

# Michigan Green Jobs Report

## *Occupations & Employment in the New Green Economy*



Working to Create Michigan's Future Today



# MICHIGAN GREEN JOBS REPORT 2009

## OCCUPATIONS & EMPLOYMENT IN THE NEW GREEN ECONOMY



### Michigan Department of Energy, Labor & Economic Growth

Bureau Of Labor Market Information & Strategic Initiatives

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# CONTENTS

Executive Summary.....	4	Michigan’s Competitive Employment Performance in Green-related Industries .....	36
Employer Survey Results.....	4	Wages in Green-related Industry Clusters.....	38
Green Related Industry Trend Analysis .....	6	Wages in Detailed Green and Green-related Industries .....	39
Green Related Firm Trends.....	6		
Occupational Trends.....	6		
Letter from Governor .....	8	Chapter III: Tracking Job Trends among Green-Related Firms.....	42
Introduction .....	9	Understanding the Data .....	42
The Potential of Michigan’s Green Economy .....	9	Job Trends among Green-Related Firms .....	42
Defining Green Jobs .....	10	Comparison to Michigan Broad Industry Sectors .....	45
Michigan’s Research Approach .....	11	Green-related Firm Sample by Industry .....	45
Quantitative Approach– Michigan Green Jobs Survey .....	11	Chapter IV: Michigan Green-Related Occupations .....	47
Analytical Approach–Examination of Industries and Occupations .....	11	Characteristics of Occupations .....	47
Qualitative Approach–Michigan Focus Groups .....	11	Identifying Green Related Occupations .....	47
Existing Research Studies on Michigan Green Jobs.....	12	Forecasts for Green-Related Occupations .....	48
Chapter I: Michigan Green Jobs Survey Results .....	13	Green Occupations: Educational & Training Requirements .....	49
Green Jobs Core Areas Definitions.....	14	Green Occupations: Career Progressions .....	51
Survey Results: Direct Green Jobs by Detailed Industry.....	16	Green Occupations: Wages .....	54
Survey Results: Green Jobs by Detailed Occupation .....	19	Green Occupations: Critical Skills and Knowledge Sets.....	55
Survey Results: Employer Expectations .....	24	Conclusion .....	61
Hiring.....	24	Public Policy and Green Jobs .....	61
Filling Vacancies .....	25	What the Future Holds: .....	61
Unique Skills.....	25	Renewable Energy Area.....	62
Training.....	27	Energy Efficiency .....	62
Chapter II: Green-Related Industries in the Michigan Economy .....	28	Batteries.....	62
Green-related Industry Analysis– Understanding the Data .....	28	Appendix 1 - Survey.....	63
Employment in Michigan’s Green Clusters .....	29	Appendix 2 - Survey Methodology .....	65
Broad Cluster Analysis–Location Quotients .....	33	Appendix 3 - Definition of Green Jobs and Core Areas Sent to Employers.....	66
Job Change in Green-Related Industries .....	34	Appendix 4 - List of Green Related Industries Reflected in Chapter II.....	68
		Appendix 5 - List of Green Related Occupations Reflected in Chapter IV.....	71

## EXECUTIVE SUMMARY

The new green economy provides Michigan a dynamic opportunity to rebuild the state's job base, attract new investment, and diversify the state's economy. We may be at a tipping point of awareness, understanding, and opportunities that a green economy can provide for Michigan's workforce, businesses, and communities.

But what exactly is the green economy, and what is a green job? How many presently exist, and what are the prospects for growth? This report represents Michigan's first attempt to provide rigorous, empirical answers to these questions so important to our economic future.

Michigan defines **green jobs** as jobs directly involved in generating or supporting a firm's green-related products or services. The state's **green economy** is defined as being comprised of industries that provide products or services in **five areas**:

1. Agriculture and natural resource conservation;
2. Clean transportation and fuels;
3. Increased energy efficiency;
4. Pollution prevention or environmental cleanup; and
5. Renewable energy production.

The Michigan Green Jobs Study used a three-pronged methodology that included quantitative, analytical and qualitative research. The quantitative work involved a survey sent to thousands of employers to uncover private sector green job trends. **This marks the first attempt in Michigan to survey employers directly in order to measure the current number of Michigan green jobs.** The analytical work involved merging labor market information and economic intelligence with survey results to uncover industry and occupational trends. The qualitative approach involved using focus groups to enhance our understanding of green-related workforce issues.

These three research methods were integrated into the findings and conclusions contained in this report.

We plan to produce a series of reports over time to track developments in Michigan's green economy.

