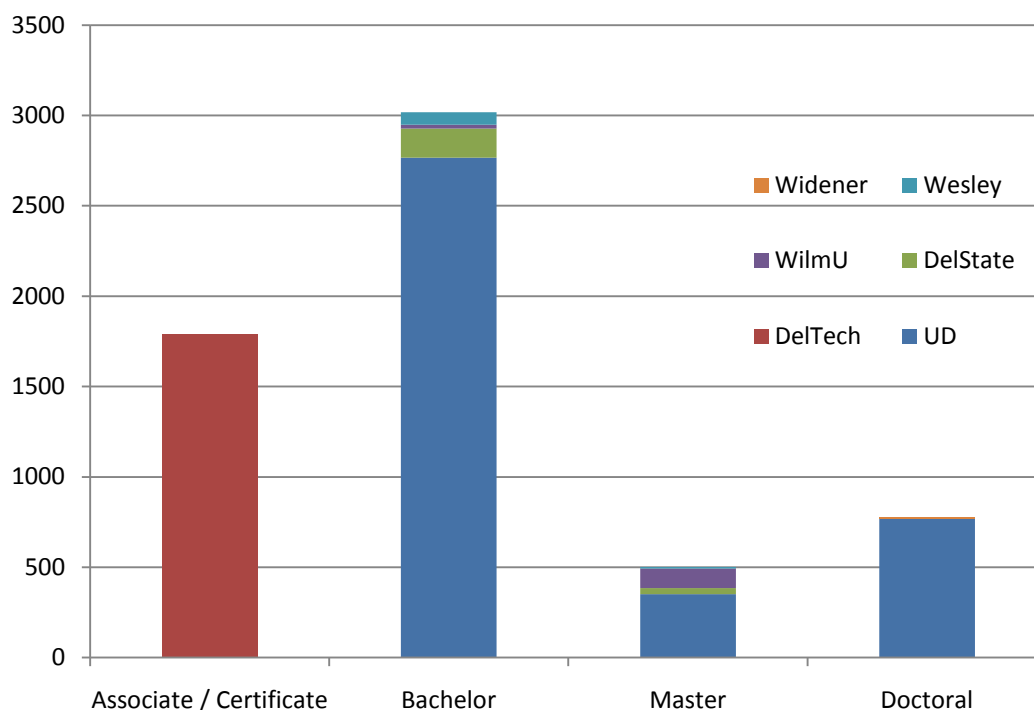
* Most apprenticeships require 4 years of on-the-job work experience and 600-800 hours of classroom instruction.

Analysis of Green Educational Programs

This section presents a more detailed analysis of the green programs. Data in this section come from a variety of sources, including telephone, in-person, and mail interviews, website searches, and data obtained from each institution's institutional research office. Data regarding enrollment size, degree completion, student demographics, and the outcomes of recent graduates was collected at the program-specific level.

Although there were 19 possible postsecondary academic institutions in Delaware, our scope was limited to just the University of Delaware, Wilmington University, Delaware Technical and Community College, Delaware State University, Widener College, and Wesley College. Tables in the appendix show that Type 3 institutions specialize in vocational training for beauty and personal services, administrative assistance and medical billing, and certificate programs in the health care industry. Similarly, Strayer University, Beebe Hospital School of Nursing, and Goldey Beacom College were ruled out as offering potentially relevant degrees, as their specializations fell outside the green areas previously mentioned.

Figure 16 Total Enrollment in Academic Green Subjects, by School and Degree Level

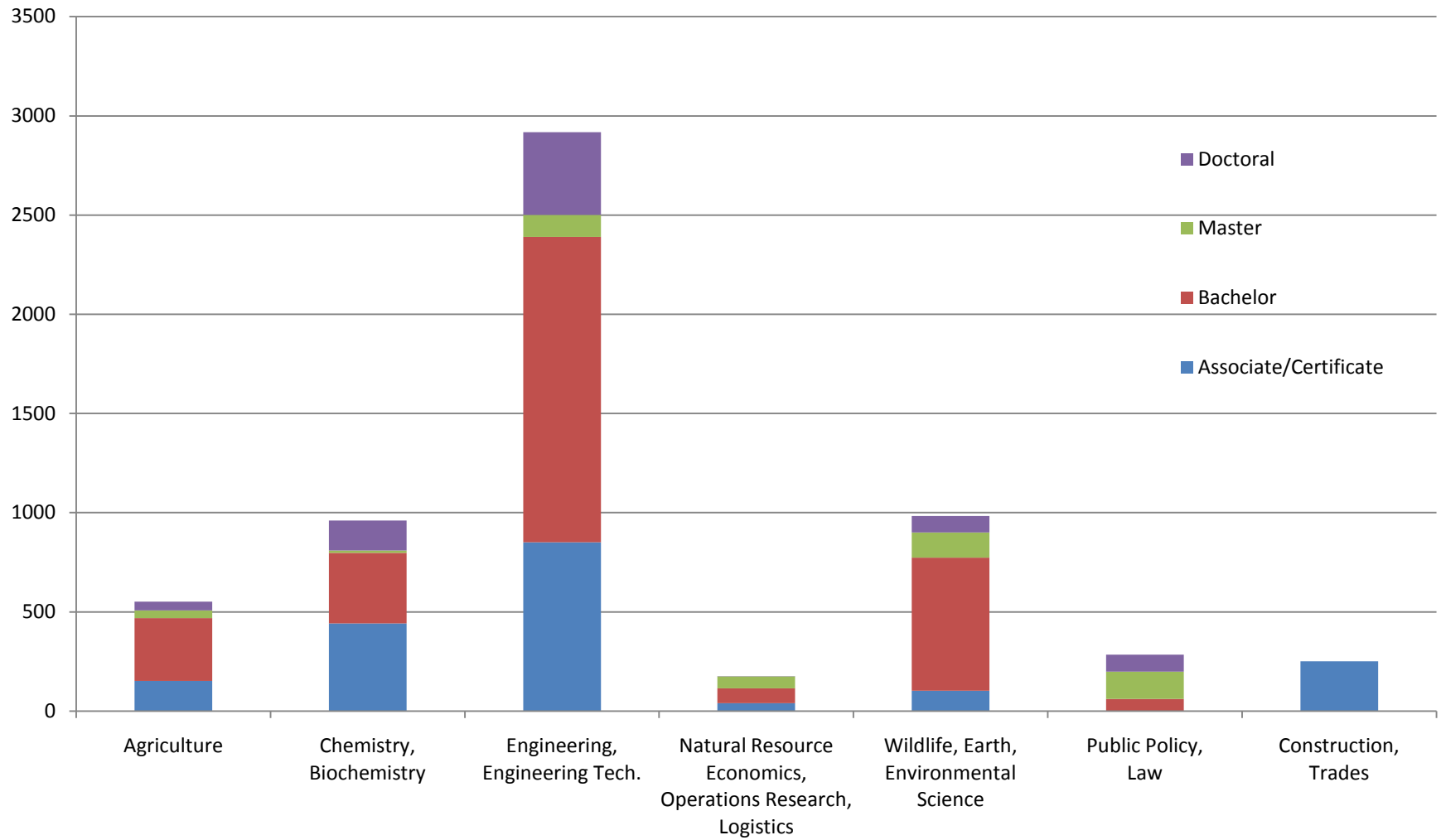


Source: Center for Applied Demography & Survey Research

Figure 16 indicates the enrollment in all green-related academic programs in 2009-2010 for each type of award and each educational institution. The figure indicates a unique fact about green academic programs in Delaware; they are almost entirely taught at either DelTech or UD. In addition, these two institutions do not award the same type of degree; DelTech offers primarily associate degrees and UD offers primarily bachelor and graduate degrees. Wesley College, Delaware State University, Wilmington University, and Widener School of Law also offer bachelor's and/or graduate degrees in green areas, but their scale is small in comparison.

An Analysis of Delaware's Green Educational Pipeline

Figure 17 Total Enrollment in Academic Green Subjects, by Subject Matter and Degree Level



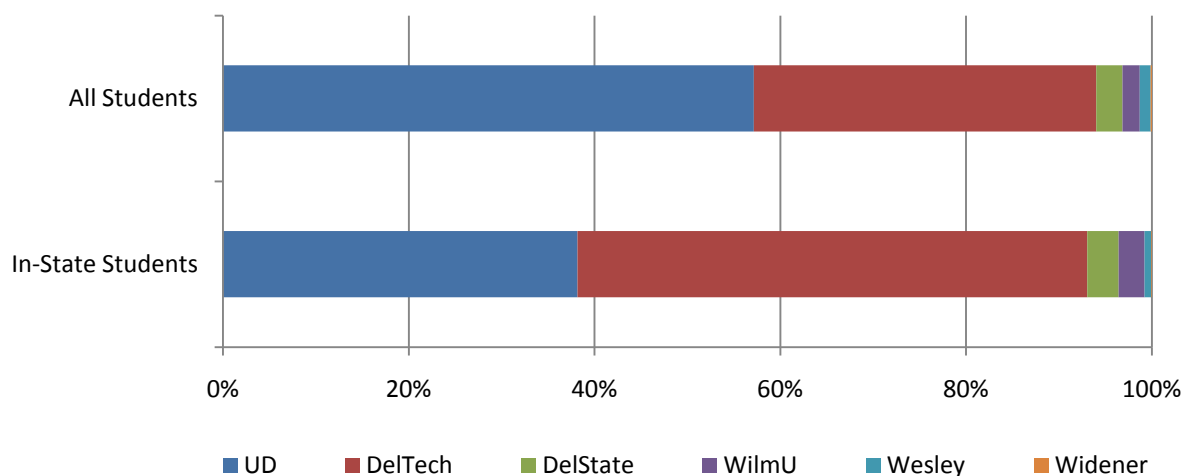
Source: Center for Applied Demography & Survey Research

Figure 17 decomposes the enrollment in a green-related academic program according to the educational area and degree level. Engineering and engineering technology enrolls the greatest number of students, followed by wildlife, earth, and environmental science, and chemistry and biochemistry. Graduate programs constitute between 20% to 30% of total enrollment in every green related field except agriculture, public policy and law, and construction. For degrees in public policy and law, graduate enrollment is nearly 80% of total enrollment.

The Green Academic Pipeline for In-State Students

The bar chart below shows that even though the majority of people enrolled in a green program is either at UD or DelTech, many more in-state students attend DelTech. In fact, the chart understates the contribution of DelTech to the educational pipeline for Delaware residents, since it does not include any vocational training programs.

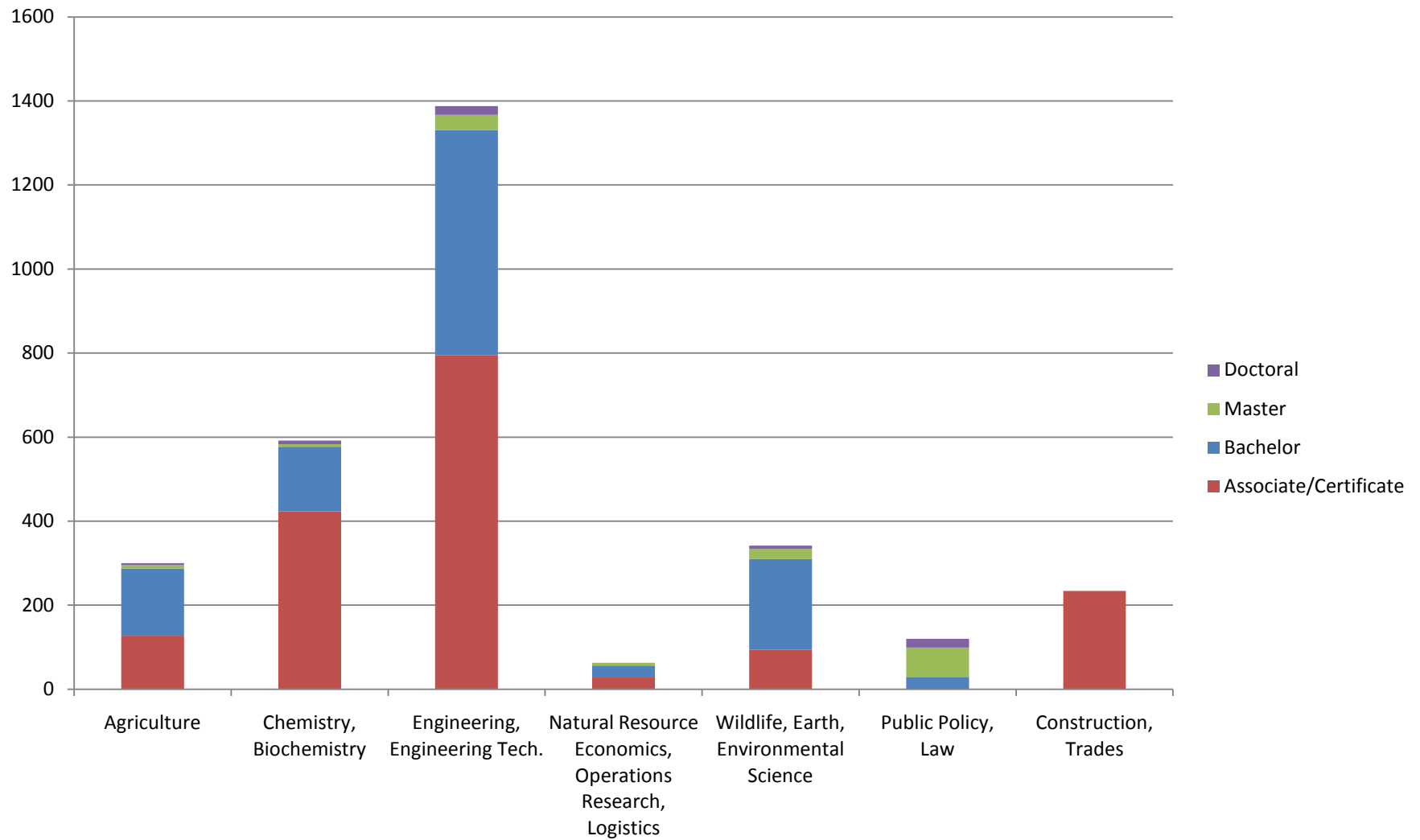
Figure 18 Comparison of Total and Residential Enrollment in Green Academic Degree Programs



Source: Center for Applied Demography & Survey Research

An Analysis of Delaware's Green Educational Pipeline

Figure 19 Residential Enrollment in Academic Green Subjects, by Subject Matter and Degree Level



Source: Center for Applied Demography & Survey Research

Figure 19 shows the enrollment in each green related subject area for Delaware residents. Engineering and engineering technology are still the most common degrees in the academic section of the green pipeline, however more in-state residents are enrolled in engineering technologies (associates) instead of engineering (bachelors and graduate).

Another notable feature of the pipeline is how few graduate degrees go to in-state students. Most in-state graduate degrees occur in public policy, engineering, and wildlife, earth, and the environmental sciences. Because graduate programs are more likely to attract applicants from other states and other countries, greater selectivity is a consequence of greater prominence. That in turn limits the number of qualifying in-state students. Of course, greater proportions of in-state students could also reflect a program tailored to state-specific issues, such as is the case for public policy (and our Center).

Detailed Analysis of Individual Green Programs

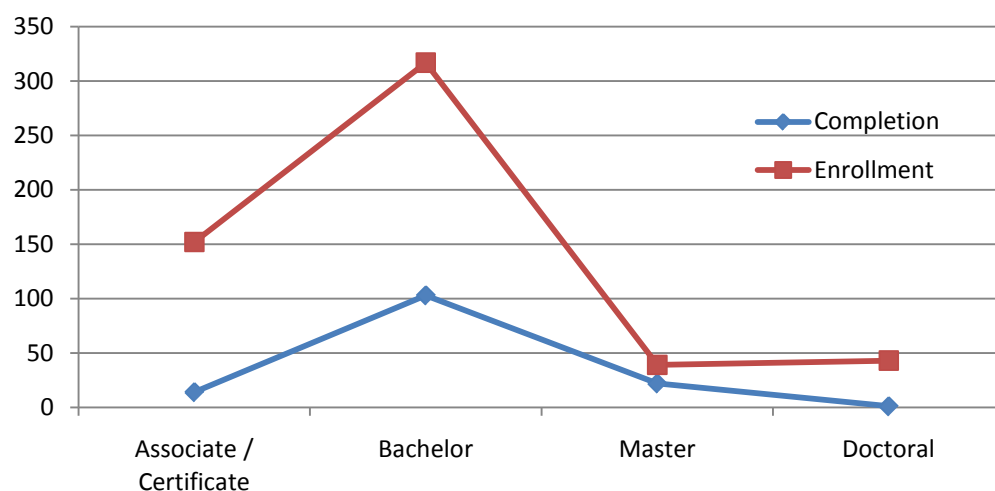
In the following pages, we analyze each of the green educational areas and report important information that characterizes Delaware's educational pipeline. Each section provides information on student enrollment, degree completion, proportion of in-state students, and other demographic information. This data was obtained from a variety of private data requests, publicly available institutional reports, and the IPEDS database.

Each section reports the percent of students that continues their education based on information obtained from exit surveys of recent graduates. Those surveys were also used to determine the percent of students that found work in a related field or full-time work upon graduation.²⁰ The figures reported by these surveys are nonstatistical, so one should not draw too firm of a conclusion on any implications.

We also identify occupations that correspond to degree programs in this list using a cross referencing and validation process similar to that in Figure 14. The 2008 and 2010 Delaware Occupational Employment Surveys for Delaware identified the employment and average hourly wage for these occupations. The 2008 wage has been inflated to 2010 nominal dollars using the Consumer Price Index.

²⁰ For associate degree programs, the employment rate refers to the proportion of those people who were working or looking for work that were also working in a related field. For bachelor degree programs and higher, the employment rate refers to those students who were working or looking for work who had found full time employment. Surveys reflect graduates of UD and DelTech only.

Green Instructional Programs in Delaware: Agriculture



	In-State Percent – All Enrollment	Average Age – All Enrollment	% Male – Graduating Class	Emp. Rate – Graduating Class	% Cont Educ – Graduating Class
Associate	84%	23.8	70%	100%	19%
Bachelor	50%	21.5	51%	56%	33%
Master	21%	28.0	41%	67%	14%
Doctoral	12%	30.4	-	-	-

- The employment rate for associate degrees includes whether the graduate was working in a related field. The employment rate for other degrees includes whether the graduate was or soon would be working in a full time occupation.

Source: Center for Applied Demography & Survey Research

The agricultural programs in Delaware's postsecondary institutions enroll students in all four levels of degree programs, although most appear at the associate or bachelor level. Nearly 15 students received an associate's degree in an agricultural subject in 2010, and 100 received a bachelor's degree. Approximately 80 students are enrolled across the graduate degree programs. Most are Delaware residents, and approximately 14% of master's students pursue further education.