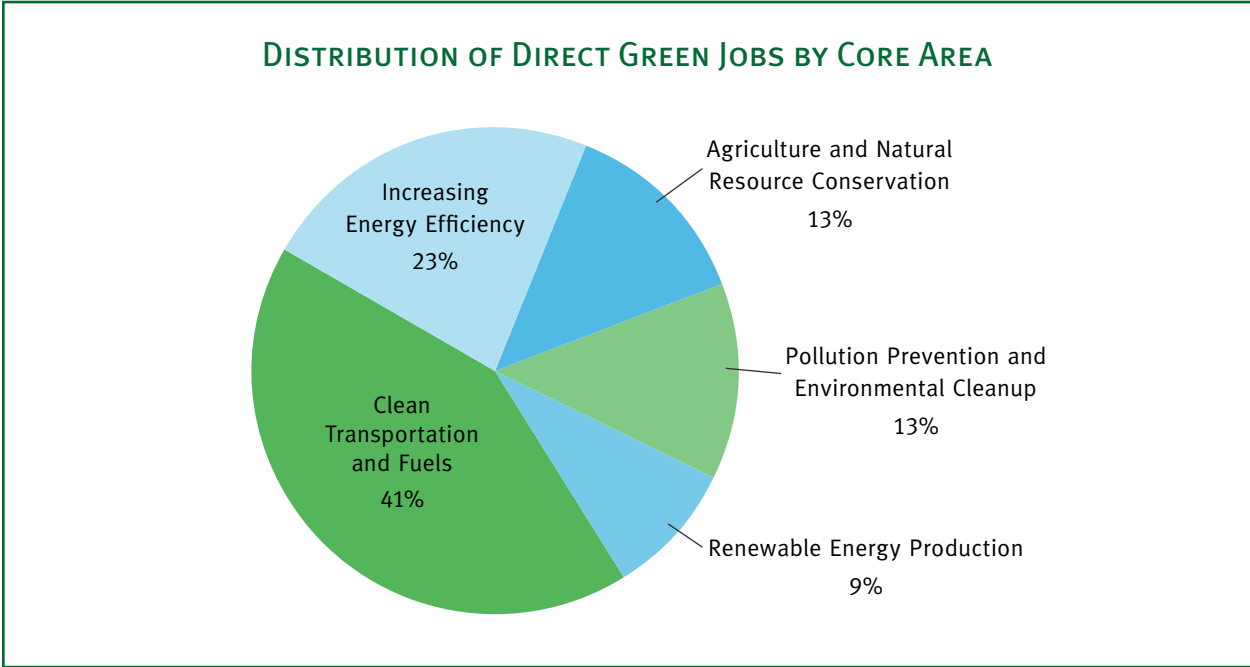
### What we found:

**Michigan boasts 109,067 total green jobs—both direct and support positions—among private sector employers. There are 96,767 direct green jobs and 12,300 support green jobs.** This is big news, but it also shows the potential for growth of the green economy. Michigan's overall private sector employment is 3.2 million; green jobs are currently 3 percent of that total.<sup>1</sup>

### Employer Survey Results

Through the employer survey, we categorized direct green jobs in Michigan into five core areas. The Clean Transportation and Fuels area comprises just over 40 percent — close to 40,000 jobs — of all green jobs. Nearly one quarter of green jobs were attributable to the Energy Efficiency core area, and most of the positions were associated with the state's construction industry. This distribution reflects Michigan's large automotive and construction sectors. Green jobs were most common in these specific industries: *Transportation Equipment Manufacturing (25,780 jobs)*, *Professional, Scientific, and Technical Services (22,178 jobs)*, *Specialty Trade Contractors (9,825 jobs)*, and *Construction of Buildings (3,571 jobs)*.

<sup>1</sup> As of February 2009, seasonally unadjusted private jobs for Michigan totaled 3,227,600 according to data from the Michigan Department of Energy, Labor & Economic Growth, Bureau of Labor Market Information and Strategic Initiatives, Current Employment Statistics program.



Source: Michigan Department of Energy, Labor & Economic Growth

From an occupational perspective, over 70 percent of direct green workers fall into three broad categories:

- Production occupations (28 percent)
- Engineering occupations (24 percent)
- Construction occupations (19 percent)

Over one-third of the positions in the Clean Transportation and Fuels Core area were engineers, and a large portion of the remainder were production positions such as assemblers or machinists. In Energy Efficiency, the two most common occupations were related to construction: *HVAC installers* and *General maintenance workers*. *Farmworkers* made up a quarter of green jobs in Agriculture and Natural Resource Conservation, while various kinds of engineers and environmental specialists were important in the Pollution Prevention and Environmental Cleanup core area. The Renewable Energy Production core area has the most diverse mix of green occupations, employing engineers, technicians, mechanics, and production staff.