An Analysis of Delaware's Green Educational Pipeline

Table 18 Potential Occupations with a Relevant Certification/Degree: Agriculture

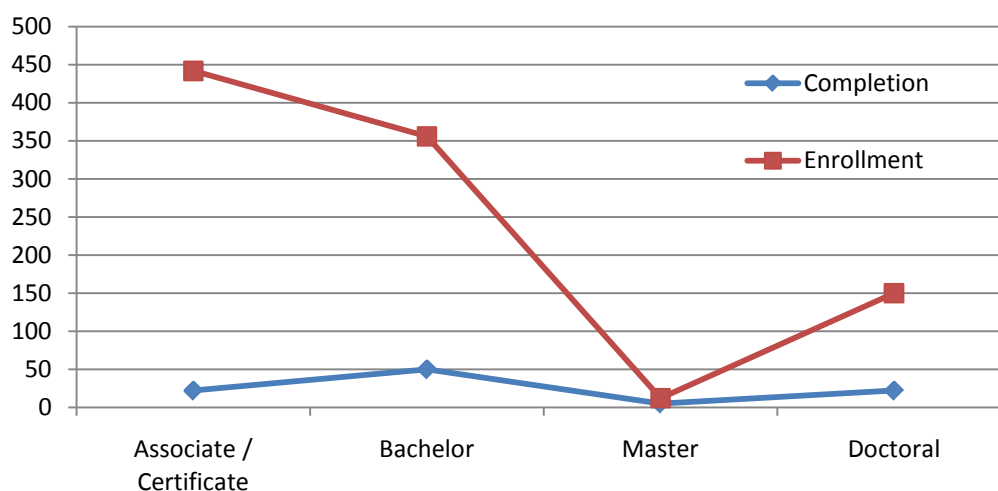
Avail in DE	SOC	Occupation title	Required Occup Educ/Exp	2008 DE Emp	2010 DE Emp	2008 Avg Wage	2010 Avg Wage	Green Survey Rank	ONET Occ. Type
Associate	11-9012	Farmers and Ranchers	LT-OTJ	-	-	-	-		ES
	37-1012	First-Line Supervisors/Managers of Landscaping, Lawn Service, and Groundskeeping Workers	Work exp	310	290	\$24.18	\$24.70	70	
	37-3012	Pesticide Handlers, Sprayers, and Applicators, Vegetation	MT-OTJ	130	140	\$17.79	\$17.79		
	45-1011	First-Line Supervisors/Managers of Farming, Fishing, and Forestry Wrkrs	Work exp	80	80	\$23.07	\$24.07		ID
Bachelor	11-9011	Farm, Ranch, and Other Agricultural Managers	Bach + exp	-	-	-	-		
	11-9012	Farmers and Ranchers	LT-OTJ	-	-	-	-		ES
	17-1012	Landscape Architects	Bachelor	110	90	\$23.30	\$24.82	59	ES
	19-1013	Soil and Plant Scientists	Bachelor	60	70	\$26.96	\$24.88		ES
	37-1012	First-Line Supervisors/Managers of Landscaping, Lawn Service, and Groundskeeping Workers	Work exp	310	290	\$24.18	\$24.70	70	
	45-1011	First-Line Supervisors/Managers of Farming, Fishing, and Forestry Wrkrs	Work exp	80	80	\$23.07	\$24.07		ID
	45-2011	Agricultural Inspectors	Work exp	-	-	-	-		ID
Master	11-9011	Farm, Ranch, Other Agricultural Mgr	Bach + exp	-	-	-	-		
	19-1013	Soil and Plant Scientists	Bachelor	60	70	\$26.96	\$24.88		ES
Doctoral	11-9011	Farm, Ranch, Other Agricultural Mgr	Bach + exp	-	-	-	-		
	19-1011	Animal Scientists	Doctoral	-	-	-	-		
	19-1013	Soil and Plant Scientists	Bachelor	60	70	\$26.96	\$24.88		ES
	25-1041	Agricultural Sciences Teachers, Postsecondary	Doctoral	-	-	-	-		
	11-9011	Farm, Ranch, and Other Agricultural Managers	Bach + exp	-	-	-	-		

Source: Delaware Department of Labor Occupational Employment Survey and Center for Applied Demography & Survey Research

Table 18 shows which occupations were associated with the agricultural programs in Delaware. The first column indicates what type of degree programs were available from a Delaware institution that would teach the knowledge necessary for the relevant occupations (listed in the second and third columns). The fourth column indicates what minimum level of training or education the Bureau of Labor Statistics lists as necessary for that occupation. For example, an associate's degree program in the pipeline can teach the knowledge needed to be a farmer or a rancher, but long term on-the-job training (LT-OTJ) is actually needed for the occupation.

The table indicates that these agricultural occupations make up a relatively small fraction of Delaware's workforce. The most common occupation is the supervisor/manager of landscaping, lawn service, and groundskeeping workers, and in general an academic education is not needed to be a landscaper or a groundskeeper. Many of the other occupations contained so few persons in Delaware that the information could not be reported. Since 2008, there have been relatively few changes occurring in the employment or wage for these occupations.

Green Instructional Programs in Delaware: Chemistry & Biochemistry



	In-State Percent – All Enrollment	Average Age – All Enrollment	% Male – Graduating Class	Emp. Rate – Graduating Class	% Cont Educ – Graduating Class
Associate	96%	23.2	79%	90%	38%
Bachelor	43%	20.9	48%	100%	57%
Master	50%	31.7	44%	100%	0%
Doctoral	6%	26.0	62%	100%	0%

- The employment rate for associate degrees includes whether the graduate was working in a related field. The employment rate for other degrees includes whether the graduate was or soon would be working in a full time occupation.

Source: Center for Applied Demography & Survey Research

Programs in the chemical and biochemical fields enroll nearly 450 students in an associate degree program and 350 students in a bachelor degree program. Despite the lower enrollment, more than twice as many bachelor degree students completed their degree than associate degree students. Approximately 150 students are enrolled in doctoral programs in chemistry and biochemistry, and 6% of those are Delaware residents. Students in these majors reported high levels of success in finding full time employment. Nearly 40% of associate degree students and 60% of bachelor degree students pursue further education.

Table 19 indicates that employment and wages have changed quite radically between 2008 and 2010. For example, the number of chemical technicians has fallen by 730 while the number of chemists rose by 860. It is likely that these isolated and conflicting changes are explained by more mundane issues of occupational coding. However, the cumulative employment declines of chemical equipment operators and tenders, biological technicians, and biochemists and biophysicists more than exceed any gains occurring in the chemists. Thus, it appears as though the occupations related to chemical and biochemical degrees have experienced weakening market conditions in Delaware.

An Analysis of Delaware's Green Educational Pipeline

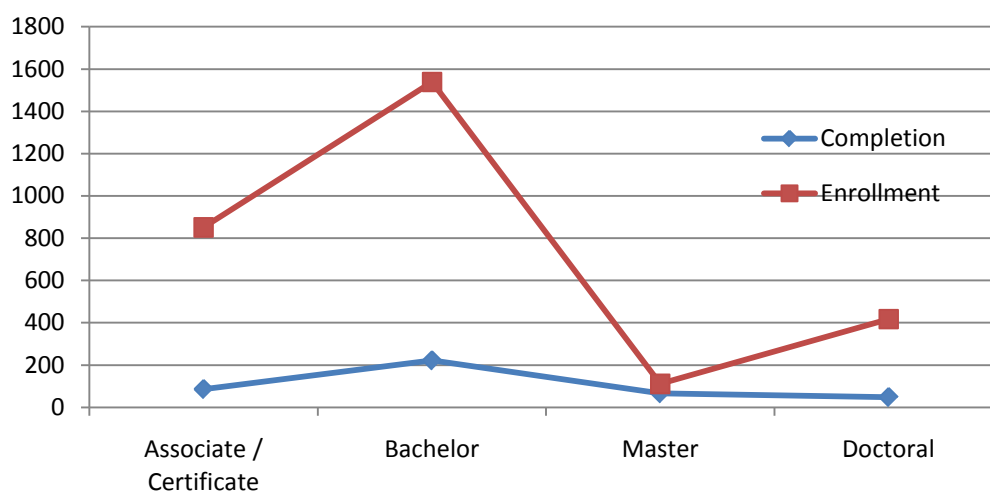
Table 19 Potential Occupations with a Relevant Degree in Chemistry or Biochemistry

Avail in DE	SOC	Occupation Title	Required Occup Educ/Exp	2008 DE Emp	2010 DE Emp	2008 Avg Wage	2010 Avg Wage	Green Survey Rank	ONET Occ. Type
Associate	51-9011	Chemical Equipment Operators and Tenders	MT-OTJ	670	510	\$24.02	\$25.95		ID
	51-8091	Chemical Plant and System Oprtrs	LT-OTJ	-	110	-	\$27.48		ID
	19-4031	Chemical Technicians	Associate	1350	620	\$27.00	\$25.53		ID
	19-4091	Environmental Science & Protection Technicians, Including Health	Associate	80	120	\$17.38	\$17.13	61	ES
	19-4099	Life, Physical, and Social Science Technicians, All Other	Associate	-	80	-	-		NE
Bachelor	19-2031	Chemists	Bachelor	1050	1910	\$41.29	\$42.00	60	ID
	19-4021	Biological Technicians	Bachelor	680	220	\$25.28	\$20.55		
	25-2031	Secondary School Teachers, Except Special and Vocational Education	Bachelor	1730	3100	\$27.88	-		
	11-9121	Natural Sciences Managers	Bach + exp	420	-	\$72.08	-	87	ID, NE
Master	19-2031	Chemists	Bachelor	1050	1910	\$41.29	\$42.00	60	ID
	25-2031	Secondary School Teachers, Except Special and Vocational Education	Bachelor	1730	3100	\$27.88	-		
	11-9121	Natural Sciences Managers	Bach + exp	420	-	\$72.08	-	87	ID, NE
Doctoral	19-2031	Chemists	Bachelor	1050	1910	\$41.29	\$42.00	60	ID
	25-2031	Secondary School Teachers, Except Special and Vocational Education	Bachelor	1730	3100	\$27.88	-		
	11-9121	Natural Sciences Managers	Bach + exp	420	-	\$72.08	-	87	ID, NE
	19-1021	Biochemists and Biophysicists	Doctoral	570	110	\$50.49	\$45.57		
	19-1042	Medical Scientists, Except Epidemiologists	Doctoral	-	-	-	-		
	25-1042	Biological Science Teachers, Postsecondary	Doctoral	-	-	-	-		
	25-1052	Chemistry Teachers, Postsecondary	Doctoral	-	-	-	-		

Source: Delaware Department of Labor Occupational Employment Survey and Center for Applied Demography & Survey Research

An Analysis of Delaware's Green Educational Pipeline

Green Instructional Programs in Delaware: Engineering and Engineering Technologies



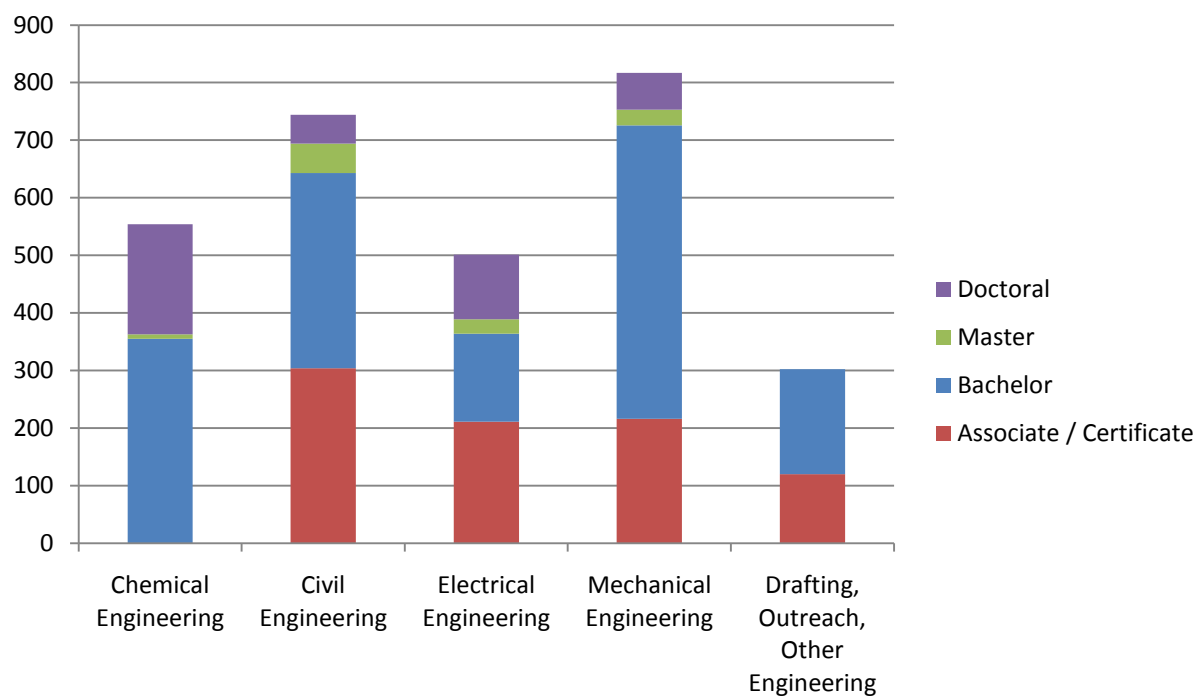
	In-State Percent – All Enrollment	Average Age – All Enrollment	% Male – Graduating Class	Emp. Rate – Graduating Class	% Cont Educ – Graduating Class
Associate	95%	24.6	83%	57%	32%
Bachelor	35%	20.2	79%	89%	21%
Master	32%	25.0	72%	85%	24%
Doctoral	5%	26.3	77%	100%	4%

- The employment rate for associate degrees includes whether the graduate was working in a related field. The employment rate for other degrees includes whether the graduate was or soon would be working in a full time occupation.

Source: Center for Applied Demography & Survey Research

Engineering and engineering technology is the largest component we consider in Delaware's green educational pipeline. Nearly 850 students are enrolled in an associate's program, 1,550 in a bachelor's program, 100 in a master's program, and 400 in a doctoral program. Almost all of the students enrolled in an associate degree program are in-state, as are a third of students at the bachelor's and master's level. Approximately one in 20 students enrolled in a doctoral engineering program are Delaware residents. The educational pipeline recently produced approximately 90 engineering students with an associate degree and 220 students with a bachelor's degree. Between 20% and 30% of non-doctoral students continue their education upon graduation.

Figure 20 Engineering and Engineering Technology Enrollment, by Field and Degree Level



Source: Center for Applied Demography & Survey Research

Figure 20 shows the engineering and engineering technology enrollment across different types of majors. Enrollment is greatest for those in mechanical engineering and civil engineering. Chemical engineering is the third largest subject area. The field is unique because there are no associate degrees offered in this subject, and it also has the highest number of students enrolled in a graduate degree program.

An Analysis of Delaware's Green Educational Pipeline

Table 20 Potential Occupations with a Relevant Engineering or Engineering Technology Certification/Degree

Avail in DE	SOC	Occupation Title	Required Occup Educ/Exp	2008 DE Emp	2010 DE Emp	2008 Avg Wage	2010 Avg Wage	Green Survey Rank	ONET Occ. Type
Certificate	17-3011	Architectural and Civil Drafters	Tech. Cert.	420	310	\$22.10	\$24.62	15	ID
	17-3012	Electrical and Electronics Drafters	Tech. Cert.	140	150	\$27.65	\$27.49	34	
	17-3013	Mechanical Drafters	Tech. Cert.	220	230	\$28.03	\$29.21	24	
	17-3019	Drafters, All Other	Tech. Cert.	20	10	\$22.89	\$25.23		
Associate	17-3011	Architectural and Civil Drafters	Tech. Cert.	420	310	\$22.10	\$24.62	15	ID
	17-3012	Electrical and Electronics Drafters	Tech. Cert.	140	150	\$27.65	\$27.49	34	
	17-3013	Mechanical Drafters	Tech. Cert.	220	230	\$28.03	\$29.21	24	
	17-3019	Drafters, All Other	Tech. Cert.	20	10	\$22.89	\$25.23		
	17-3022	Civil Engineering Technicians	Associate	400	380	\$20.03	\$19.54	26	
	17-3023	Electrical and Electronic Engineering Technicians	Associate	710	310	\$22.39	\$22.44	118	ID, ES
	17-3024	Electro-Mechanical Technicians	Associate						ES, NE
	17-3027	Mechanical Engineering Technicians	Associate	130	160	\$27.01	\$24.12	118	NE
Bachelor	17-3029	Engineering Technicians, Except Drafters, All Other	Associate	20		\$29.13	\$26.63		NE
	11-9041	Engineering Managers	Bach + exp	360	430	\$61.58	\$63.67	16	ES
	13-1051	Cost Estimators	Bachelor	780	720	\$28.82	\$30.33	9	
	17-2041	Chemical Engineers	Bachelor	540	710	\$46.44	\$56.17	56	ID
	17-2051	Civil Engineers	Bachelor	950	980	\$41.21	\$36.91	2	ES, NE
	17-2071	Electrical Engineers	Bachelor	740	840	\$42.88	\$41.84	30	ES
	17-2072	Electronics Engineers, Exc Computer	Bachelor	440		\$44.71	\$41.81		ES
	17-2141	Mechanical Engineers	Bachelor	440	570	\$40.11	\$38.74	11	ES, NE
	11-9121	Natural Sciences Managers	Bach + exp	420		\$72.08		87	ID, NE

Source: Delaware Department of Labor Occupational Employment Survey and Center for Applied Demography & Survey Research

During the last two years, engineering professions that require at least a bachelor's degree have performed relatively well. Chemical engineers, electrical engineers, mechanical engineers, and engineering managers gained employment despite the recession, but wages did fall for many occupations. Few occupations attainable with an associate's degree in engineering technology experienced employment gains. The electrical and electronic engineering technicians and the architectural and civil drafters experienced substantial employment declines.

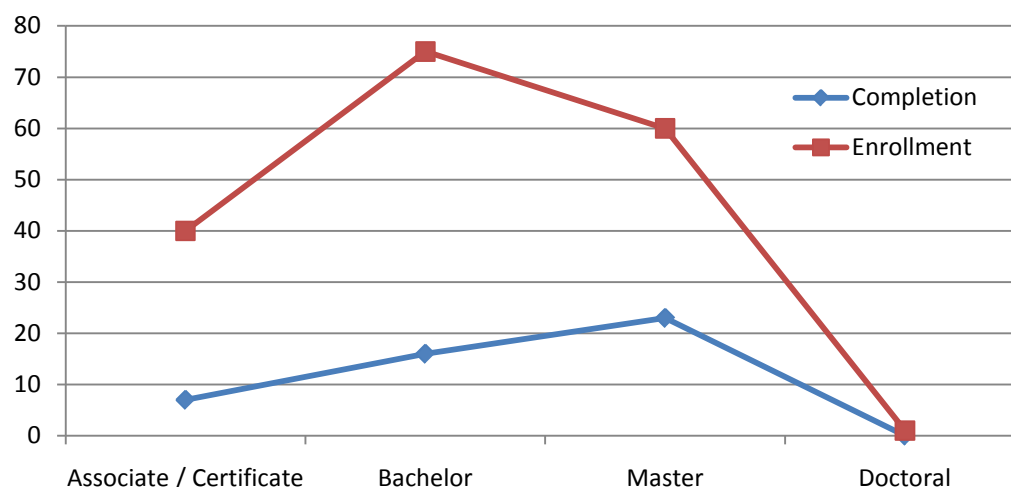
An Analysis of Delaware's Green Educational Pipeline

Table 20 Potential Occupations with a Relevant Engineering or Engineering Technology Certification/Degree (cont)

Avail in DE	SOC	Occupation Title	Required Occup Educ/Exp	2008 DE Emp	2010 DE Emp	2008 Avg Wage	2010 Avg Wage	Green Survey Rank	ONET Occ. Type
Master	11-9041	Engineering Managers	Bach + exp	360	430	\$62.37	\$63.67	16	ES
	13-1051	Cost Estimators	Bachelor	780	720	\$29.19	\$30.33	9	
	17-2041	Chemical Engineers	Bachelor	540	710	\$47.03	\$56.17	56	ID
	17-2051	Civil Engineers	Bachelor	950	980	\$41.74	\$36.91	2	ES, NE
	17-2071	Electrical Engineers	Bachelor	740	840	\$43.43	\$41.84	30	ES
	17-2072	Electronics Engineers, Exc Computer	Bachelor	440	-	\$45.28	\$41.81		ES
	17-2141	Mechanical Engineers	Bachelor	440	570	\$40.62	\$38.74	11	ES, NE
	19-2032	Materials Scientists	Bachelor	70	90	\$38.95	\$42.79		ID
Doctoral	11-9041	Engineering Managers	Bach + exp	360	430	\$62.37	\$63.67	16	ES
	13-1051	Cost Estimators	Bachelor	780	720	\$29.19	\$30.33	9	
	17-2041	Chemical Engineers	Bachelor	540	710	\$47.03	\$56.17	56	ID
	17-2051	Civil Engineers	Bachelor	950	980	\$41.74	\$36.91	2	ES, NE
	17-2071	Electrical Engineers	Bachelor	740	840	\$43.43	\$41.84	30	ES
	17-2072	Electronics Engineers, Exc Computer	Bachelor	440	-	\$45.28	\$41.81		ES
	17-2141	Mechanical Engineers	Bachelor	440	570	\$40.62	\$38.74	11	ES, NE
	19-2032	Materials Scientists	Bachelor	70	90	\$38.95	\$42.79		ID
	25-1032	Engineering Teachers, Postsecondary	Doctoral	-	-	-	-		

Source: Delaware Department of Labor Occupational Employment Survey and Center for Applied Demography & Survey Research

Green Instructional Programs in Delaware: Natural Resource Economics, Operations Research, and Logistics



	In-State Percent – All Enrollment	Average Age – All Enrollment	% Male – Graduating Class	Emp. Rate – Graduating Class	% Cont Educ – Graduating Class
Associate	93%	28.0	50%	n/a	60%
Bachelor	37%	20.5	62%	83%	12%
Master	12%	26.6	49%	80%	0%
Doctoral	-	-	-	-	-

- The employment rate for associate degrees includes whether the graduate was working in a related field. The employment rate for other degrees includes whether the graduate was or soon would be working in a full time occupation.