The survey asked employers to outline their expected hiring needs for the next two years. Growth occupations most frequently cited include engineers, skilled trades, and certain technical specialist job titles. The occupations cited span a variety of education and skill levels.

**Despite the need for some specialized green skills, employers in the focus groups stressed that workers still need the basics.** Green skills are an overlay of new skills and knowledge; and learners cannot access the new knowledge without the requisite foundation. **Skills in science, technology, engineering and math will be important, and positions with these skills may be most difficult to fill.** Nearly 70 percent of employers in the survey said training their green-related workers would be workplace-based as they looked to upgrade or enhance current workers' knowledge. This finding reinforces the importance of career ladders for current and incoming workers.



## Green Related Industry Trend Analysis

To gather additional information not captured by the employer survey, Michigan identified over 100 industries considered to be green related. Not all jobs in these industries are green jobs, but these are sectors that could potentially benefit from an expansion of the Michigan green economy. Green related industries have recorded job losses since 2004, like the rest of the Michigan economy, but several specific green related industries have added jobs: *Semiconductor Manufacturing, Recyclable Material Wholesalers, and Environmental Consulting Services.*

A handful of detailed green-related sectors in Michigan are not only relatively highly concentrated in terms of jobs, but also managed to record employment growth from 2004 to 2008. *Process & logistics consulting* firms, which offer operating advice and assistance in areas such as manufacturing operations improvement, productivity, production planning, and quality assurance, were 44 percent more concentrated in Michigan than in the United States in the second quarter of 2008. Employment in this industry was up nearly four percent since 2004. Firms in the business of *Industrial design services* have also recorded employment expansion since 2004, and are highly concentrated in the Michigan economy. Taken as a whole, the green-related industries selected for this study comprise a higher share of total jobs in Michigan than is true of the national economy.

Not all jobs in these green-related sectors are currently generated by the green economy. *However, if green business expands in the state, many existing Michigan firms in these sectors could have the expertise to diversify into green business activities.*

## Green Related Firm Trends

Michigan analyzed a small sample of 358 green related firms' trends over a three year period to shed light on potential employment trends. While findings from this analysis are intriguing, they are indicators only and cannot be generalized to the health of all green-related firms in Michigan given the sample size. Firms in the **Renewable Energy Production** cluster added nearly 1,900 jobs from 2005 to 2008, a growth rate of 30 percent. This finding is an indicator that firms in this cluster are the most likely to experience job growth, even though they represent less than 10 percent of the overall green jobs in Michigan. Renewable Energy Production includes areas like wind and solar manufacturing and installation.

The sample also suggests that green-related firms may be a significant source of entrepreneurial activity. Of the 358 sample firms, 70 appear to have been newly created since 2005, creating 600 jobs – a much higher rate of startups than is seen in the overall Michigan economy. In all, the sample firms added more than 2,500 jobs, an impressive employment expansion of 7.7 percent (the total Michigan average was negative 5.4 percent). This small segment of the green economy far outpaced employment trends for the Michigan economy as a whole.

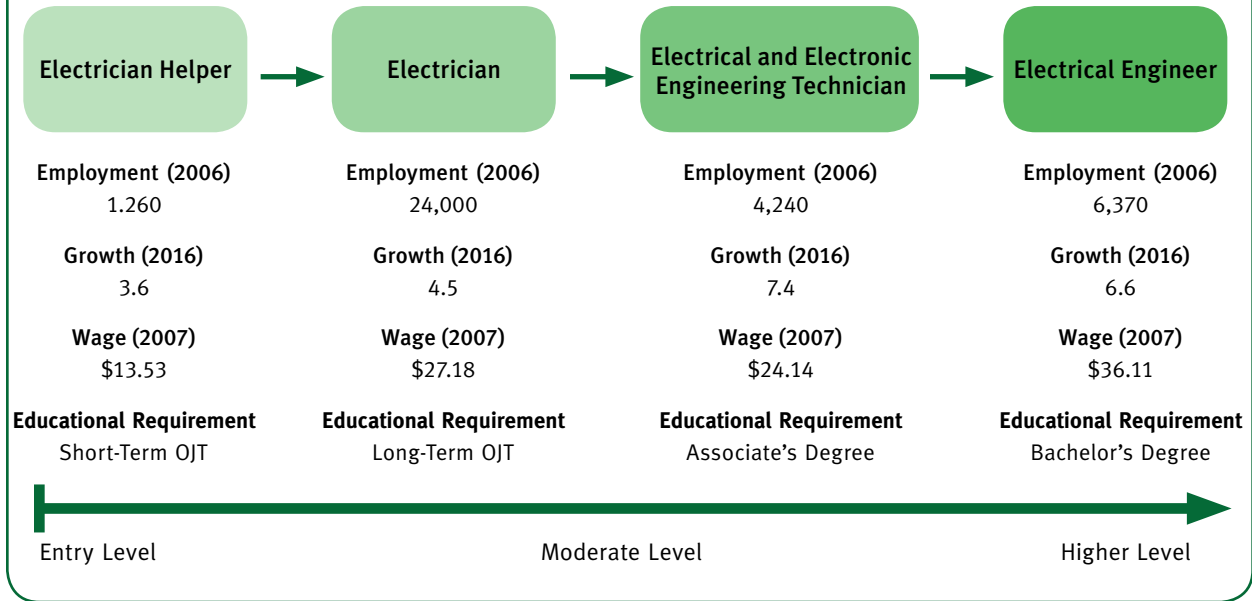
## Occupational Trends

Green jobs can be found across the spectrum of broad occupational categories, such as professional workers with specific skill sets directly needed by green-related firms; production, maintenance, and transportation occupations; critical occupations for small start-up green-related firms, such as sales engineers or technical sales representatives; and jobs in teaching or training that will be needed to prepare

### GREEN JOBS IN MICHIGAN—

The opportunity to create new Michigan jobs rests overwhelmingly with the clean energy, green-collar economy. We know the combination of these targeted efforts, coupled with the determination of Michigan's workers' to embrace the green economy, will help transform our state.

## SAMPLE CAREER PROGRESSION: RENEWABLE ENERGY



the future green-related workforce. Green-related occupations with above average expected job growth rates include engineering, professional and mid-skill mechanic and laborer positions. Careers in green-related occupations exist at all levels of educational attainment. This sample career progression in the renewable energy area illustrates the job potential in green.

Green-related industries hold the potential for workers to earn above average wage rates. Thirteen of the top 15 broad industries in terms of green jobs paid more than the private sector average weekly wage of \$811, while ten were well above this average (at least \$100 per week more). Furthermore, eight of the top 15 green industries paid more than \$1,000 per week, or over \$50,000 per year.

**What the Future Holds:** The opportunity to create new Michigan jobs rests overwhelmingly with the clean energy, green-collar economy. With our advanced manufacturing expertise, our depth of engineering talent, and our local access to original equipment manufacturers (OEMs) and suppliers, we are poised to create tens of thousands of good-paying green jobs for Michigan workers. In the renewable energy sector, Michigan has the potential to become a regional and global powerhouse in wind turbine

manufacturing with Michigan's engineering expertise and modernized machining. Investments in energy efficiency represent a major opportunity for Michigan to create jobs, save money, and reduce our reliance on fossil fuels. By replacing traditional fossil fuel energy, Michigan's energy efficiency program will save Michigan over \$3 billion in electricity costs over the next 20 years. Advanced energy storage, and in particular the production of lithium ion batteries for cars, holds enormous potential for job creation in Michigan. Michigan is rapidly becoming a center for advanced energy storage innovation aimed at, among other things, electrifying the automobile.

We know the combination of these targeted efforts, coupled with the determination of Michigan's workers to embrace the green economy, will help transform our state.

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## LETTER FROM GOVERNOR



STATE OF MICHIGAN  
OFFICE OF THE GOVERNOR  
LANSING

JENNIFER M. GRANHOLM  
GOVERNOR

JOHN D. CHERRY, JR.  
LT. GOVERNOR

May 11, 2009

Dear Friends:

These are both challenging and exciting times as we work to transform Michigan into the nation's leading green state. Our aggressive efforts to grow a renewable energy industry in Michigan will create jobs, diversify our economy, help break our dependence on foreign oil and fossil fuels, and create healthier communities for us and future generations.

We are seeing new green industries take hold in Michigan because of our abundant renewable resources, our research and development initiatives, our advanced manufacturing experience, and especially because of our highly skilled workforce. In conjunction with our unparalleled economic development incentives, these assets are making Michigan the renewable energy hub of North America and the advanced-battery capital of the world.