Source: Center for Applied Demography & Survey Research

In this category, enrollment is more evenly distributed across associate degree (40 students), bachelor degree (100 students), and master degree (60 students) programs. A high percentage of associate degree students continue their education, but relatively few bachelor's and master's degree students did. As with other categories, the number of in-state students enrolled falls as the level of award rises.

An Analysis of Delaware's Green Educational Pipeline

Table 21 Potential Occupations with a Degree in Natural Resource Economics, Operations Research, and Logistics

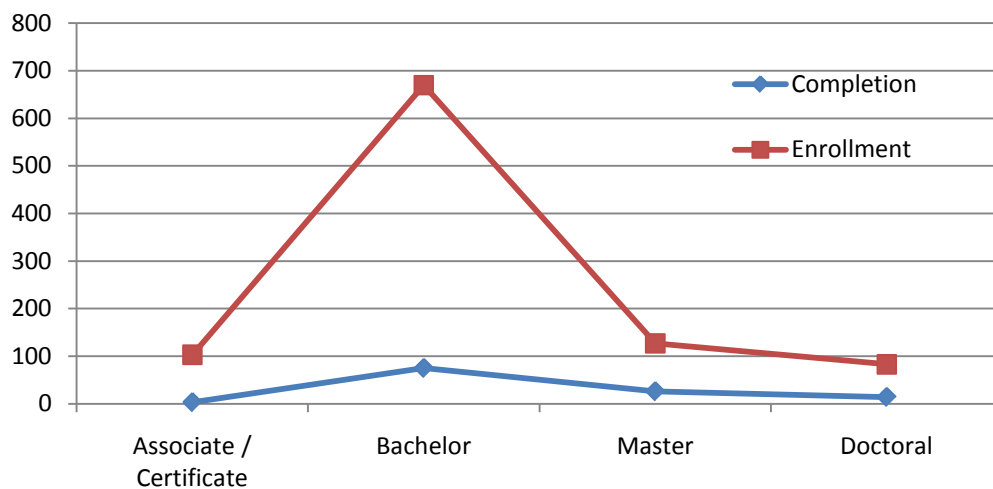
Avail in DE	SOC	Occupation Title	Required Occup Educ/Exp	2008 DE Emp	2010 DE Emp	2008 Avg Wage	2010 Avg Wage	Green Survey Rank	ONET Occ. Type
Bachelor	11-3021	Computer and Information Systems Managers	Bach + exp	1280	1550	\$63.04	\$62.76	122	
	11-3051	Industrial Production Managers	Work exp	470	370	\$48.40	\$49.55		ID, NE
	13-1081	Logisticians	Bachelor	470	480	\$35.64	\$37.75		NE
	15-2011	Actuaries	Bach + exp	140	120	\$50.74	\$49.22		
	15-2041	Statisticians	Master	70	80	\$35.66	\$39.86		
	19-3022	Survey Researchers	Bachelor	-	-	-	-		
	33-3031	Fish and Game Wardens	Associate	-	-	-	-		ID
	49-1011	First-Line Supervisors/Managers of Mechanics, Installers, and Repairers	Work exp	1360	1150	\$30.30	\$30.83	29	ID
	51-1011	First-Line Supervisors/Managers of Production and Operating Workers	Work exp	1500	1400	\$28.11	\$28.44	73	ID
Master	11-3051	Industrial Production Managers	Work exp	470	370	\$48.40	\$49.55		ID, NE
	11-3071	Transportation, Storage, & Distribution Managers	Work exp	480	340	\$56.63	\$57.53	137	ES
	11-9121	Natural Sciences Managers	Bach + exp	420	-	\$73.00	-	87	ID, NE
	15-2011	Actuaries	Bach + exp	140	120	\$50.74	\$49.22		
	15-2031	Operations Research Analysts	Master	350	210	\$36.82	\$33.01		
	15-2041	Statisticians	Master	70	80	\$35.66	\$39.86		
	19-3022	Survey Researchers	Bachelor	-	-	-	-		
	19-3011	Economists	Master	80	40	\$35.84	\$34.59		NE
Doctoral	15-2031	Operations Research Analysts	Master	350	210	\$36.35	\$33.01		
	11-9121	Natural Sciences Managers	Bach + exp	420		\$72.08		87	ID, NE

Source: Delaware Department of Labor Occupational Employment Survey and Center for Applied Demography & Survey Research

Although there is an associate's degree in operations management, the Bureau of Labor Statistics only linked occupations requiring a bachelor's degree or higher level of education. Thus, it is no surprise that so many associate degree graduates continue their education. Programs in this area tend to be evenly split by gender, and 12% of graduate students in these programs are residents. Many of the occupations that are relevant to degrees in these areas experienced declining employment during the recession. For example, the number of employed industrial production managers fell by nearly 20%, and the number of operations research analysts fell by 40%.

An Analysis of Delaware's Green Educational Pipeline

Green Instructional Programs in Delaware: Plants, Animals, and the Environment



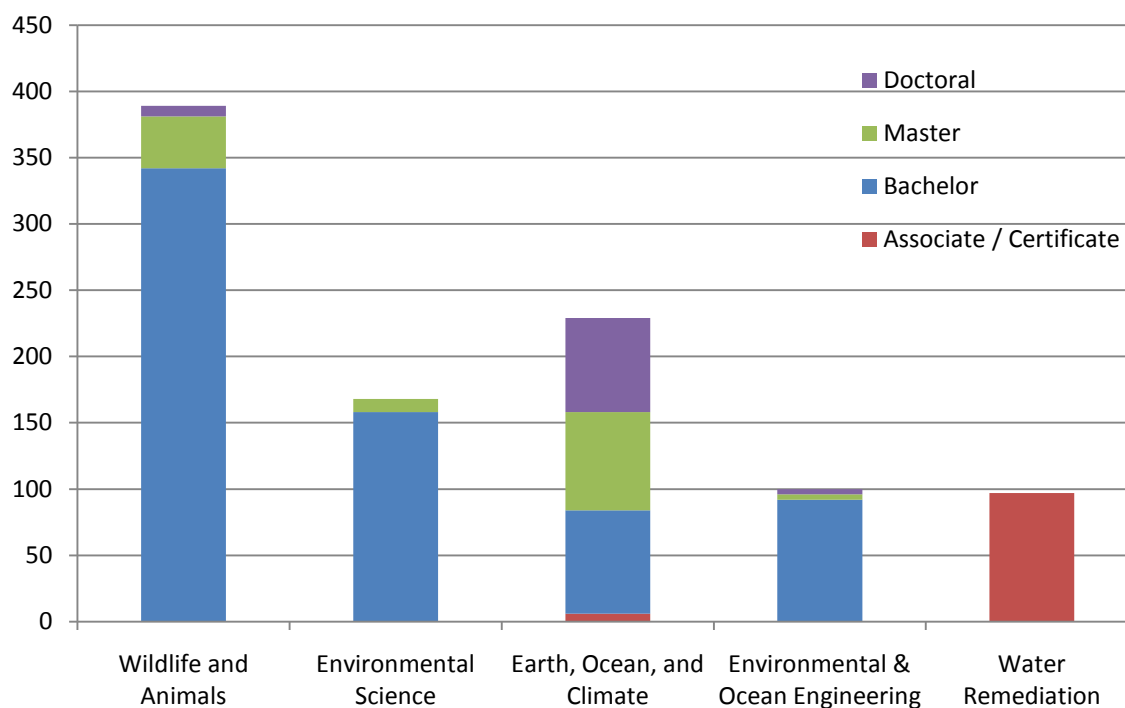
	In-State Percent – All Enrollment	Average Age – All Enrollment	% Male – Graduating Class	Emp. Rate – Graduating Class	% Cont Educ – Graduating Class
Associate	94%	27.9	63%	100%	0%
Bachelor	32%	19.9	29%	70%	28%
Master	19%	28.0	43%	67%	10%
Doctoral	10%	31.4	50%	100%	0%

- The employment rate for associate degrees includes whether the graduate was working in a related field. The employment rate for other degrees includes whether the graduate was or soon would be working in a full time occupation.

Source: Center for Applied Demography & Survey Research

Next to engineering, the most common green educational category was related to wildlife, earth, and environmental science. Nearly 100 students are enrolled in an associate degree program, and 800 are enrolled in a bachelor's degree program. The master's and doctoral level programs currently enroll between 125 and 165 students. Approximately 125 bachelor's degrees, 45 master's degrees, and 15 doctoral degrees were conferred by Delaware institutions. There is a relatively small number of males enrolled at the bachelor level, but that proportion tends to equalize at the graduate level.

Figure 21 Enrollment in Subjects Related to Wildlife, Earth, and the Environment



Source: Center for Applied Demography & Survey Research

Figure 21 shows the enrollment in different fields within this category. Majors focusing heavily on wildlife, animals, and ecological systems enroll nearly 390 students, while those related to earth sciences, climate, marine studies, and oceanography enroll nearly 225 students. The latter enrolls more graduate students than do all of the other subjects combined. The associate and certificate degrees in this area are almost completely concentrated in water supply and treatment.

An Analysis of Delaware's Green Educational Pipeline

Table 22 Potential Occupations with a Relevant Certification/Degree Related to Plants, Animals, and the Environment

Avail in DE	SOC	Occupation Title	Required Occup Educ/Exp	2008 DE Emp	2010 DE Emp	2008 Avg Wage	2010 Avg Wage	Green Survey Rank	ONET Occ. Type
Certificate	17-1021	Cartographers & Photogrammetrists	Bachelor	10	-	\$24.28	-	87	
	17-3025	Environmental Engineering Tech's	Associate	80	30	\$19.13	\$25.72		ES
	51-8031	Water and Liquid Waste Treatment Plant and System Operators	LT-OTJ	270	280	\$18.83	\$20.38	74	
Associate	51-8031	Water and Liquid Waste Treatment Plant and System Operators	LT-OTJ	270	280	\$18.59	\$20.38	74	
	17-3025	Environmental Engineering Tech's	Associate	80	30	\$18.89	\$25.72		ES
Bachelor	11-9041	Engineering Managers	Bach + exp	360	430	\$62.37	\$63.67	16	ES
	11-9121	Natural Sciences Managers	Bach + exp	420	-	\$73.00	-	87	ID, NE
	17-2081	Environmental Engineers	Bachelor	250	130	\$34.94	\$36.83	111	ES
	17-2111	Health and Safety Engineers, Except Mining Safety Engineers & Inspectors	Bachelor	110	70	\$38.99	\$39.05	78	ID
	19-1023	Zoologists and Wildlife Biologists	Bachelor	10	10	\$41.13	\$40.32		ID
	19-1031	Conservation Scientists	Bachelor	-	20	-	\$30.67		ES
	19-1032	Foresters	Bachelor	-	10	-	\$24.29		
	25-2022	Middle School Teachers, Except Special and Vocational Education	Bachelor	1930	2560	\$26.46	-		
	25-2031	Secondary School Teachers, Except Special and Vocational Education	Bachelor	1730	3100	\$28.23	-		
	33-3031	Fish and Game Wardens	Associate	-	-	-	-		ID

Source: Delaware Department of Labor Occupational Employment Survey and Center for Applied Demography & Survey Research

With the exception of middle and secondary school teachers, most occupations related to these degrees generally did not undergo substantial changes between 2008 and 2010. Both environmental engineering technicians and environmental engineers decreased employment between 2008 and 2010, but also experienced wage gains. Engineering managers, other managers, and environmental scientists and specialists experienced employment gains during the last two years. There was a relatively small number of specialists in this area, and managers had much higher salaries than non-managers.

An Analysis of Delaware's Green Educational Pipeline

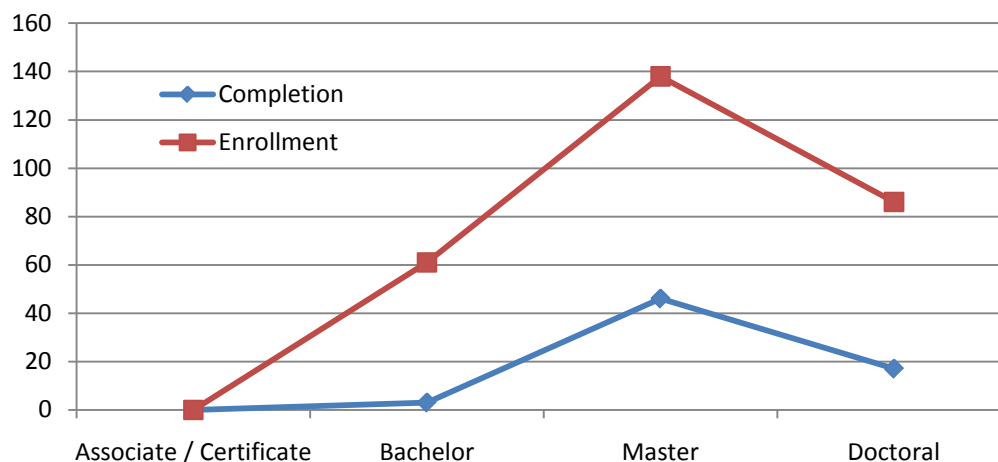
Table 22 Potential Occupations with a Relevant Certification/Degree Related to Plants, Animals, and the Environment (cont)

Avail in DE	SOC	Occupation Title	Required Occup Educ/Exp	2008 DE Emp	2010 DE Emp	2008 Avg Wage	2010 Avg Wage	Green Survey Rank	ONET Occ. Type
Master	11-9041	Engineering Managers	Bach + exp	360	430	\$62.37	\$63.67	16	ES
	11-9121	Natural Sciences Managers	Bach + exp	420	-	\$73.00	-	87	ID, NE
	11-9199	Managers, All Other	Work exp	460	640	\$53.70	\$58.91		NE
	17-2081	Environmental Engineers	Bachelor	250	130	\$34.94	\$36.83	111	ES
	19-1023	Zoologists and Wildlife Biologists	Bachelor	10	10	\$41.13	\$40.32		ID
	19-1031	Conservation Scientists	Bachelor	-	20	-	\$30.67		ES
	19-2041	Environmental Scientists and Specialists, Including Health	Master	310	370	\$29.82	\$28.77	18	ID, NE
	19-2042	Geoscientists, Except Hydrologists and Geographers	Master	50	40	\$34.09	\$38.00	49	ES
	19-2043	Hydrologists	Master	30	30	\$31.92	\$28.55	80	ID
	19-3092	Geographers	Master	-	-	-	-		
Doctoral	11-9121	Natural Sciences Managers	Bach + exp	420	-	\$73.00	-	87	ID, NE
	19-1023	Zoologists and Wildlife Biologists	Bachelor	10	10	\$41.13	\$40.32		ID
	19-1029	Biological Scientists, All Other	Doctoral	60	20	\$25.41	\$31.89		
	19-2021	Atmospheric and Space Scientists	Bachelor	-	-	-	-		ES
	19-2042	Geoscientists, Except Hydrologists and Geographers	Master	50	40	\$34.09	\$38.00	49	ES
	19-2043	Hydrologists	Master	30	30	\$31.92	\$28.55	80	ID
	19-3092	Geographers	Master	-	-	-	-		
	25-1042	Biological Science Teachers, Postsecondary	Doctoral	-	-	-	-		
	25-1051	Atmospheric, Earth, Marine, and Space Sciences Teachers, Postsecondary	Doctoral	-	-	-	-		
	25-1064	Geography Teachers, Postsecondary	Doctoral	-	-	-	-		

Source: Delaware Department of Labor Occupational Employment Survey and Center for Applied Demography & Survey Research

An Analysis of Delaware's Green Educational Pipeline

Green Instructional Programs in Delaware: Public Policy and Law



	In-State Percent – All Enrollment	Average Age – All Enrollment	% Male – Graduating Class	Emp. Rate – Graduating Class	% Cont Educ – Graduating Class
Associate	-	-		-	-
Bachelor	48%	23.3	n/a	n/a	n/a
Master	51%	32.9	36%	85%	0%
Doctoral	24%	35.3	56%	100%	0%

- The employment rate for associate degrees includes whether the graduate was working in a related field. The employment rate for other degrees includes whether the graduate was or soon would be working in a full time occupation.

Source: Center for Applied Demography & Survey Research

Degrees in public policy and law are most commonly found at the graduate level, particularly at the master's level.²¹ More in-state students are enrolled in these degrees than any other.

Students in public policy and law tend to be older, on average, than students in other fields.

²¹ Legal degrees (J.D.'s) are usually awarded without majors or official concentrations, so it is generally difficult to identify all students being trained in environmental law. However, Widener College School of Law is currently the only program in the state of Delaware awarding J.D. degrees, and the school has a program that integrates the resources of faculty members who share an interest in environmental law. A certificate program is available for student's that want to distinguish themselves as an environmental lawyer. However, students without those certificates may still learn and practice environmental law.

An Analysis of Delaware's Green Educational Pipeline

Table 23 Potential Occupations with a Relevant Degree in Public Policy

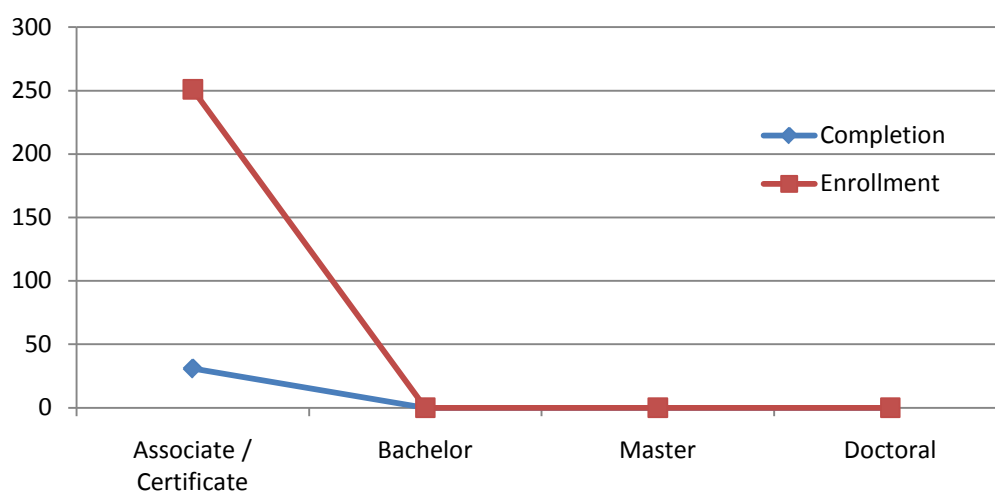
Avail in DE	SOC	Occupation Title	Required Occup Educ/Exp	2008 DE Emp	2010 DE Emp	2008 Avg Wage	2010 Avg Wage	Green Survey Rank	ONET Occ. Type
Bachelor	11-1011	Chief Executives	Bach + exp	500	310	\$94.07	\$105.40	62	NE
	11-1021	General and Operations Managers	Bach + exp	4180	4140	\$60.90	\$63.70	7	ES
	11-1031	Legislators	Bach + exp	-	190	-	-		
	11-9131	Postmasters & Mail Superintendent	Work exp	-	50	-	\$33.78		
	11-9151	Social & Community Service Mgrs	Bachelor	690	590	\$30.65	\$29.35		
	11-9199	Managers, All Other	Work exp	460	640	\$53.70	\$58.91		NE
Master	11-1011	Chief Executives	Bach + exp	500	310	\$94.07	\$105.40	62	NE
	11-1021	General and Operations Managers	Bach + exp	4180	4140	\$60.90	\$63.70	7	ES
	11-1031	Legislators	Bach + exp	-	190	-	-		
	11-9131	Postmasters and Mail Superintendents	Work exp	-	50	-	\$33.78		
	11-9151	Social & Community Service Mgrs	Bachelor	690	590	\$30.65	\$29.35		
	11-9199	Managers, All Other	Work exp	460	640	\$53.70	\$58.91		NE
	19-3051	Urban and Regional Planners	Master	190	180	\$30.13	\$29.14		ES
Doctoral	19-3051	Urban and Regional Planners	Master	190	180	\$29.75	\$29.14		ES
	23-1011	Lawyers	Prof. Cert.	2340	2620	\$70.74	\$72.96		
	25-1069	Social Sciences Teachers, Postsecondary, All Other	Doctoral	-	-	-	-		

Source: Delaware Department of Labor Occupational Employment Survey and Center for Applied Demography & Survey Research

The occupations linked to those degrees did not show an overall trend in employment. Chief executive officers, social and community service managers, and transportation, storage, and distribution managers had declines in employment, but other managers and lawyers gained employment. Although the employment pattern is mixed, the wages of most occupations have risen fairly consistently since 2008. For example, the average wage of chief executive officers increased rather sharply during the last two years despite falling employment.

An Analysis of Delaware's Green Educational Pipeline

Green Instructional Programs in Delaware: Construction and Trades



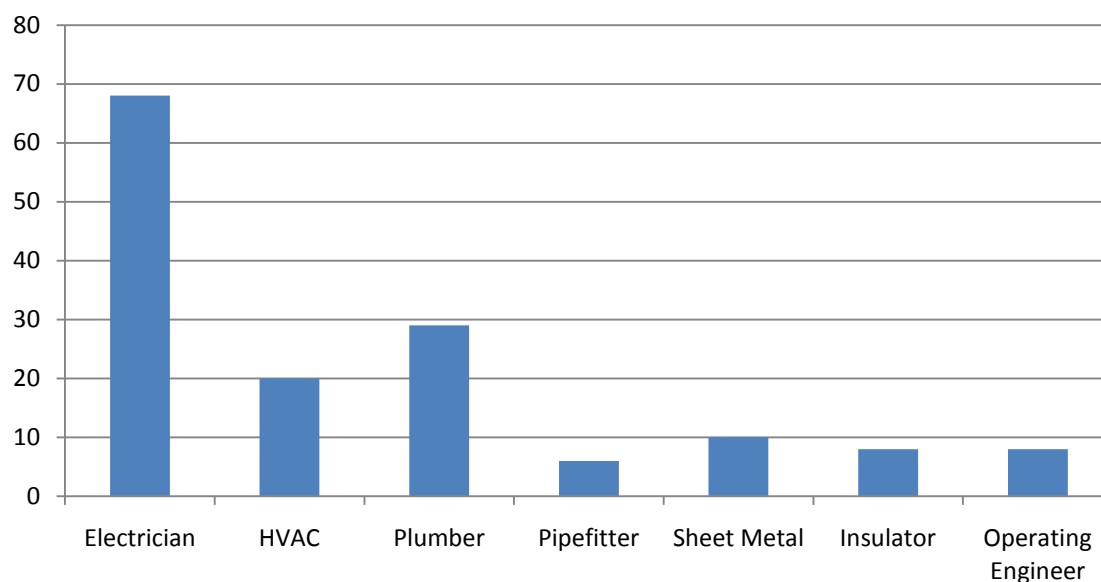
	In-State Percent – All Enrollment	Average Age – All Enrollment	% Male – Graduating Class	Emp. Rate – Graduating Class	% Cont Educ – Graduating Class
Associate	93%	26.9	84%	82%	10%

- The employment rate for associate degrees includes whether the graduate was working in a related field.

Source: Center for Applied Demography & Survey Research

In the academic pipeline, the construction and trades category consists entirely of certificates, diplomas, and associate degrees. Nearly 250 students are enrolled in these areas, of which approximately 30 graduated in 2010. A relatively small number of graduates continues their education, and of those working or looking for work, 82% had found employment in a related area. As with other associate degree programs, students enrolled in these fields are primarily Delaware residents. However, most people learning the construction and trade skills did so outside of the college environment.

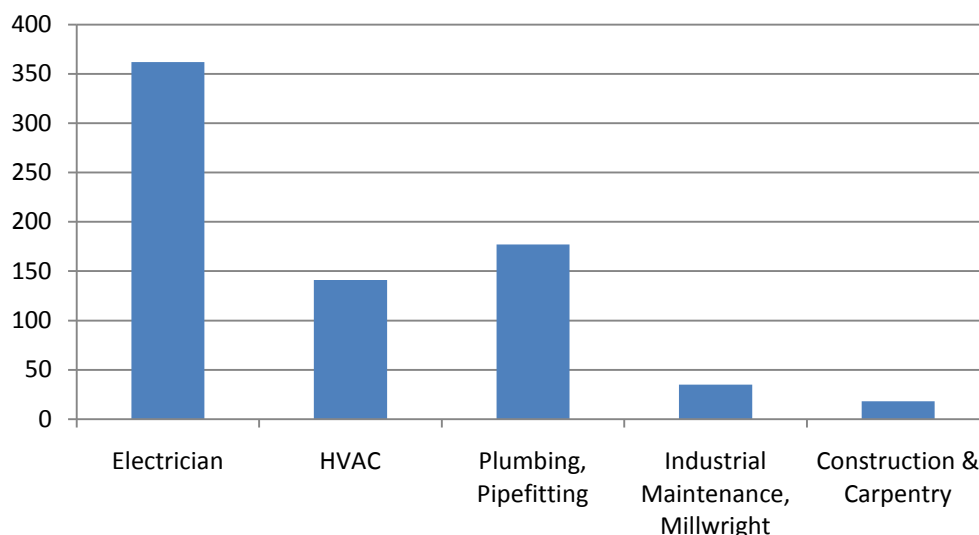
Figure 22 Journey Papers Awarded in Delaware, 2010



• Source: Delaware Department of Labor

For those in the vocational component of the green pipeline, journeyman status is analogous to a bachelor's degree. The status applies to any person who completes a four to five year apprenticeship program in a particular trade. That program requires 2,000 hours of work experience each year, and at least 600 hours of relevant coursework over the duration of the apprenticeship. Figure 22 shows the number of persons who received their journey papers in 2010. Electrical apprentices are clearly the most common, followed by plumbers and pipefitters, and HVAC technicians. A relatively small number of persons received their certifications in sheet metal, equipment and machine insulation, and heavy machine operators.

Figure 23 Enrollment in Non-Union Apprenticeship Training, 2010



Source: Center for Applied Demography & Survey Research

Figure 23 shows the number of persons enrolled in apprenticeship training through the adult divisions of the vocational high schools. Electricians attract the most number of apprenticeships (approximately 350), with plumbing and pipefitting (approximately 175) and HVAC (approximately 140) capturing most of the remaining apprentices. Students can also receive technical training at these schools without the formality of an apprenticeship.

Unfortunately complete records on technical training and union apprenticeship enrollment were incomplete. However, extrapolating from the responses we did receive, we estimate that enrollment in these technical training sessions is approximately 75% the size of non-union apprenticeship programs. Similarly, we expect that union apprenticeship programs are likely 25% to 33% the size of nonunion apprenticeship programs.

The educational pipeline is much smaller for programs that specialize in green related areas.²² Approximately 15 students received training in solar panel installation over the last year in Delaware's adult vocational schools, and DelTech is beginning to offer an associate degree program in that area. During 2010, approximately 45 students enrolled in courses that specialize in green related energy audits. The number of students enrolled in weatherization is more difficult to measure, because most programs that teach basic construction skills are often referred to as weatherization training. We estimate that between 120 to 150 people received specialized training in weatherization last year.

Delaware's pipeline also consists of shorter courses in safety and remediation. Although it can vary, most sessions take between one day and one week to complete. Programs related to water contamination and water treatment enrolled at least 700 persons in 2010, and programs related to asbestos and hazardous materials enrolled at least 450 persons. Enrollment in these courses is largely in response to U.S. Environmental Protection Agency regulations. Institutions offering these programs emphasize that the program capacity and curricula can be tailored to meet client needs.

That many more people are enrolled in an apprenticeship program could reflect the fact that most construction companies offer both green and non-green services (Brown and Ratledge, 2011). Because companies need employees versatile enough to do whatever projects are available, such specialized training programs would mostly apply as a complement to a worker's existing skills or to companies that specialize in that particular service.

²² Online courses in green related fields, such as a solar installer, wind maintenance technician, and natural gas power plant operator were also available through PolyTech's, Sussex Tech's, and Delaware Technical and Community College's websites. We did not include these courses in the educational pipeline.

An Analysis of Delaware's Green Educational Pipeline

Table 24 Potential Occupations with a Relevant Degree/Certificate: Construction and Trades

Avail in DE	SOC	Occupation Title	Required Occup Educ/Exp	2008 DE Emp	2010 DE Emp	2008 Avg Wage	2010 Avg Wage	Green Survey Rank	ONET Occ. Type
Non-Degree Training	17-3029	Engineering Tech's, Except Drafters, Other	Associate	20	-	\$29.50	\$26.63		NE
	29-9011	Occupational Health & Safety Specialists	Bachelor	220	430	\$27.48	\$29.94	79	ID
	47-4011	Construction and Building Inspectors	Work exp	410	390	\$22.68	\$22.80	77	ES
	47-4041	Hazardous Materials Removal Workers	MT-OTJ	110	130	\$20.82	\$18.48		ES
	47-4071	Septic Tank Servicer & Sewer Pipe Cleanr	MT-OTJ	70	60	\$16.13	\$18.22		
	47-4099	Construction and Related Workers, Oth	MT-OTJ	30	40	\$15.96	\$18.32	81	NE
	49-2098	Security & Fire Alarm Systems Installers	Tech. Cert.	190	220	\$22.29	\$25.79		
	49-9021	Heating, Air Conditioning, and Refrigeration Mechanics and Installers	Tech. Cert.	1410	980	\$20.55	\$22.36	4	
	49-9042	Maintenance and Repair Workers, Gen	MT-OTJ	3930	3160	\$17.76	\$17.59	40	ES
	49-9097	Signal and Track Switch Repairers	MT-OTJ	-	-	-	-		
	49-9099	Installation, Maintenance, and Repair Workers, All Other	MT-OTJ	400	340	\$17.04	\$19.04		ID,ES,NE
	47-3012	Helpers--Carpenters	ST-OTJ	240	160	\$12.12	\$13.39		ID
	47-3013	Helpers--Electricians	ST-OTJ	380	130	\$12.98	\$14.13	38	
	47-3015	Helpers--Pipelayers, Plumbers, Pipefitters, and Steamfitters	ST-OTJ	130	130	\$13.54	\$12.60	27	
	47-3019	Helpers, Construction Trades, All Other	ST-OTJ	70	100	\$11.93	\$13.36	37	
Associate & Certificate	11-9021	Construction Managers	Bachelor	910	600	\$45.89	\$49.92	13	ES
	17-3029	Engineering Technicians, Except Drafters, All Other	Associate	20	-	\$29.50	\$26.63		NE
	27-1025	Interior Designers	Associate	160	100	\$20.25	\$22.31	121	
	49-9021	Heating, Air Conditioning, and Refrigeration Mechanics and Installers	Tech. Cert.	1410	980	\$20.55	\$22.36	4	

Source: Delaware Department of Labor Occupational Employment Survey and Center for Applied Demography & Survey Research

Since 2008, occupations linked to the certificate and associate degrees have experienced substantial declines in employment. For example, there were nearly 800 fewer employed general maintenance and repair workers in 2010 as there were in 2008 and 300 fewer construction managers. These declines are undoubtedly attributable to the recession and collapsed housing market. Occupations most common among green businesses, namely plumbers, pipefitters, and steamfitters, first line supervisors/managers of construction trade workers, and HVAC mechanics experienced declines similar to the other occupations listed in the table.

An Analysis of Delaware's Green Educational Pipeline

Table 24 Potential Occupations with a Relevant Degree/Certificate: Construction and Trades (cont)

Avail in DE	SOC	Occupation Title	Required Occup Educ/Exp	2008 DE Emp	2010 DE Emp	2008 Avg Wage	2010 Avg Wage	Green Survey Rank	ONET Occ. Type
Journey Papers	29-9011	Occupational Health and Safety Specialists	Bachelor	220	430	\$27.48	\$29.94	79	ID
	37-1011	First-Line Supervisors/Managers of Housekeeping and Janitorial Workers	Work exp	1100	440	\$17.09	\$18.00	126	
	47-1011	First-Line Supervisors/Managers of Construction Trades and Extraction Wrkrs	Work exp	2270	1810	\$31.00	\$31.39	3	NE
	47-2011	Boilermakers	LT-OTJ	-	30	-	\$27.51		ID
	47-2031	Carpenters	LT-OTJ	2820	1800	\$21.62	\$20.81	35	ID
	47-2111	Electricians	LT-OTJ	2130	1580	\$23.96	\$23.26	20	ID
	47-2131	Insulation Workers, Floor, Ceiling, & Wall	MT-OTJ	250	-	\$18.33	\$14.61	65	ID
	47-2132	Insulation Workers, Mechanical	MT-OTJ	450	330	\$22.10	\$21.68	48	
	47-2152	Plumbers, Pipefitters, and Steamfitters	LT-OTJ	1630	1480	\$24.29	\$23.79	1	ES
	47-4041	Hazardous Materials Removal Workers	MT-OTJ	110	130	\$20.82	\$18.48		ES
	47-4071	Septic Tank Servicer & Sewer Pipe Cleaner	MT-OTJ	70	60	\$16.13	\$18.22		
	49-1011	First-Line Supervisors/Managers of Mechanics, Installers, and Repairers	Work exp	1360	1150	\$30.30	\$30.83	29	ID
	49-2098	Security and Fire Alarm Systems Installers	Tech. Cert.	190	220	\$22.29	\$25.79		
	49-3042	Mobile Heavy Equipment Mechanics, Except Engines	LT-OTJ	470	440	\$21.33	\$21.28		
	49-3043	Rail Car Repairers	LT-OTJ	90	-	\$21.95	-		
	49-9021	Heating, Air Conditioning, and Refrigeration Mechanics and Installers	Tech. Cert.	1410	980	\$20.55	\$22.36	4	
	49-9041	Industrial Machinery Mechanics	LT-OTJ	750	680	\$25.65	\$24.91		ID
	49-9042	Maintenance and Repair Workers, General	MT-OTJ	3930	3160	\$17.76	\$17.59	40	ES
	49-9043	Maintenance Workers, Machinery	MT-OTJ	50	-	\$18.99	\$16.96		
	49-9044	Millwrights	LT-OTJ	160	120	\$27.29	\$23.17	96	ID
	49-9045	Refractory Mat. Repairer, Exc. Brickmason	MT-OTJ	-	-	-	-		
	49-9051	Electrical PowerLine Installers & Repairers	LT-OTJ	420	220	\$27.94	\$30.24		ID
	49-9097	Signal and Track Switch Repairers	MT-OTJ	-	-	-	-		
	49-9099	Installation, Maintenance, and Repair Workers, All Other	MT-OTJ	400	340	\$17.04	\$19.04		ID, ES, NE
	51-4023	Rolling Machine Setters, Operators, and Tenders, Metal and Plastic	MT-OTJ	140	-	\$17.06	-		
	51-4031	Cutting, Punching, and Press Machine Setters, Oprtrs, &Tenders, Metal/Plastic	MT-OTJ	390	230	\$15.17	\$15.44		ID
	51-4061	Model Makers, Metal and Plastic	LT-OTJ	-	-	-	-		

Source: Delaware Department of Labor Occupational Employment Survey and Center for Applied Demography & Survey Research

Comparing Wages across Bachelor Degree Selection

In this section we explore the value of a green bachelor's degree program by looking at the wages of persons with similar degrees. All data comes from the 2009 American Community Survey and is based on a sample of the U.S. population. The American Community Survey did not ask for information concerning the type of associate degrees, graduate degrees, or vocational certifications.

Table 25 shows the expected wage of a four year college degree for the broad type of major attained.²³ The first column shows the average wage of persons who obtained a bachelor's degree but did not attain a graduate education. The third column shows the average wage for persons who attained a graduate degree after attaining a bachelor's degree in the listed field. The fifth column shows the unemployment rate for all persons with a bachelor's degree in the respective major. The 90% margin of error has been calculated for each field.²⁴ Categories containing green majors are highlighted.

In 2009, persons with bachelor's degrees in an engineering field were paid an average wage of \$80,200. The next two green-related majors with the highest wages were in construction services and engineering technologies. Persons receiving bachelor's degrees in the environment or natural resources were paid an average of \$52,600. At the lower end of the green spectrum are degrees in public affairs, policy, and social work. The table also indicates that people who pursued graduate education received higher wages.

²³ Students were categorized based on their first major. Second majors were not included.

²⁴ The 90% margin of error (MOE) indicates the degree of uncertainty within the estimates due to statistical sampling issues. Larger values indicate a greater of uncertainty. For majors with relatively few persons enrolled (Electrical and Mechanic Repairs and Technology, Military Technology, Precision Production and Industrial Arts), the uncertainty is particularly strong).

An Analysis of Delaware's Green Educational Pipeline

Table 25 Average Wage and Unemployment Rate for Persons with a Bachelor Degree: Broad Majors, 2009

Green Majors	Bachelor only		+ Grad Degree		All Degrees	
	Avg. Wage	90% MOE (+/-)	Avg. Wage	90% MOE (+/-)	Unem. Rate	90% MOE (+/-)
Engineering	\$80,200	1,500	\$105,400	2,800	4.7	0.4
Construction Services	\$73,800	9,200	\$89,400	33,700	5.6	3.1
Engineering Technologies	\$66,900	3,900	\$83,400	7,700	6.1	1.4
Physical Sciences	\$61,300	3,100	\$105,400	4,200	3.9	0.7
Environment and Natural Resources	\$52,600	3,800	\$73,900	9,400	4.9	1.5
Electrical and Mechanic Repairs and Tech	\$52,100	13,200	\$86,400	38,200	5.8	9.5
Agriculture	\$49,100	3,400	\$71,700	7,700	3.2	0.9
Biology and Life Sciences	\$48,900	2,300	\$107,900	3,100	3.3	0.5
Public Affairs, Policy, and Social Work	\$41,000	2,200	\$56,400	3,500	4.8	1.2
Computer and Information Sciences	\$69,600	1,900	\$90,000	3,900	5.8	0.8
Mathematics and Statistics	\$68,100	4,300	\$94,500	5,100	4.9	0.9
Transportation Sciences & Technologies	\$67,700	6,600	\$89,300	14,700	3.6	1.6
Business	\$66,400	800	\$94,300	2,300	5.3	0.3
Social Sciences	\$62,400	2,300	\$96,900	3,600	5.2	0.4
Military Technologies	\$61,800	31,900	\$101,900	62,700	1.9	6.1
Architecture	\$60,400	3,800	\$74,000	7,900	8.6	1.4
History	\$56,200	4,200	\$88,800	4,800	5.3	0.9
Medical and Health Sciences and Services	\$56,000	1,100	\$81,800	3,000	2.3	0.4
Interdisciplinary and Multi-Disciplinary	\$55,000	3,400	\$91,600	6,900	4.9	1.1
Nuclear, Industrial Radiology, & BioMed.	\$53,300	10,300	\$60,300	37,300	2.5	4.1
Criminal Justice and Fire Protection	\$52,300	2,300	\$69,600	7,000	4.2	0.8
Communications	\$52,000	2,000	\$67,800	4,200	6.1	0.7
Philosophy and Religious Studies	\$51,800	8,200	\$71,500	7,500	5.3	1.3
Precision Production and Industrial Arts	\$50,800	25,800	\$107,200	98,500	6.9	10.5
Law	\$49,400	7,700	\$85,600	19,800	7.8	4.2
Liberal Arts and Humanities	\$49,200	3,000	\$70,600	5,100	5.5	0.9
Cosmetology Services and Culinary Arts	\$48,300	9,100	\$54,100	27,100	8.8	7.0
English Language, Literature, & Compos.	\$47,800	2,400	\$69,300	3,400	5.5	0.7
Communication Technologies	\$47,000	7,400	\$53,100	18,900	8.3	4.2
Area, Ethnic, and Civilization Studies	\$46,900	10,000	\$76,300	11,800	6.4	2.4
Linguistics and Foreign Languages	\$44,000	4,000	\$69,300	7,300	5.5	1.2
Psychology	\$43,800	1,600	\$66,000	2,400	5.0	0.5
Physical Fitness, Parks, Recreation, and	\$41,600	3,000	\$65,500	8,000	4.6	1.3
Fine Arts	\$39,800	1,600	\$51,400	3,100	7.5	0.8
Education Administration and Teaching	\$38,500	600	\$54,500	700	3.3	0.3
Family and Consumer Sciences	\$36,700	2,800	\$54,600	5,300	3.3	0.9
Theology and Religious Vocations	\$35,600	3,400	\$45,300	3,900	3.4	1.0
Library Science	\$33,000	16,200	\$58,300	18,500	4.7	4.8

Source: 2009 American Community Survey

An Analysis of Delaware's Green Educational Pipeline

Table 26 Average Wage for Persons with a Bachelor Degree: Detailed Green Majors, 2009

Green Majors	Bachelor only		+ Grad Degree	
	Avg. Wage	90% MOE (+/-)	Avg. Wage	90% MOE (+/-)
Geosciences	\$96,500	41,400	\$90,500	21,500
Chemical Engineering	\$91,800	7,400	\$114,000	9,400
Electrical Engineering	\$83,400	2,800	\$108,800	4,600
Engineering and Industrial Management	\$82,000	18,900	\$90,200	21,300
Industrial and Manufacturing Engineering	\$79,500	7,600	\$101,300	11,300
Civil Engineering	\$78,800	4,400	\$99,000	6,500
Computer Engineering	\$78,400	4,700	\$92,900	8,200
Engineering Mechanics, Physics, and Science	\$76,600	19,900	\$103,800	24,300
Geological and Geophysical Engineering	\$76,200	37,300	\$122,600	67,700
Construction Services	\$73,800	9,200	\$89,400	33,700
Environmental Engineering	\$72,200	19,300	\$83,900	29,500
General Engineering	\$71,700	3,500	\$102,700	10,000
Materials Engineering and Materials Science	\$69,300	17,500	\$98,500	20,000
Oceanography	\$69,200	21,600	\$78,600	23,100
Statistics and Decision Science	\$68,500	24,700	\$99,400	27,400
Transportation Sciences and Technologies	\$67,700	6,600	\$89,300	14,700
Miscellaneous Engineering	\$67,400	8,600	\$108,100	30,400
Soil Science	\$65,800	33,600	\$81,700	49,900
Miscellaneous Engineering Technologies	\$65,600	9,100	\$78,300	17,600
Mechanical Engineering Related Technology	\$65,100	11,400	\$95,300	31,600
Electrical Engineering Technology	\$65,000	7,000	\$76,000	14,800
Industrial Production Technologies	\$64,900	6,700	\$83,600	16,500
Geology and Earth Science	\$63,700	8,200	\$82,600	8,700
Architectural Engineering	\$62,400	14,900	\$87,400	22,900
Public Administration	\$62,200	7,100	\$83,900	16,600
Atmospheric Sciences and Meteorology	\$62,100	17,400	\$70,900	18,100
Forestry	\$62,100	9,200	\$69,900	11,700
Engineering Technologies	\$62,000	10,900	\$84,300	24,200
Operations, Logistics and E-Commerce	\$61,900	8,400	\$113,900	31,000
Agricultural Economics	\$61,900	10,700	\$92,800	38,200
Chemistry	\$57,300	4,000	\$113,200	6,800
Geography	\$56,700	5,300	\$74,800	12,000

Source: 2009 American Community Survey

Table 26 Average Wage for Persons with a Bachelor Degree: Detailed Green Majors, 2009 (cont)

Green Majors	Bachelor only		+ Grad Degree	
	Avg. Wage	90% MOE (+/-)	Avg. Wage	90% MOE (+/-)
Public Policy	\$53,000	21,500	\$98,700	29,900
Plant Science and Agronomy	\$52,400	10,800	\$66,000	13,800
Electrical and Mechanic Repairs and Tech	\$52,100	13,200	\$86,400	38,200
Biochemical Sciences	\$51,900	10,200	\$115,700	13,600
Zoology	\$50,300	8,100	\$119,500	15,200
Agriculture Production and Management	\$49,900	5,400	\$67,200	17,100
Natural Resources Management	\$49,700	5,400	\$76,100	17,700
Environmental Science	\$49,200	5,800	\$74,400	13,900
Animal Sciences	\$43,800	5,700	\$71,500	12,200
General Agriculture	\$43,300	6,000	\$65,200	13,800
Ecology	\$42,800	6,700	\$77,800	21,100
Molecular Biology	\$42,600	10,200	\$103,400	17,700
Botany	\$40,700	15,000	\$64,200	19,300
Miscellaneous Agriculture	\$39,400	16,200	\$59,600	22,200

Source: 2009 American Community Survey

Table 26 reports the average wage for more detailed degree programs relevant to the green industry. The average wage of someone with a bachelor's degree in geoscience tops the list, however the high margin of error indicates that a large amount of uncertainty is in that estimate. Engineering degrees rank among the most lucrative type of green degrees one could receive. Agricultural degrees are among the least lucrative degrees in the country. Degrees related to natural resource economics tend to receive slightly more compensation than chemistry and biochemistry degrees. Degrees related to wildlife and environmental science tended to be less paid than degrees in the earth sciences.²⁵

²⁵ A conventional hypothesis test should be performed to determine whether the wages of any two particular fields are statistically different.

Discussion

In this section, we discuss pertinent implications from previous sections. Complementary data is added for perspective. First, we discuss labor market implications based on the changing employment and wage patterns for occupations relevant to persons exiting the green educational pipeline. Next, we summarize the educational implications of a survey administered to green businesses in Delaware. Then we synthesize the opinions of educators in the pipeline, and briefly discuss the role of mathematics.

Supply and Demand Issues for Select Occupations

No one would be surprised to learn that employment has declined considerably over the last two years. Conventional wisdom tells us that during recessionary environments, businesses cut back the number of employees because consumers purchase less goods and services. After witnessing high declines in employment (particularly in the construction sector where consumer demand has dried up the most), we are tempted to attribute such declines on the recession and point towards an overall decline in demand. However, if that were true, we also expect to witness falling wages. Our reasoning comes down to the basic theory of supply and demand.

Figure 24 Expected Differences between a Decrease in Demand and a Decrease in Supply

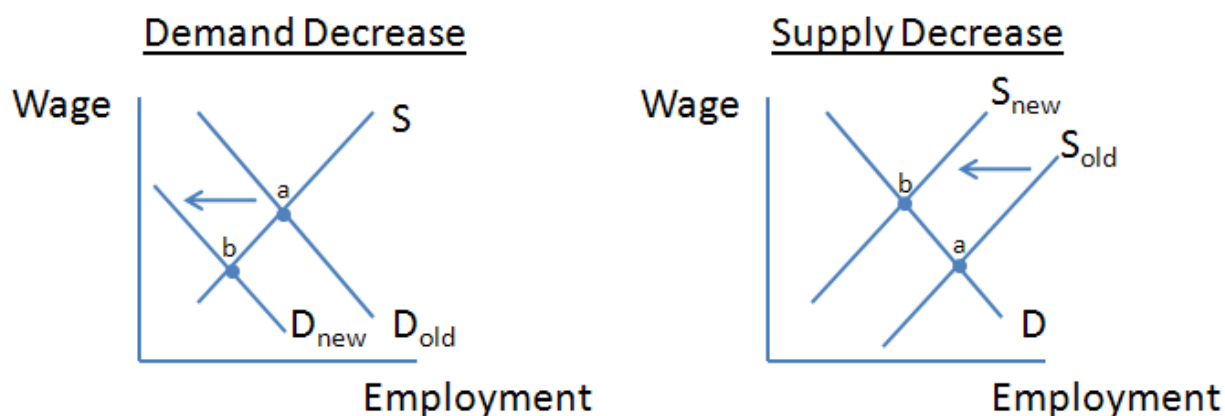


Figure 24 shows two supply and demand diagrams. The one on the left shows a decrease in employment caused by a decline in demand. As demand for a particular occupation falls, the demand curve shifts to the left ($D_{old} \rightarrow D_{new}$), and a new equilibrium is reached (b) where both wage and employment levels are lower than before (a). However, if the labor market experienced a decrease in supply ($S_{old} \rightarrow S_{new}$), then moving to the new equilibrium ($a \rightarrow b$) would result in lower employment but higher wages. Changes in wages and employment can be very informative in conjunction with the basic theory of supply and demand.

Before we proceed, the reader should know that the nature of occupational data is more sensitive to statistical uncertainty than other types of labor market information. It is difficult to detect actual changes in wages and employment at the detailed occupational level.²⁶ However, the occupational information presented in this report is still the best possible estimates provided by the data. Patterns found across different occupations could potentially be revealing important features of Delaware's green economy.

²⁶ At more aggregate occupational codes, we found statistically significant (95% confidence) employment declines in the life, physical, and social science occupations (SOC 19-0000), community and social service occupations (21-0000), office and administrative support occupations (43-0000), construction and extraction occupations (47-0000), installation, maintenance and repair occupations (49-0000), and transportation and material moving occupations (53-0000). We also found significant real wage increases (CPI adjusted) for management occupations (11-0000), office and administrative support occupations (43-0000), and installation, maintenance and repair occupations (49-0000).

An Analysis of Delaware's Green Educational Pipeline

Table 27 Occupations Attainable With a Green Degree Experiencing Declines in Employment and Wages

Required Education	Occupational Title	Employment Change 08-10	Wage Change 08-10	Naïve Expectation ²⁷
MT-OTJ	Insulation Workers, Mechanical	-27%	-2%	Demand -
	Maintenance and Repair Workers, General	-20%*	-1%	Demand -
LT-OTJ	Carpenters	-36%*	-4%	Demand -
	Electricians	-26%*	-3%	Demand -
	Plumbers, Pipefitters, and Steamfitters	-9%	-2%	Demand -
	Mobile Heavy Equipment Mechanics, Except Engines	-6%	-0%	Demand -
	Industrial Machinery Mechanics	-9%	-3%	Demand -
	Millwrights	-25%	-15%*	Demand -
Associate	Civil Engineering Technicians	-5%	-4%*	Demand -
	Electrical and Electronic Engineering Technicians	-56%*	-1%	Demand -
Bachelor	Social and Community Service Managers	-15%*	-4%*	Demand -
Master	Operations Research Analysts	-40%*	-10%*	Demand -
	Economists	-53%*	-5%	Demand -
Bach + exp	Administrative Services Managers	-6%	-4%	Demand -
	Management Analysts	-18%*	-2%	Demand -
	Actuaries	-14%	-3%	Demand -

• 2008 wages adjusted for inflation using CPI index

* Employment/wage significantly less in 2010 at 90% confidence.

Source: Delaware Department of Labor Occupational Employment Survey and Center for Applied Demography & Survey Research

Table 27 shows which of the green-related occupations in the previous section experienced declines in wages and employment.^{28,29} Practically all of the conventional trade professions that require long term on-the-job training saw declining wages and employment between 2008 and 2010. Civil and electrical engineering technicians also experienced these effects. On the upper end of the educational ladder, actuaries, economists, and operations research analysts are occupations that seem to have witnessed the symptoms of falling demand.

²⁷ "Naïve expectations" refers to the expected underlying change in labor market conditions that would apply if the restrictive assumptions behind the classical supply and demand paradigm were true.

²⁸ Due to rounding issues, we ignored occupations whose employment changed by 10 or less in absolute value.

²⁹ A one-tailed test of statistical significance was performed comparing wages and employment between 2008 and 2010. The confidence of the test was kept intentionally weak (90% confidence) due to the nature of occupational data. The Bureau of Labor Statistics also uses 90% confidence levels when analyzing occupational data.

An Analysis of Delaware's Green Educational Pipeline

Table 28 Occupations Attainable With a Green Degree Experiencing Declines in Employment and Increases in Wages

Required Education	Occupational Title	Employment Change 08-10	Wage Change 08-10	Naïve Expectation
ST-OTJ	Helpers--Electricians	-66%*	9%*	Supply -
	Helpers--Carpenters	-33%*	10%*	Supply -
LT-OTJ	Electrical Power-Line Installers and Repairers	-48%*	8%*	Supply -
MT-OTJ	Installation, Maintenance, and Repair Workers, All Other	-15%	12%*	Supply -
	Cut, Punch, & Press Machine Setter, Oprtr & Tender, Metal/Plastic	-41%*	2%	Supply -
	Chemical Equipment Operators and Tenders	-24%*	7%*	Supply -
Tech. Cert.	Architectural and Civil Drafters	-26%	10%*	Supply -
	Heating, Air Conditioning, and Refrigeration Mechanics & Installers	-30%*	9%*	Supply -
Work exp	Industrial Production Managers	-21%*	2%	Supply -
	Transportation, Storage, and Distribution Managers	-29%*	2%	Supply -
	First-Line Sup's/Mgr's of Housekeeping and Janitorial Workers	-60%*	5%*	Supply -
	First-Line Sup's/Mgr's of Landscaping, Lawn Service, and Grounds	-6%	2%	Supply -
	First-Line Supervisors/Managers of Construction Trades and Extrtn	-20%*	1%	Supply -
	Construction and Building Inspectors	-5%	1%	Supply -
	First-Line Sup's/Mgr's of Mechanics, Installers, and Repairers	-15%*	2%	Supply -
	First-Line Sup's/Mgr's of Production and Operating Workers	-7%	1%	Supply -
Associate	Environmental Engineering Technicians	-63%*	34%*	Supply -
	Interior Designers	-38%*	10%	Supply -
Bachelor	Construction Managers	-34%*	9%*	Supply -
	Cost Estimators	-8%	4%	Supply -
	Landscape Architects	-18%	7%	Supply -
	Environmental Engineers	-48%*	5%	Supply -
	Health & Safety Engineers, Exc. Mining Safety Engineers & Inspctrs	-36%	0%	Supply -
Bach + exp	Chief Executives	-38%*	12%*	Supply -
	General and Operations Managers	-1%	5%*	Supply -
	Sales Managers	-26%	15%*	Supply -

• 2008 wages adjusted for inflation using CPI index

* Employment significantly less in 2010 / wage significantly more in 2010 at 90% confidence.

Source: Delaware Department of Labor Occupational Employment Survey and Center for Applied Demography & Survey Research

Given the severity of the recession, we expected more occupations would show evidence of declining demand. On the contrary, most occupations exhibited signs of declining supply. Table 28 shows occupations where the wages have increased but employment has decreased.

At face value, it seems difficult to accept that such rampant job loss is attributable to a decline in the supply of workers. Of course, plausible hypotheses do exist. One could argue that extended unemployment benefits reduced the incentive to work and led to skill atrophy among the unemployed. It is also possible that the aging demographic effects are reducing the number of primarily older occupations, while younger workers are less interested in learning the skill sets of these occupations.

Other explanations are possible if additional considerations are allowed beyond the simple supply and demand paradigm. For example, one hypothesis is that companies are looking for employees with certain characteristics. Those without such characteristics are more likely to be fired or turned down for a position. On the other hand, persons who possess those characteristics see improved wages. For example, if employers discriminate based on whether an employee is currently unemployed or near retirement, the supply of labor that the business considers has effectively fallen.

A similar explanation is that there is a problem matching job seekers with potential employers. For example, companies may have increased scrutiny of job applicants in search of the ideal candidate or employees that can perform multiple job duties. There are two rationales for this hypothesis. First, during a recession employers attempt to maintain productivity by looking for efficiencies within their operations. Employees that are specialized in one particular area are more likely to be fired if their job duties can be performed by other, existing employees. Second, businesses that are uncertain about what kind of goods and services need to be produced in the future will want employees versatile enough to do any task that might be required. In this hypothesis, poor job matching is the result of increased uncertainty.

According to both the discrimination and job-matching explanations, businesses would perceive that the workers applying for jobs are not qualified enough for the jobs being offered. This change in business demand effectively lowers the number of job candidates that are considered, and would exhibit same wage and employment patterns as a decline in labor supply. Both hypotheses also imply that there are job openings available, but companies are less likely to fill them. A recent symposium at the Bureau of Labor Statistics presented evidence that a relatively high proportion of job openings were not filled in 2010, and these vacancies were driven by events happening in the construction sector (Clayton, Spletzer, and Wohlson, 2011).

If labor supply is falling due to household behavior, then policies that encourage motivation and job training should help to correct labor market imbalances. If job discrimination is the reason, further research is needed to understand what exclusionary criteria are being applied and how applicants can overcome those restrictions. If the job matching hypothesis applies, then unemployed persons should receive training in areas that complement their existing skill set or in other areas being demanded by businesses. Of course, multiple explanations could be valid, and it is entirely plausible that each explanation is true for particular segments of the workforce.

Regardless of which explanation is true, the type of occupations that appear to show declining labor supplies includes those occupations specially geared towards more conventional green projects. In particular electrician helpers, carpenter helpers, other installation, maintenance, and repair workers, power line installers and repairers, construction and building inspectors, and HVAC mechanics, installers, and repairers seem to have wage gains but employment declines.

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Table 29 Occupations Attainable With a Green Degree Experiencing Increases in Employment and Wages

Required Education	Occupational Title	Employment Change 08-10	Wage Change 08-10	Naïve Expectation
ST-OTJ	Helpers, Construction Trades, All Other	43%	12%	Demand +
Tech. Cert.	Security and Fire Alarm Systems Installers	16%	16%*	Demand +
Work exp	Managers, All Other	39%*	10%*	Demand +
Bachelor	Chemical Engineers	31%	19%*	Demand +
	Materials Scientists	29%	10%	Demand +
	Occupational Health and Safety Specialists	95%*	9%*	Demand +
Bach + exp	Engineering Managers	19%	2%	Demand +
Prof. Cert.	Lawyers	12%	2%	Demand +

• 2008 wages adjusted for inflation using CPI index

* Employment/wage significantly more in 2010 at 90% confidence.

Source: Delaware Department of Labor Occupational Employment Survey and Center for Applied Demography & Survey Research

Table 29 shows those occupations where both wages and employment have increased over the last two years. The occupations are indicative of areas where secular demand increases may have outperformed the recessionary effects. Chemical engineers and material scientists make up many of these occupations, but so too did other construction helpers and occupational health and safety specialists.

An Analysis of Delaware's Green Educational Pipeline

Table 30 Occupations Attainable With a Green Degree Experiencing Increases in Employment and Declining Wages

Required Education	Occupational Title	Employment Change 08-10	Wage Change 08-10	Naïve Expectation
MT-OTJ	Hazardous Materials Removal Workers	18%	-11%*	Supply +
Associate	Mechanical Engineering Technicians	23%	-12%*	Supply +
Associate	Environmental Science and Protection Technicians, Incl. Health	50%*	-3%	Supply +
Bachelor	Civil Engineers	3%	-12%*	Supply +
Bachelor	Electrical Engineers	14%	-4%	Supply +
Bachelor	Mechanical Engineers	30%	-5%	Supply +
Master	Environmental Scientists and Specialists, Including Health	21%*	-4%	Supply +
Bach + exp	Computer and Information Systems Managers	21%	0%	Supply +

• 2008 wages adjusted for inflation using CPI index

* Employment significantly more in 2010 / wage significantly less in 2010 at 90% confidence.

Source: Delaware Department of Labor Occupational Employment Survey and Center for Applied Demography & Survey Research

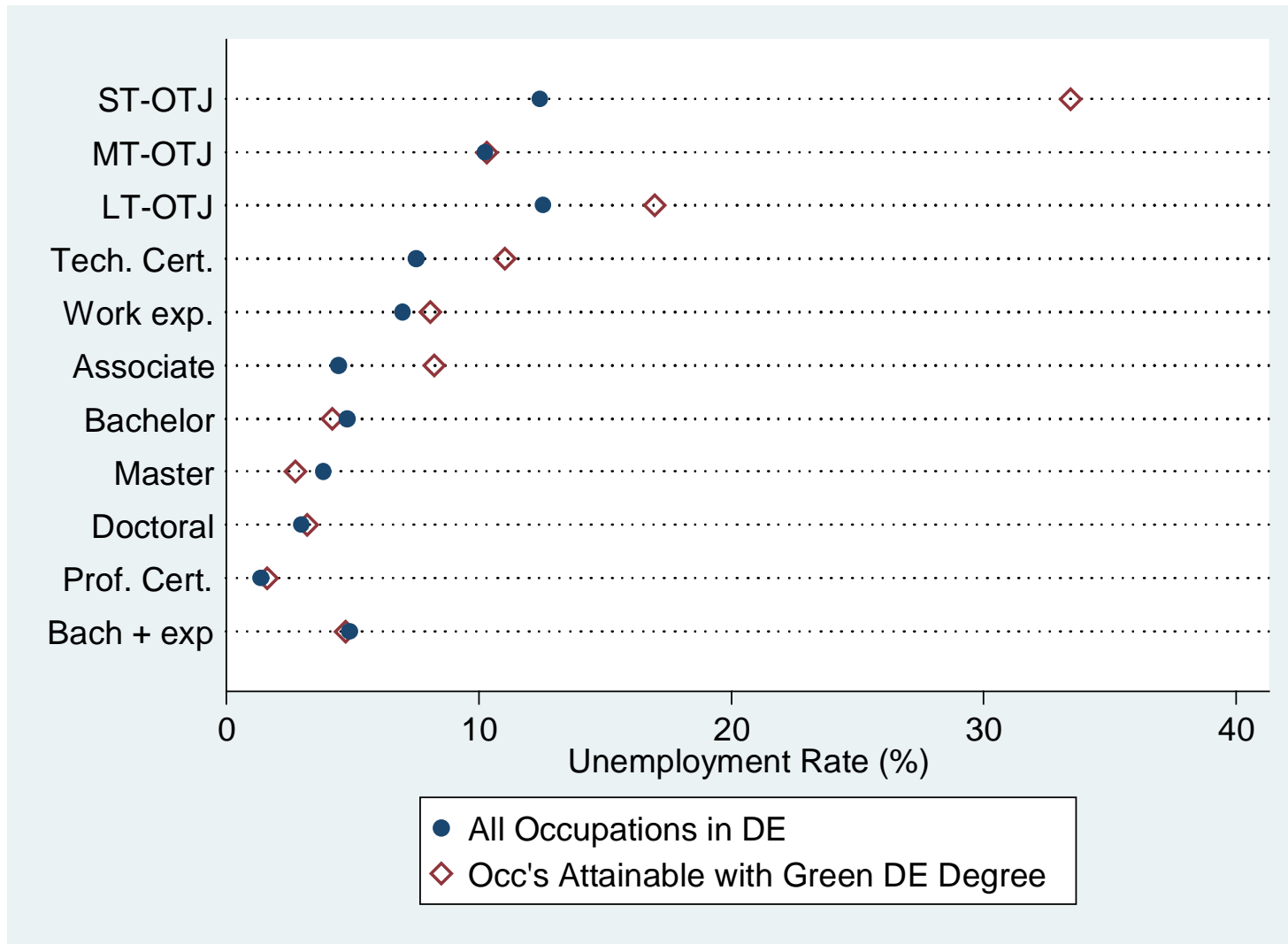
Table 30 shows specific occupations that declined in wage and increased in employment that would traditionally be evidence of increased labor supply. Many of these occupations are the traditional engineering professions, such as civil, electrical, and mechanical engineers. Other occupations include environmental science technicians, environmental scientists and specialists, and hazardous materials removal workers. So far, businesses have employed these additional occupations but at lower wages.

Figure 25 uses national unemployment rates for 2010 to better understand the labor conditions of Delaware workers.³⁰ The figure shows a weighted average of those rates for selected occupations.³¹ In each line, the blue dot indicates the weighted average of all occupations requiring the same level of experience, training, or educational background. The hollow diamond refers just to those occupations that could be obtained with one of the green degrees and training discussed in this report (see Table 18 through Table 24).

³⁰ SOC codes are given the unemployment rates of the CPS occupational group to which they belong.

³¹ Occupational weights have been adjusted to reflect Delaware's specific occupational composition.

Figure 25 National Unemployment Rates for Relevant Occupations, by Training and Educational Requirements



• Source: Currently Population Survey, Outgoing Rotation Groups, 2010 and Center for Applied Demography & Survey Research

For all occupations requiring short term (ST-OTJ) or long term on-the-job training (LT-OTJ), the blue dots indicate that unemployment rates averaged near 12.5%. Occupations needing moderate on-the-job training (MT-OTJ) are expected to have unemployment rates near 10%. The average rate for occupations requiring an associate's or bachelor's degree is less than 5%. Occupations requiring more education and training tend to have lower unemployment rates.

The hollow diamonds indicate the expected unemployment rates for potentially green occupations. Unemployment rates were substantially worse for nonacademic, green-related occupations at the associate degree level and below. In particular, green occupations requiring short term on the job training (helpers of construction and trades) have exceptionally high unemployment rates. More generally, green occupations requiring an associate's degree, work experience, short term on-the-job training, or long term on-the-job training had higher rates of unemployment than occupations with similar levels of training or experience.

Those green occupations requiring an associate's degree or less likely have high unemployment rates because they are concentrated in or related to construction. Until the demand for this industry picks up, students receiving related training face a weak labor market. Of course, green policy may be raising the demand for selected skills, like weatherization, building performance analyst, and solar photovoltaic installation, but not enough to offset the much larger declines of the larger industry.

On the other hand, green occupations requiring a bachelor's degree or a master's degree have slightly lower unemployment rates than all jobs of similar requirements. This likely reflects the fact that certain occupations are important to both the green and non-green industries. For example, a person with a bachelor's degree in engineering may have less trouble finding a job than a person with a bachelor's degree in some other field.

Survey Results of Green Businesses

The Center conducted a recent survey of green businesses in the state to understand what type of businesses make up the green components of our economy (Brown and Ratledge, 2011). In that survey, we asked for what type of instructional programs businesses believed to be most relevant and desirable in their employees. Table 31 lists the programs that are mentioned most frequently by green businesses.

Companies selling energy-efficient goods and services were undoubtedly the largest sector in Delaware's green economy. They primarily wanted their workers to be trained with technical skills or associate degrees rather than more advanced academic degrees. In fact, a vo-tech high school graduate with general construction skills was cited most frequently by companies in this sector. With the exception of mechanical engineering (#20) and LEED certification, the energy efficiency sector's top 20 list of relevant programs generally required less than four years of instruction.

The second column of Table 31 shows the skills most often cited by companies in Delaware's renewable energy sector. Auditing of a building's energy performance, as recognized by BPI certification, is most commonly cited by companies selling renewable energy products and services. That training is available at any one of DelTech's campuses and also at the adult division at Sussex Tech. Compared to the energy efficiency sector, renewable energy companies were more likely to find four year academic degrees desirable.

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Table 31 Top 20 Most Cited Relevant and Desirable Technical Training / Academic Programs cited by Delaware's Green Businesses

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.

Source: Center for Applied Demography & Survey Research

The third column reports the training and education most commonly cited by companies in the natural resource conservation sector. This sector is the primary one that found degrees related to wildlife, earth, and the environmental sciences as relevant. These companies most frequently cited training in geographical information systems (GIS), followed by natural resource economics, and soil and environmental science. Degrees in environmental engineering and environmental technology also ranked relatively high.

Like the energy-efficiency sector, the pollution reduction and recycling sector most frequently mentioned that vo-tech high school students with a construction background were relevant and desirable. The next most relevant programs include a bachelor's degree in soil and environmental science and one in civil engineering. Programs intended to mitigate pollution directly, such as soil remediation, asbestos safety, wastewater treatment, and lead abatement also ranked in the top 20.

In the final column of Table 31, all of Delaware's green businesses are evaluated as one group. Relatively few green companies mentioned an academic degree as being desirable and relevant. The four-year degrees that stood out were in environmental engineering, and mechanical engineering. LEED certification is a skill that requires advanced engineering skills, but is not a formal degree. In the nonacademic pipeline, HVAC training, geothermal technology, and general construction skills ranked particularly high.

Opinions of Academic Educators

As part of our analysis of the pipeline, we surveyed and interviewed department chairs and administrators of various academic programs offered in Delaware's green pipeline. We asked educators to rank how they perceived student interest and whether any curriculum changes specifically addressed green related issues. We also asked what skills students most needed to have to be successful in those programs, and how well prepared students were who entered. Finally, educators were asked to indicate if they saw any changes in the career prospects of graduates that could be attributable to 'going green'.

The responses generally indicated that there was no single trend in student interest for green related majors. Educators in chemistry, biochemistry and engineering related fields indicated that applicant interest was quite high, but those in agriculture, wildlife, earth, and the environment indicated that student interest depended on the particular major in question. Student interest in engineering technologies was not perceived as being very high.

Many educators indicated that green related issues were being addressed in the curricula. For example, sustainable landscape and agricultural methods were being integrated into agricultural programs. Educators in the wildlife, earth and environmental science areas said that the curricula have increasingly emphasized the importance of ecosystems and ecological diversity. Many changes are underway in the engineering and engineering technology curricula, including the introduction of more LEED related issues, the design of sustainable infrastructure, and an increased graduate focus on cutting edge materials related to renewable energy technology.

Almost every educator agreed that students entering a green related program would be best equipped with an analytical mindset and a strong mathematical background. Agricultural instructors also emphasized the importance of the natural sciences, while chemistry and biochemistry educators felt that students would be best equipped with a background in calculus and statistics. The engineering and engineering technology faculty mentioned the importance of chemistry and physics, and felt that advanced calculus classes were most helpful for students to know. Besides science and math, students entering a field related to wildlife, earth, and the environment would do well to possess taxonomic and communication skills. Students entering fields in public policy and law need to be able to express ideas clearly and possess organizational skills.

With a couple of exceptions at the associate degree level, educators were generally favorable about the initial quality of students. Those dissenting educators believed that students needed to be better prepared in mathematics before exiting high school. When the educators were asked about the career prospects of their graduates, most either said that they did not know what those prospects looked like or that there was not yet much of an influence coming from green related issues. The exception was in engineering department chairs, who believed that many green opportunities existed for their graduates, and that companies expected graduates to have specific green skills.

Opinions of Adult Vocational Educators

We also interviewed adult vocational educators, administrators of union apprenticeship programs, and private business owners that provide relevant training to the workforce. During the interview process, we asked how the recession has affected training and career prospects for students going through their program. We also asked about the quality of applicants and what skills an applicant most needed to have. Finally, we asked each interviewee to name one thing that was most important for policy makers and the public to know about their program. This section summarizes the opinions of those educators.

In general, most vocational instructors said that the number of people wanting to learn a trade increased during the recession, and these applicants have backgrounds that are more diverse than applicants prior to the recession. Many more persons want to learn a trade to pursue an interest that they previously had but chose not to pursue. In Delaware's community colleges for instance, enrollment in non-degree introductory courses in HVAC, refrigeration, and residential wiring, and blueprint reading increased 60% between 2008 and 2010.

Most instructors have also seen a decline in the number of apprenticeships being offered. Because apprentices learn via work experience, in periods of low demand there is simply less experience to be had. Union apprenticeship programs have scaled back their admittance rate considerably. Some nonunion instructors also indicated reduced interest in sponsorships, and pointed to the reluctance of employers to commit to guaranteed wage increases that are associated with apprenticeships.

In terms of applicant quality, the instructors strongly emphasized deficiencies in three areas: mechanical skill, mathematical ability, and job readiness. Of the three, job readiness was the most prohibitive. Approximately half of the interviewees said that applicants most needed to improve their punctuality and motivation; lack of attendance was cited as the major reason people fail apprenticeships. For applicants without these behavioral issues, the most important skill that applicants could have is mechanical dexterity (including object visualization). While the educators believed that there was a limited degree of substitution between mathematical and mechanical skills, mechanical aptitude was more important. The educators believed that mathematical deficiencies were relatively easy to overcome through coursework, but mechanical skills are only developed through practice and experience, and are far more difficult to teach.

There were generally two issues that educators and trainers felt were most important to communicate to the public. First, the instructors perceived that the desire to cut costs has resulted in employers being unwilling to invest in the skills of their own employees. Similarly, some companies have leaned their operations to such a great extent, that the opportunity cost of investing in an employee's development is simply too great. As a consequence of the failure to invest, companies are finding outsourcing and off-shoring options are relatively more profitable.

The second issue raised by the vocational educators was that an insufficient number of children were learning mechanical skills. They voiced concern over policies that steer children towards an academic education and away from a vocational one. Students that pursue a college education are less likely to have learned the mechanical ability needed for a trade occupation. Educators were particularly worried over the cumulative and deleterious effects that these policies are having on the workforce. Policies that cut mechanical skills out of the entry-level workforce (high school graduates) leave employers in construction with an increasingly limited pool of skilled applicants.

Mathematical Skills and Degree Choice

Improving the mathematical skills of our population has been a stated priority of the U.S. Department of Education for at least the last three administrations.³² This has important implications, since the department chairs of green academic programs almost unanimously responded that students undertaking green instruction would be best equipped with an analytical mindset and a solid background in math and science. Vocational trainers and adult educators also acknowledged that persons applying for apprenticeships lacked the ability to do simple algebra (though they believed such skills could easily be learned).

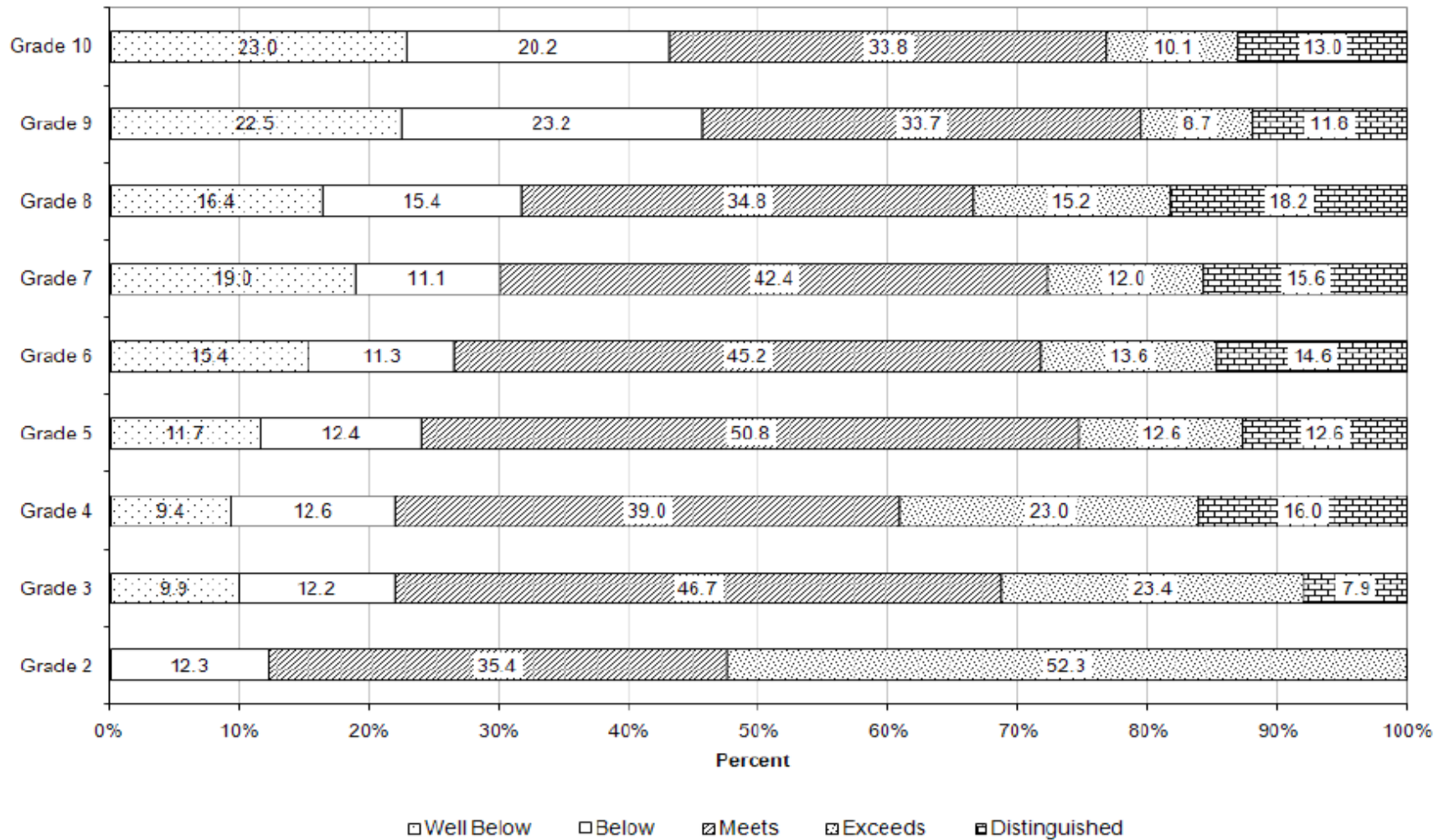
That most green educational programs require strong science and mathematical backgrounds is also consistent with the results of a survey of green businesses (Brown and Ratledge, 2011). In that survey, we found that green businesses are more likely to employ occupations that use engineering and mathematical skills than similar, non-green companies. In fact, when explicitly asked what skills would be most helpful to their business, basic skills (i.e. reading, writing, arithmetic, and the softer skills of employability) were the second most common response, and mathematics specifically was the third most common response. Mechanical and craft skills was the most common response.

Figure 26 shows the SAT10 scores in mathematical performance for Delaware's elementary, primary, and secondary school students. The figure indicates that more students fail to meet expectations as they move on into higher grades.

³² <http://www2.ed.gov/about/overview/mission/archived-priorities.html>

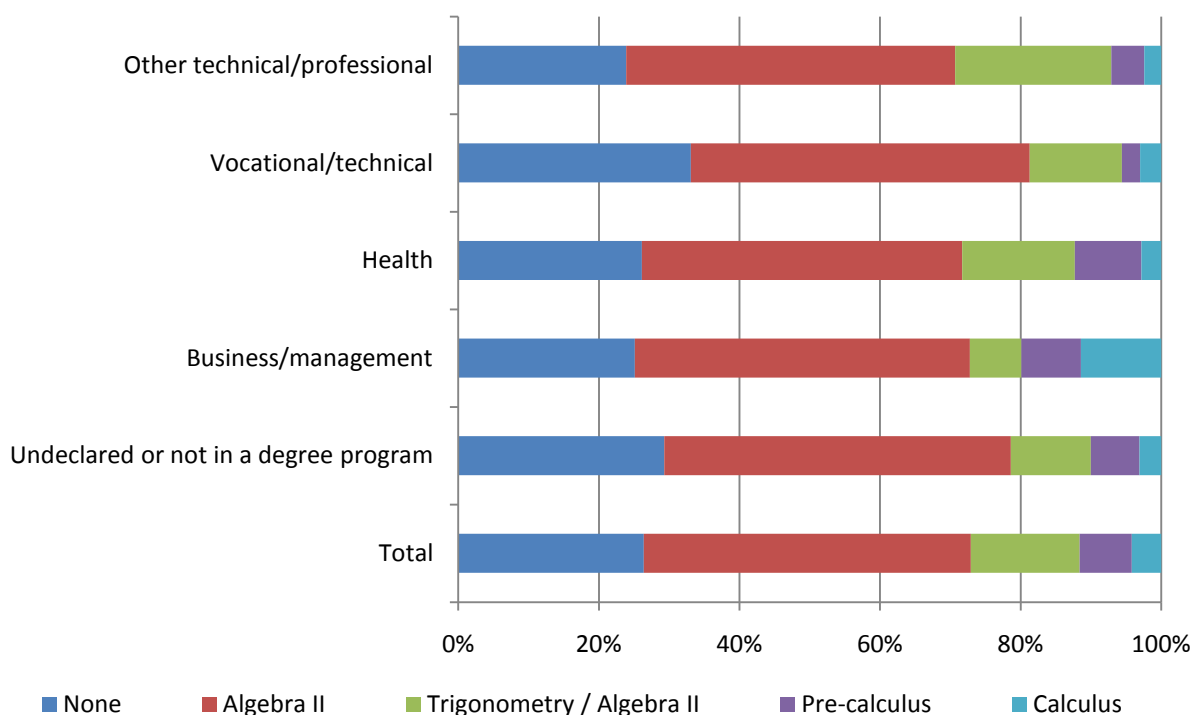
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Figure 26 **Delaware Student Testing Program: How Well Mathematical Performance Levels Are Meeting Expectations, 2010**



Source: Delaware Department of Education, Curriculum and Instructional Support Branch. "Delaware Student Testing Program: State Summary Results of the Reading and Mathematics Assessment, Spring 2010 Administration Grades 2 through 10". July 2010.

Figure 27 First Year Certificate Student: % Taking Math Classes Beyond Algebra in High School, 2003-2004



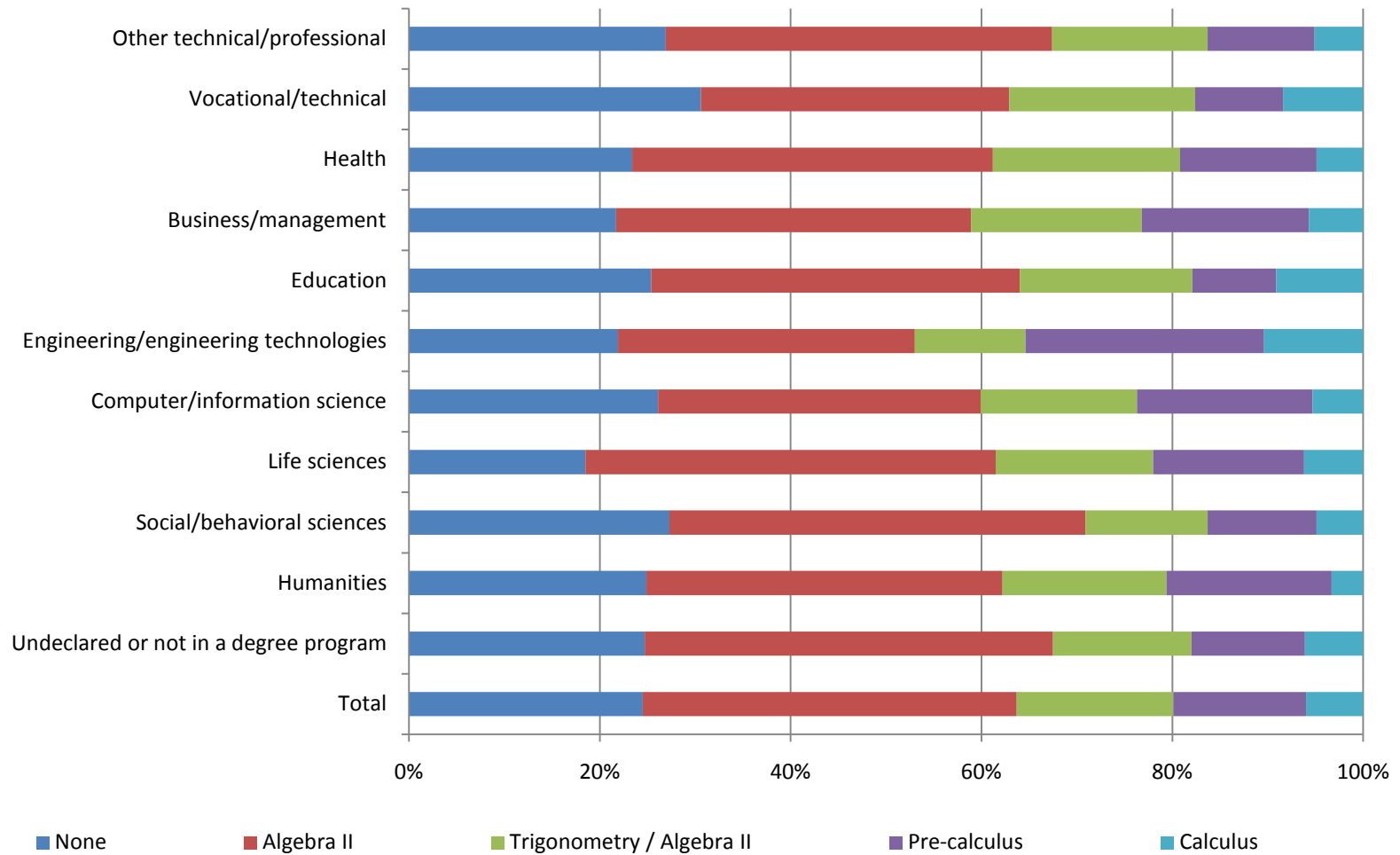
Source: U.S. Department of Education, National Center for Education Statistics, 2003-04 Beginning Postsecondary Students Longitudinal Study, Second Follow-up (BPS:04/09).

How well students do in high school math is an important predictor of their choices regarding further education. Figure 27 shows the most advanced high school math class taken by students entering a postsecondary certificate program for the first time. Approximately 80% that entered a vocational or technical certificate program did not take courses beyond Algebra II, and there is no information on how well they performed in that subject.

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Figure 28

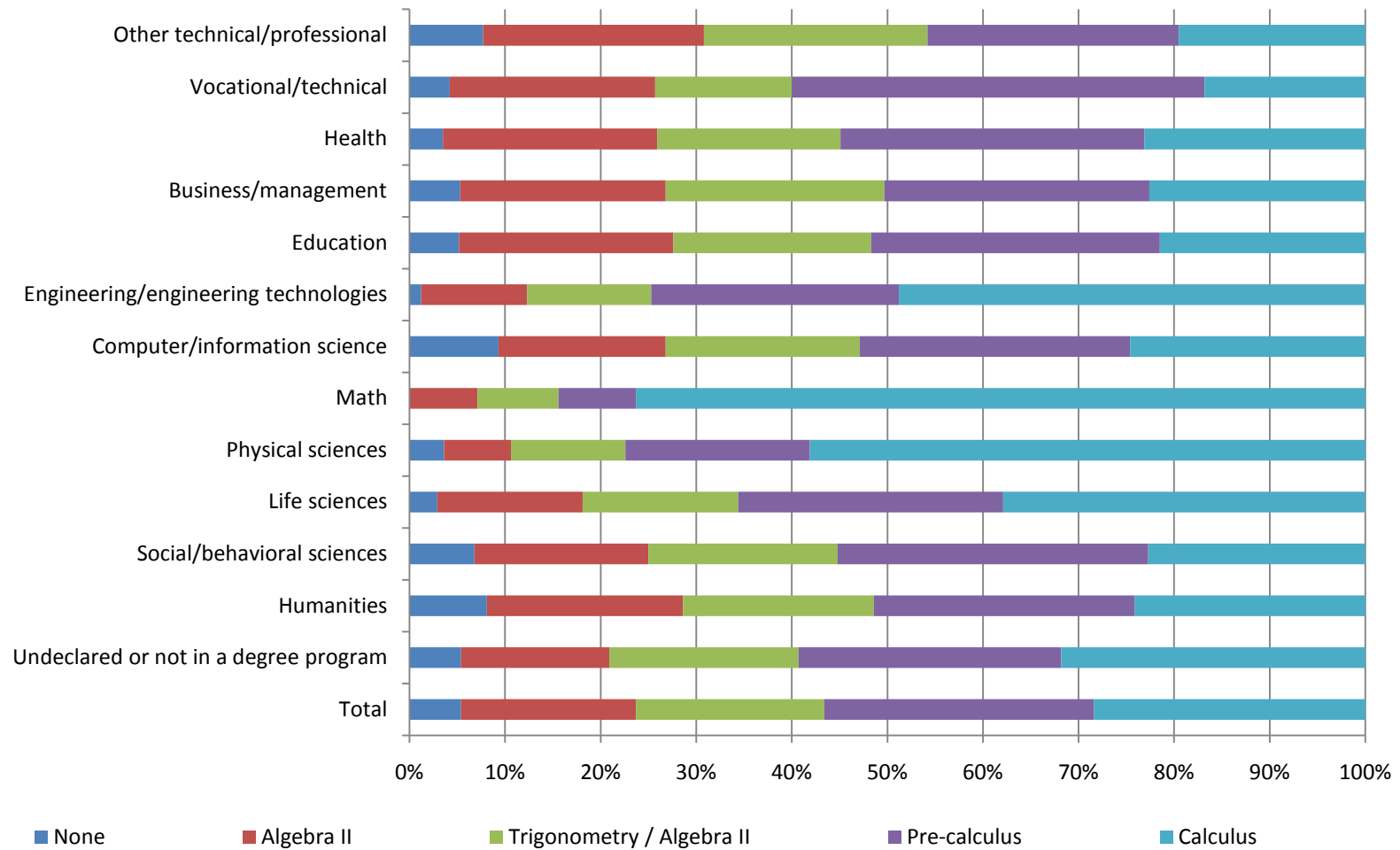
First Year Associate Degree Students: % Taking Math Classes Beyond Algebra in High School, 2003-2004



Source: U.S. Department of Education, National Center for Education Statistics, 2003-04 Beginning Postsecondary Students Longitudinal Study, Second Follow-up (BPS:04/09).

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Figure 29 First Year Bachelor Degree Students: % Taking Math Classes Beyond Algebra in High School, 2003-2004



Source: U.S. Department of Education, National Center for Education Statistics, 2003-04 Beginning Postsecondary Students Longitudinal Study, Second Follow-up (BPS:04/09).

Figure 28 and Figure 29 show the high school mathematical backgrounds of first year students entering an associate program and bachelor program, respectively. Like Figure 27, this chart decomposes those backgrounds by choice of major. Students entering the engineering, engineering technology, or physical science majors had better backgrounds in math than students entering other majors. Students entering vocational or technical majors are not much different in terms of mathematical background than the average student.

Economists have long maintained that people choose careers for which they are most suited. The same is true for choosing how much and what type of education to take. For example, students entering philosophy or music likely choose those degrees because they have the interest, ability, and preparation that best suits such majors. The main point is that educational policies cannot simply encourage students to switch from a non-green major to green one without also tackling the more challenging issues of student interest, ability, and preparation. These factors undoubtedly play a role in explaining the wage differences across academic majors as well. Similar logic applies to persons at in other stages of the green pipeline.

Conclusion

The purpose of this report was to provide useful descriptions of the components of Delaware's educational pipeline that are relevant to the environment and the green economy. The report is rich in content and covers many areas. Hopefully, readers have gained a better understanding of the current status of that pipeline.

In Delaware, 29% of the state's adult labor force has a bachelor's degree or higher level of education, 26% has some other college experience, and 33% has a high school diploma or equivalent degree. The remaining 11% do not have a high school diploma. Whether measured by the unemployment rate or the ability to find full time employment, the effects of the recession have been worse for people with less education. Based on the existing composition of Delaware's workforce, if the green economy creates jobs for persons without a high school degree, it will most likely be in construction or remediation services.

The type of degrees granted by Delaware institutions has undergone a transition over the last 10 years. Degrees in beauty and personal services, education, business, nursing, accounting, economics, finance, and physical fitness/sports management have been on the rise, while degrees in history, consumer economics, and fashion have been declining. More pertinent to the green economy are the increasing number of undergraduate degrees in engineering and construction, and the decreasing number of undergraduate degrees related to wildlife, earth, and the environment.

Classifying instructional programs between green or non green is a relatively subjective process. If the green label was granted to a program that prepares students for any green job, most educational programs would be classified as green. Despite this caveat, we still identified instructional programs in engineering, engineering technology, wildlife, earth, and environmental science, construction and trades, chemistry and biochemistry, natural resource economics, operations research, logistics, environmental law, and public policy as being most relevant based on the curricula, faculty research, and number of green jobs that linked to each area. The green pipeline is divided between academic degrees and vocational training.

In terms of enrollment size, the major academic institutions in the green pipeline are the University of Delaware (UD) and Delaware Technical and Community College (DelTech). During the 2009-2010 academic year, 51 people were enrolled in a certificate degree program, 1,788 in an associate's degree program, 3,018 in a bachelor's degree program, 502 in a master's degree program, and 780 in a doctoral degree program. DelTech specializes in associate degrees and workforce training, while UD specializes in bachelor's and graduate degree programs.

Within the academic section of Delaware's green pipeline, engineering and engineering technology was the largest area of study. The next largest was with respect to the wildlife, earth, and environmental sciences. Education in chemistry, biochemistry, and then agriculture are the next largest components in the educational pipeline. The programs at DelTech were notable because so much of their curricula is being updated to explicitly address green related issues.

The nonacademic sector of the educational pipeline is almost entirely made up of training in the construction and trades. Although there is not the formal credentialism that the academic pipeline has, there still are very different levels of instruction available. Green related training taking less than one week to complete is primarily offered by DelTech or private companies. DelTech, the adult vocational schools, and the Delaware Skills Center offer green-related instruction that can take up to three months to complete. A four to five year apprenticeship program can be also be taken through an adult vocational school or a local trade union. However, apprenticeship programs require company or union sponsorship, and sponsorship is sensitive to economic conditions.

It is difficult to get an accurate count of persons learning a relevant construction or trade. In the vocational schools, there are approximately 750 persons enrolled in an apprenticeship. We estimate that there are likely 200 to 250 persons enrolled in a relevant union apprenticeship and 550 persons enrolled in some other kind of technical training. In sum, the construction and trades sector would be the second largest green component next to engineering and engineering technologies in Delaware's pipeline. Almost all of the vocational training in the major trades teach green related skills in case there is customer demand for those skills.

We also found that the shorter, stand-alone courses teaching the more publicized green skills are actually a relatively small piece in the green educational pipeline. In 2010, approximately 15 students received stand-alone training in solar panel installation and 45 received instruction on performing residential energy audits. We also estimate that between 120 and 150 students received weatherization training.

Those green academic programs that enrolled the highest proportion of in-state students were in agriculture, chemistry and biochemistry, and public policy, and that proportion declines as the level of academic degree increases. Associate degree programs and technical certificates were almost entirely comprised of in state students, while residential enrollment of most doctoral degree programs was less than 10%. Persons enrolled in bachelor degree programs are generally between the ages of 20 and 21. The age of persons enrolled green related programs varied by program and degree.

Persons receiving a bachelor or graduate degree related to wildlife, earth science, and the environment or agriculture reported the least success in finding full time employment. This is in line with national wage trends. The 2009 American Community Survey indicated that persons with these bachelor degrees tended to have the lowest wages of all green related degrees. Persons receiving an engineering degree had the highest expected wages. Of course, it is difficult to link the career outcomes of recent graduate directly to Delaware's economy, since so few of these students are in-state and are more likely to leave upon graduation.

The recession may be having profound effects on occupations attainable with green training or a green degree. Occupations attainable with a bachelor's degree (or higher level of education) in a green area had no higher rates of unemployment than occupations related to other academic degrees. However, occupations available to people with a green associate's degree or vocational training have substantially much higher unemployment rates, and these jobs tend to be in construction and manufacturing. Demand appears to have fallen for conventional tradesmen (i.e. plumbers, electricians, carpenters, etc.) and engineering technicians, however many occupations seem to be signaling declines in the supply of labor.

Different hypotheses were presented that could explain the signs of falling labor supply. One explanation is that the workforce is aging in certain key occupations, but the younger generation is generally disinterested in those professions. Another is that businesses may be becoming increasingly selective over which job applicants they hire during recessions. Applicants failing to meet the additional criteria are less likely to even be considered for employment, and that decision effectively reduces the labor supply.

We also collected the opinions of academic department chairs and administrators, as well as from vocational instructors in the green pipeline. For students to be successful in the academic pipeline, the educators emphasized the importance of math, science, and analytical skill. For students to be successful in the nonacademic pipeline, the educators emphasized the importance of behavioral changes as well as an earlier development of mechanical aptitude. We showed evidence that the mathematics attained in high school strongly influenced whether people enter an academic program or not, as well as in which field they choose to major if they go.

A previous survey had indicated that businesses selling green goods and services most frequently mentioned the desirability of a vo-tech high school graduate with a construction background. Green businesses also thought that it would be relevant and desirable if their employees had skills related to HVAC, energy management, environmental technology, and geothermal technology. Green businesses also commonly cited persons with LEED certification or an academic background in mechanical or environmental engineering.

Of course, the types of skills demanded by green businesses do not necessarily reflect those skills needed by companies that 'go green' by operating with a greater sense of environmental awareness. These companies may need an entirely different set of skills among their employees, but those skills were outside the scope of our study.

Whether businesses will demand employees with green skills remains to be seen, and policy makers should think carefully about which training programs they promote. Increasing the labor supply under weak demand conditions will raise the unemployment rate and put even further downward pressure on wages. On the other hand, if skill mismatch between companies and employees explains the gap, then training is appropriate.

Of course, there are tremendous difficulties involved with forecasting the future green economy. Crucial pieces of information are not yet known, such as the rate at which energy prices rise or what will be written by future legislation. Moreover, forecasts typically rely on patterns and correlations uncovered from historical records. Not only do such records not yet exist for the green economy, but the type of green economy that has been envisioned may be quite different from the past. For both reasons, we feel that it is essential to develop an initial set of facts for the green educational pipeline.

Just as we recognize the inherent uncertainty in the green economy, we must also recognize the opportunities that could be lost by being too dismissive. If events unfold that propel the green economy into the spotlight permanently and our society is not prepared to meet that demand, then potential market gains would be wasted and standards of living would decline while the future workforce readied itself. If policies prepare for that situation, it is critical that we understand what the capabilities are in Delaware's educational system.

The Center has written this report so that policy makers and the public have facts and a better understanding about Delaware's green economy and the corresponding educational pipeline. We hope that the information proves useful.

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Appendix

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Table 32 Completions of Certificate Programs Less than 1 Year, by Institution and Degree Classification: 2010

<u>Program Type</u>	Dawn Institute	DelTech - Owens	Harris - Dover	DelTech - Stanton	Academy Massage & Bodywork	Institute Cosmetol.	Harris - Wilm.	DelTech - Terry	DE Coll. Art & Design	Schiller Douglas Hair Design	Total
Arts and Theatre									4		4
Business Mgmt & Logistics		1						1			2
Administrative / Medical Records	182	15	107								304
Computer Sci. / Info Mgmt			1					1	5		7
Criminal Justice				1							1
Education								2			2
Engineering & Engineering Tech.		2						2			4
Language & Literature		38		44							82
Legal	11	10						3			24
Nursing & Health	155										155
Physical Ed. / Sports	11										11
Psychology / Development				3				2			5
Construction		117							1		118
Beauty / Personal Service	48		6		46	35	16			6	157
Total	407	183	114	48	46	35	16	11	10	6	876

Source: Integrated Postsecondary Data System (IPEDS), National Center for Education Statistics, and Center for Applied Demography & Survey Research

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Table 33 Completions of Certificate Programs More than 1 and Less than 2 Years, by Institution and Degree Classification: 2010

	Harris - Wilm	DelTech - Owens	DelTech - Terry	Schiller Douglas Hair Design	DE Academy - Paul Mitchell	DelTech - Stanton	Harris - Dover	Institute Cosmetol.	Total
Accounting/Finance/Economics		24				1			25
Business Mgmt & Logistics		63	1						64
Chemistry / Biochemistry / Biology						3			3
Administrative / Medical Records	274	2				12			288
Education		12				1			13
Engineering & Engineering Tech.		19				3			22
Marketing		20	1						21
Nursing & Health	74	113	72			11	31		301
Psychology / Development		26	1						27
Construction		26				3			29
Beauty / Personal Service	25			63	38			27	153
Total	373	305	75	63	38	34	31	27	946

Source: Integrated Postsecondary Data System (IPEDS), National Center for Education Statistics, and Center for Applied Demography & Survey Research

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Table 34 Associate Degree Completions, by Institution and Degree Classification: 2010

	DelTech - Stanton	DelTech - Owens	DelTech - Terry	UDel	WilmU	DE Coll. Art & Design	Wesley	Goldey	Beebe	Strayer	Widener	Total
Accounting/Finance/Economics	18	21	14					5		2		60
Agriculture		14		1								15
Arts and Theatre			26			50						76
Business Mgmt	49	69	28				51	19		12		228
Chemistry / Biochemistry / Biology	20	2	1									23
Administrative / Medical Records	3	4	2									9
Communication		11	10									21
Computer Sci. / Info Mgmt	18	6	7		8			2		1		42
Criminal Justice	39	20	18									77
Education	26	31	24	9	7							97
Engineering & Engineering Tech.	47	44	39									130
Hotel/Hospitality	15		8									23
Legal		8	4								2	14
Marketing	1	7	2							1		11
Mathematics / Physics		3	1									4
Nat Resource Econ / Op Research	7											7
Nursing & Health	208	119	64						21		1	413
Other Social Sciences				244	58		1					303
Physical Ed. / Sports	24	12										36
Wildlife, Earth, Environment		3										3
Psychology / Development	28	25	28									81
Construction	19	22	9			10						60
Total	522	421	285	254	73	60	52	26	21	16	3	1,733

Source: Integrated Postsecondary Data System (IPEDS), National Center for Education Statistics, and Center for Applied Demography & Survey Research

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Table 35 Bachelor Degree Completions, by Institution and Degree Classification: 2010

	UDel	WilmU	DelState	Wesley	Goldey	Widener	Strayer	Total
Accounting/Finance/Economics	349	116	16	6	52	0	2	541
Agriculture	91		14					105
Arts and Theatre	68	16	8					92
Aviation		5	10					15
Business Mgmt	53	301	55	78	62	4	10	563
Chemistry / Biochemistry / Biology	188	2	32	6				228
Administrative / Medical Records				1				1
Communication	122	25	43	11				201
Computer Sci. / Info Mgmt	67	73	5		3	0	1	149
Consumer Econ / Fashion	77		10					87
Criminal Justice	86	92	33				0	211
Cultural Studies	44							44
Education	191	116	8	14				329
Engineering & Engineering Tech.	229		3					232
Food & Nutrition	67		7					74
History	149		5	7				161
Hotel/Hospitality	77		6					83
Language & Literature	216		12	7				235
Legal		38		14		12		64
Marketing	211	34	0	0	22			267
Mathematics / Physics	50	4	7	1				62
Music	53		7					60
Nat Resource Econ / Op Research	18					0		16
Nursing & Health	260	108	18	47		0		433
Other Social Sciences	117	121	3	15		1		257
Physical Ed. / Sports	117	14	36	38				205
Wildlife, Earth, Environment	74		4	0				78
Policy & Administration			7					7
Political Sci. and Intn'l Relations	169		10	4				183
Psychology / Development	220	211	77	14	0			522
Total	3,361	1,276	436	263	139	17	13	5,505

Source: Integrated Postsecondary Data System (IPEDS), National Center for Education Statistics, and Center for Applied Demography & Survey Research

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Table 36 Master Degree Completions, by Institution and Degree Classification: 2010

	WilmU	UDel	Goldey	DelState	Wesley	Strayer	Widener	Total
Accounting/Finance/Economics	44	49	113			3		209
Agriculture		18		2				20
Arts and Theatre		14		5				19
Business Mgmt	215	111	74	23	39	19		481
Chemistry / Biochemistry / Biology		11		10				21
Communication		5						5
Computer Sci. / Info Mgmt	56	24	22			2		104
Consumer Econ / Fashion		1						1
Criminal Justice	55							55
Education	718	102		18	13	4		855
Engineering & Engineering Tech.		66						66
Food & Nutrition		8						8
History		22		3				25
Hotel/Hospitality		4						4
Language & Literature		34		0				34
Legal							22	22
Marketing	24		33					57
Mathematics / Physics		15		2				17
Music		6						6
Nat Resource Econ / Op Research	2	22						24
Nursing & Health	122	28		3	27	2		182
Other Social Sciences		12						12
Physical Ed. / Sports		8		10	0			18
Wildlife, Earth, Environment		17		4	3			24
Policy & Administration	16	50				0		66
Political Sci. and Intn'l Relations		9						9
Psychology / Development	69	16		36				121
Total	1,321	652	242	116	82	28	22	2,465

Source: Integrated Postsecondary Data System (IPEDS), National Center for Education Statistics, and Center for Applied Demography & Survey Research

An Analysis of Delaware's Green Educational Pipeline

Table 37 Doctoral Degree Completions, by Institution and Degree Classification: 2010

	Widener	UDel	WilmU	DelState	Total
Accounting/Finance/Economics		2			2
Agriculture		1			
Arts and Theatre		3			3
Chemistry / Biochemistry / Biology		32			32
Computer Sci. / Info Mgmt		6			6
Criminal Justice		2			2
Education		32	37	6	75
Engineering & Engineering Tech.		48			48
History		3			3
Language & Literature		4			4
Legal	254				254
Mathematics / Physics		8		1	9
Other Social Sciences		16			16
Physical Ed. / Sports		30			30
Wildlife, Earth, Environment		17			18
Policy & Administration		11			11
Political Sci. and Intn'l Relations		5			5
Psychology / Development		10			10
Total	254	230	37	7	528

Source: Integrated Postsecondary Data System (IPEDS), National Center for Education Statistics, and Center for Applied Demography & Survey Research

An Analysis of Delaware's Green Educational Pipeline

Table 38 Green Occupations and Relevant Instructional Fields Detected by the Process Approach

Min. Req's	ONET Green Title	Instruction Fields
ST-OTJ	Truck Drivers, Heavy and Tractor-Trailer (ES)	Construction and Trades
	Helpers--Carpenters (ID)	Construction and Trades
MT-OTJ	Bus Drivers, Transit and Intercity (ID)	Construction and Trades
	Computer-Controlled Machine Tool Operators, Metal and Plastic (ID)	Construction and Trades
	Geothermal Technicians (NE)	Construction and Trades
	Wind Turbine Service Technicians (NE)	
	Heating & Air Conditioning Mechanics & Installers (ES)	
	Refrigeration Mechanics and Installers (ID)	
	Cutting, Punching, and Press Machine Setters, Operators, and Tenders, Metal and Plastic (ID)	Construction and Trades
	Insulation Workers, Floor, Ceiling, and Wall (ID)	Construction and Trades
	Maintenance and Repair Workers, General (ES)	Construction and Trades
	Hazardous Materials Removal Workers (ES)	Construction and Trades
	Roofers (ES)	Construction and Trades
	Solar Photovoltaic Installers (NE)	Construction and Trades
	Solar Thermal Installers and Technicians (NE)	
	Weatherization Installers and Technicians (NE)	
	Chemical Equipment Operators and Tenders (ID)	Chemistry / Biochemistry
LT-OTJ	Construction Carpenters (ID)	Construction and Trades
	Rough Carpenters (ID)	
	Electricians (ID)	Construction and Trades
	Pipe Fitters and Steamfitters (ES)	Construction and Trades
	Plumbers (ES)	
	Farmers and Ranchers (ES)	Agriculture Wildlife, Earth, Environment
	Chemical Plant and System Operators (ID)	Chemistry / Biochemistry
	Boilermakers (ID)	Construction and Trades
	Electrical Power-Line Installers and Repairers (ID)	Construction and Trades
	Industrial Machinery Mechanics (ID)	Construction and Trades
	Millwrights (ID)	Construction and Trades
Tech. Cert.	Architectural Drafters (ID)	Engineering & Engineering Tech.
	Automotive Specialty Technicians (ES)	Construction and Trades
Associates	Automotive Engineering Technicians (NE)	Engineering & Engineering Tech.
	Chemical Technicians (ID)	Chemistry / Biochemistry
	Electrical Engineering Technicians (ES)	Engineering & Engineering Tech.
	Electronics Engineering Technicians (ID)	

Source: Center for Applied Demography & Survey Research

An Analysis of Delaware's Green Educational Pipeline

Table 38 Green Occupations and Relevant Instructional Fields Detected by the Process Approach (cont)

Min. Req's	ONET Green Title	Instruction Fields
Associates	Electrical Engineering Technologists (NE)	
	Electromechanical Engineering Technologists (NE)	
	Electronics Engineering Technologists (NE)	
	Fuel Cell Technicians (NE)	
	Industrial Engineering Technologists (NE)	Chemistry / Biochemistry
	Manufacturing Engineering Technologists (NE)	Construction and Trades
	Manufacturing Production Technicians (NE)	Engineering & Engineering Tech.
	Mechanical Engineering Technologists (NE)	
	Nanotechnology Engineering Technicians (NE)	
	Nanotechnology Engineering Technologists (NE)	
	Photonics Technicians (NE)	
	Environmental Engineering Technicians (ES)	Wildlife, Earth, Environment
	Environmental Science and Protection Technicians, Including Health (ES)	Chemistry / Biochemistry
Work exp	Fish and Game Wardens (ID)	Nat Resource Econ / Op Research/ Log. Wildlife, Earth, Environment
	Geographic Information Systems Technicians (NE)	Computer Sci. / Info Mgmt
	Geospatial Information Scientists and Technologists (NE)	Mathematics / Physics
	Industrial Engineering Technicians (ES)	Engineering & Engineering Tech.
	Precision Agriculture Technicians (NE)	Chemistry / Biochemistry
	Remote Sensing Technicians (NE)	
	Robotics Technicians (NE)	
	Electro-Mechanical Technicians (ES)	Engineering & Engineering Tech.
	Agricultural Inspectors (ID)	Agriculture
	Biofuels Production Managers (NE)	
	Biomass Production Managers (NE)	
	Geothermal Production Managers (NE)	Business Management
	Hydroelectric Production Managers (NE)	Nat Resource Econ / Op Research/ Log.
	Methane/Landfill Gas Collection System Operators (NE)	
	Industrial Production Managers (ID)	
	Brownfield Redevelopment Specialists and Site Managers (NE)	Accounting/Finance/Economics
	Compliance Managers (NE)	Business Management
	Logistics Managers (NE)	Nat Resource Econ / Op Research/ Log.
	Regulatory Affairs Managers (NE)	Policy & Administration
	Supply Chain Managers (NE)	Political Sci. and Intn'l Relations
	Wind Energy Operations Managers (NE)	Wildlife, Earth, Environment
	Wind Energy Project Managers (NE)	
	Construction and Building Inspectors (ES)	Construction and Trades
	First-Line Supervisors/Managers of Agricultural Crop and Horticultural Workers (ID)	Agriculture
	First-Line Supervisors/Managers of Logging Workers (ID)	Wildlife, Earth, Environment

Source: Center for Applied Demography & Survey Research

An Analysis of Delaware's Green Educational Pipeline

Table 38 Green Occupations and Relevant Instructional Fields Detected by the Process Approach (cont)

Min. Req's	ONET Green Title	Instruction Fields
Work exp	First-Line Supervisors/Managers of Mechanics, Installers, and Repairers (ID)	Construction and Trades Nat Resource Econ / Op Research / Logistics
	First-Line Supervisors/Managers of Production and Operating Workers (ID)	Nat Resource Econ / Op Research / Logistics
	Solar Energy Installation Managers (NE)	Construction and Trades
	Storage and Distribution Managers (ES) Transportation Managers (ES)	Aviation Business Management Nat Resource Econ / Op Research / Logistics Policy & Administration
Bachelor	Aerospace Engineers (ES)	Engineering & Engineering Tech.
	Atmospheric and Space Scientists (ES)	Wildlife, Earth, Environment
	Automotive Engineers (NE) Fuel Cell Engineers (NE) Mechanical Engineers (ES)	Engineering & Engineering Tech.
	Biochemical Engineers (NE) Energy Engineers (NE) Manufacturing Engineers (NE) Mechatronics Engineers (NE) Microsystems Engineers (NE) Nanosystems Engineers (NE) Photonics Engineers (NE) Robotics Engineers (NE) Solar Energy Systems Engineers (NE) Validation Engineers (NE) Wind Energy Engineers (NE)	Engineering & Engineering Tech. Wildlife, Earth, Environment
	Chemical Engineers (ID)	Engineering & Engineering Tech.
	Chemists (ID)	Chemistry / Biochemistry
	Commercial and Industrial Designers (ID)	Arts and Theatre Construction and Trades
	Computer Software Engineers, Systems Software (ID)	Computer Sci. / Info Mgmt Engineering & Engineering Tech.
	Construction Managers (ES)	Construction and Trades Engineering & Engineering Tech. Business Management Nat Resource Econ / Op Research / Logistics
	Electrical Engineers (ES)	Engineering & Engineering Tech.
	Electronics Engineers, Except Computer (ES)	Engineering & Engineering Tech.
	Energy Auditors (NE) Sustainability Specialists (NE)	Engineering & Engineering Tech. Construction and Trades Marketing
	Environmental Engineers (ES)	Wildlife, Earth, Environment
	Farm and Home Management Advisors (ID)	Consumer Econ / Fashion
	Financial Analysts (ES)	Accounting/Finance/Economics

Source: Center for Applied Demography & Survey Research

An Analysis of Delaware's Green Educational Pipeline

Table 38 Green Occupations and Relevant Instructional Fields Detected by the Process Approach (cont)

Min. Req's	ONET Green Title	Instruction Fields
Bachelor	Financial Quantitative Analysts (NE)	Accounting/Finance/Economics
	Investment Underwriters (NE)	
	Risk Management Specialists (NE)	
	Industrial Safety and Health Engineers(ID)	Wildlife, Earth, Environment
	Landscape Architects (ES)	Agriculture
	Logistics Analysts (NE)	Nat Resource Econ / Op Research / Logistics
	Logistics Engineers (NE)	
	Materials Scientists (ID)	Engineering & Engineering Tech.
	Personal Financial Advisors (ES)	Accounting/Finance/Economics
	Public Relations Specialists (ES)	Communication
	Reporters and Correspondents (ES)	Marketing
	Occupational Health and Safety Specialists (ID)	Communication
	Soil and Plant Scientists (ES)	Construction and Trades
	Soil and Water Conservationists (ES)	Agriculture
	Training and Development Specialists(ES)	Wildlife, Earth, Environment
	Transportation Engineers (NE)	Wildlife, Earth, Environment
	Water/Wastewater Engineers (NE)	Wildlife, Earth, Environment
	Civil Engineers (ES)	Wildlife, Earth, Environment
	Zoologists and Wildlife Biologists (ID)	Wildlife, Earth, Environment
Masters	Climate Change Analysts (NE)	Wildlife, Earth, Environment
	Environmental Restoration Planners (NE)	
	Industrial Ecologists (NE)	
	Environmental Scientists and Specialists, Including Health (ID)	
	Environmental Economists (NE)	Accounting/Finance/Economics
	Geoscientists, Exc. Hydrologists & Geographers (ES)	Nat Resource Econ / Op Research / Logistics
	Hydrologists (ID)	Wildlife, Earth, Environment
	Transportation Planners (NE)	Wildlife, Earth, Environment
	Urban and Regional Planners (ES)	Policy & Administration

Source: Center for Applied Demography & Survey Research

An Analysis of Delaware's Green Educational Pipeline

Table 38 Green Occupations and Relevant Instructional Fields Detected by the Process Approach (cont)

Bach + exp	Arbitrators, Mediators, and Conciliators (ES)	Legal
	Biofuels/Biodiesel Technology and Product Development Managers (ES)	Agriculture
	Engineering Managers (ES)	Engineering & Engineering Tech. Wildlife, Earth, Environment
	Chief Sustainability Officers (NE)	Accounting/Finance/Economics Business Management Policy & Administration
	General and Operations Managers (ES)	Accounting/Finance/Economics Business Management Policy & Administration
	Green Marketers (NE)	Marketing
	Marketing Managers (ES)	Marketing
	Water Resource Specialists (NE) Natural Sciences Managers (ID)	Chemistry / Biochemistry Engineering & Engineering Tech. Nat Resource Econ / Op Research / Logistics Wildlife, Earth, Environment

Source: Center for Applied Demography & Survey Research

An Analysis of Delaware's Green Educational Pipeline

Table 39 Green Occupations and Relevant Instructional Fields Detected by the Output Approach

Education	Rank	SOC	Occupation Title	Suitable Education Areas
ST-OTJ	23	53-3032	Truck Drivers, Heavy and Tractor-Trailer	Construction and Trades
	27	47-3015	Helpers—Pipelayers, plumbers, pipefitters, and steamfitters	Construction and Trades
	37	47-3019	All other helpers, construction trades	Construction and Trades
	38	47-3013	Helpers—Electricians	Construction and Trades
	115	53-3033	Truck Drivers, Light or Delivery Services	Construction and Trades
MT-OTJ	8	43-3031	Bookkeeping, accounting, and auditing clerks	Accounting/Finance/Economics
	12	43-6014	Secretaries, except legal, medical, and executive	Administrative / Medical Records
	40	49-9042	Maintenance and repair workers, general	Construction and Trades
	45	47-2141	Painters, construction and maintenance	Construction and Trades
	48	47-2132	Insulation workers, mechanical	Construction and Trades
	65	47-2131	Insulation workers, floor, ceiling, and wall	Construction and Trades
	72	47-2181	Roofers	Construction and Trades
	81	47-4099	Construction and related workers, all other	Construction and Trades
	91	43-3051	Payroll and timekeeping clerks	Accounting/Finance/Economics
	116	43-9021	Data entry keyers	Chemistry / Biochemistry
LT-OTJ	1	47-2152	Plumbers, Pipefitters, and Steamfitters	Construction and Trades
	20	47-2111	Electricians	Construction and Trades
	22	47-2211	Sheet metal workers	Construction and Trades
	35	47-2031	Carpenters	Construction and Trades
	66	13-1023	Purchasing Agents, Except Wholesale, Retail, and Farm Products	Marketing
	74	51-8031	Water and Liquid Waste Treatment Plant and System Operators	Wildlife, Earth, Environment
	96	49-9044	Millwrights	Construction and Trades
Tech. Cert.	4	49-9021	Heating, Air Conditioning, and Refrigeration Mechanics and Installers	Construction and Trades
	14	49-3023	Automotive Service Technicians and Mechanics	Construction and Trades
	15	17-3011	Architectural and Civil Drafters	Engineering & Engineering Tech.
	24	17-3013	Mechanical Drafters	Engineering & Engineering Tech.
	34	17-3012	Electrical and Electronics Drafters	Engineering & Engineering Tech.

Source: Center for Applied Demography & Survey Research

An Analysis of Delaware's Green Educational Pipeline

Table 39 Green Occupations and Relevant Instructional Fields Detected by the Output Approach (cont)

Education	Rank	SOC	Occupation Title	Suitable Education Areas
Work exp	3	47-1011	First-Line Supervisors/Managers of Construction Trades and Extraction Workers	Construction and Trades
	29	49-1011	First-Line Supervisors/Managers of Mechanics, Installers, and Repairers	Nat Resource Econ / Op Research / Logistics Construction and Trades
	36	41-4012	Sales Representatives, Wholesale & Mfg, Except Technical and Scientific Products	Marketing
	46	43-1011	First-Line Supervisors/Managers of Office and Administrative Support Workers	Business Management Administrative / Medical Records
	47	43-6011	Executive Secretaries and Admin. Assistants	Administrative / Medical Records
	70	37-1012	First-Line Supervisors/Managers of Landscaping, Lawn Service, and Groundskeeping Workers	Agriculture
	73	51-1011	First-Line Supervisors/Managers of Production and Operating Workers	Nat Resource Econ / Op Research / Logistics
	77	47-4011	Construction and Building Inspectors	Construction and Trades
	126	37-1011	First-line supervisors/managers of housekeeping and janitorial workers	Construction and Trades
	137	11-3071	Transportation, Storage, and Distribution Managers	Aviation Business Management Nat Resource Econ / Op Research / Logistics Policy & Administration
Associate	26	17-3022	Civil Engineering Technicians	Engineering & Engineering Tech. Construction and Trades
	61	19-4091	Environmental Science and Protection Technicians, Including Health	Chemistry / Biochemistry
	118	17-3023	Electrical and Electronic Engineering Technicians	Engineering & Engineering Tech.
	118	17-3027	Mechanical Engineering Technicians	Engineering & Engineering Tech.
	121	27-1025	Interior Designers	Construction and Trades

Source: Center for Applied Demography & Survey Research

An Analysis of Delaware's Green Educational Pipeline

Table 39 Green Occupations and Relevant Instructional Fields Detected by the Output Approach (cont)

Education	Rank	SOC	Occupation Title	Suitable Education Areas
Bachelor	2	17-2051	Civil Engineers	Engineering & Engineering Tech.
	9	13-1051	Cost Estimators	Business Management Engineering & Engineering Tech.
	11	17-2141	Mechanical Engineers	Engineering & Engineering Tech.
	13	11-9021	Construction Managers	Business Management Nat Resource Econ / Op Research/ Log. Construction and Trades Engineering & Engineering Tech
	25	13-2011	Accountants and Auditors	Accounting/Finance/Economics
	30	17-2071	Electrical Engineers	Engineering & Engineering Tech.
	32	27-3031	Public Relations Specialists	Communication Marketing
	56	17-2041	Chemical Engineers	Engineering & Engineering Tech.
	59	17-1012	Landscape Architects	Agriculture
	60	19-2031	Chemists	Chemistry / Biochemistry
	78	17-2111	Health and Safety Engineers, Except Mining Safety Engineers and Inspectors	Wildlife, Earth, Environment
	79	29-9011	Occupational health and safety specialists	Construction and Trades
	84	27-1024	Graphic Designers	Arts & Theatre Computer Sci. / Info Mgmt
	87	17-1021	Cartographers and photogrammetrists	Wildlife, Earth, Environment
	93	15-1021	Computer Programmers	Computer Sci. / Info Mgmt Engineering & Engineering Tech.
	104	27-3041	Editors	Communication
	104	27-3043	Writers and Authors	Communication
	111	17-2081	Environmental Engineers	Wildlife, Earth, Environment
	114	13-1071	Employment, Recruitment, and Placement Specialists	Business Management
	118	15-1071	Network & Computer Systems Administrators	Computer Sci. / Info Mgmt
	127	13-1199	Business Operations Specialists, All Other	Marketing
	128	13-1072	Compensation, Benefits, and Job Analysis Specialists	Business Management

Source: Center for Applied Demography & Survey Research

An Analysis of Delaware's Green Educational Pipeline

Table 39 Green Occupations and Relevant Instructional Fields Detected by the Output Approach (cont)

Education	Rank	SOC	Occupation Title	Suitable Education Areas
Master	18	19-2041	Environmental Scientists and Specialists, Including Health	Wildlife, Earth, Environment
	49	19-2042	Geoscientists, Except Hydrologists and Geographers	Wildlife, Earth, Environment
	80	19-2043	Hydrologists	Wildlife, Earth, Environment
Bach + exp	7	11-1021	General and Operations Managers	Accounting/Finance/Economics Business Management Policy & Administration
	16	11-9041	Engineering Managers	Agriculture Engineering & Engineering Tech. Wildlife, Earth, Environment
	62	11-1011	Chief Executives	Accounting/Finance/Economics Business Management Policy & Administration
	68	11-3031	Financial Managers	Accounting/Finance/Economics
	87	11-9121	Natural Sciences Managers	Chemistry / Biochemistry Engineering & Engineering Tech. Mathematics / Physics Nat Resource Econ / Op Research / Logistics Wildlife, Earth, Environment
	95	11-2031	Public Relations Managers	Communication
	99	11-2022	Sales Managers	Business Management Marketing
	107	27-1011	Art Directors	Arts and Theatre
	111	11-3011	Administrative Services Managers	Business Management
	122	11-3021	Computer and Information Systems Managers	Computer Sci. / Info Mgmt Natural Resource Econ / Op Research / Logistics

Source: Center for Applied Demography & Survey Research