Our Renewable Portfolio Standard (RPS) and our goal to reduce fossil fuels by 45 percent by 2020 are also driving investment and the creation of green jobs. By aggressively pursuing advanced energy storage, wind and solar technologies, biofuels, geothermal, and other green industries, Michigan stands to create tens of thousands of new green jobs for Michigan citizens.

No state can match our Green Jobs Initiative that supports employers by meeting their worker training needs in emerging renewable energy and green jobs industries. The findings in this report, provided by Michigan employers, are instrumental in helping us capture our full potential in the green economy, and we thank them for their invaluable input.

Michigan's move to a clean energy, green economy will create all kinds of jobs for all kinds of people. These are the jobs that will reshape our economy and accelerate our recovery.

Sincerely yours,

A blue ink signature of Jennifer M. Granholm, written in a cursive style.

Jennifer M. Granholm  
Governor

A blue ink signature of John D. Cherry, Jr., written in a cursive style.

John D. Cherry, Jr.  
Lt. Governor



## INTRODUCTION

The economic potential of the green economy has been an increasingly high-profile topic in Michigan and across the nation.

Nationally, the passage of the 2009 American Recovery and Reinvestment Act targeted the U.S. renewable energy industry and also funds investments in the weatherization of federal buildings and private housing throughout the country.

In Michigan, Governor Jennifer M. Granholm has signed legislation to increase tax incentives for the development and manufacturing of advanced batteries, and proposed a series of energy and green-related initiatives in her February 2009 State of the State address.

Interest has also never been higher in obtaining information on the quantity and characteristics of jobs produced by the green economy. However, private and public research organizations have only recently taken steps to attempt to define and measure green jobs for the U.S. and for individual states.

There are several reasons for this. First, traditional information sources and databases on industries and occupations are not specific enough to accurately measure the number of green jobs in the economy. In addition, a uniform definition of green jobs does not yet exist. An examination of existing studies on the topic reveals that most reports define green jobs slightly differently. This makes it difficult to conduct direct comparisons and evaluate trends using these studies.

In spite of these challenges, the need for improved information on the green economy remains high. The impact of climate change, the potential health benefits from pollution prevention, the need to reduce domestic dependence on foreign oil, and the opportunity that the green sector presents for new business opportunities and job creation are all reasons for further study of this broad sector. Recognizing the importance of such issues, policymakers and industry leaders are striving to gain

a better understanding of the breadth and nature of Michigan's green economy.

The analysis that follows focuses on the green economy and the jobs, industries, and occupations that it contains. This study presents the results from the first actual survey of Michigan employers that attempts to quantify the current number of Michigan green jobs. In addition, this report utilizes existing workforce data produced by the Michigan Department of Energy, Labor & Economic Growth to address questions regarding the characteristics of green-related sectors that were not addressed in the survey findings. This study focuses on the size and broad characteristics of current green jobs in Michigan, but will also serve as an important baseline measure for tracking future green industry growth.

### The Potential of Michigan's Green Economy

Though there is not yet a common mechanism for defining the green economy, it is clearly related to the development of new technologies that advance the production and use of clean energy, and conserve the earth's natural resources. To be green means very broadly to be in the business of developing environmentally-friendly, sustainable solutions to resource allocation and environmental challenges.

However, when it comes to developing a more precise definition of this topic, researchers typically need to focus on specific segments of the green economy.

This report defines the Michigan green economy as industries that provide products or services related to renewable energy, increased energy efficiency, clean transportation and fuels, agriculture and natural resource conservation, and pollution prevention or environmental cleanup.

If the Michigan green economy successfully expands, a variety of benefits could be realized

by the residents of Michigan. First, a greener economy would seem to be vital to a state that has many competitive advantages due to its rich natural resources. An emphasis on sustainable energy sources could help reduce the state's carbon footprint and improve air and water quality. An expansion of the green economy would also contribute to national goals to meet current and future energy needs while reducing current reliance on foreign energy sources.

Major benefits could also accrue to Michigan's workforce, as the greening of the economy holds promise for new and diverse employment opportunities. By moving the economy into renewable and clean energy solutions, Michigan will establish a more diverse industry mix—one that will be better positioned to capitalize on future high growth sectors and reduce the cyclical impact of future economic downturns. Michigan's long-term goal has been to increase the diversification of the state economy and

invest in the jobs of the future. Existing Michigan companies could benefit from expansion of the green economy by providing products, parts, and services to this potential growth sector.

## Defining Green Jobs

As indicated above, existing research studies contain many different definitions of a green job. The definitions used must be broad enough and flexible enough to encompass the very different economic activities that are often thought of as related to the green economy. However, if defined too broadly, the term "green jobs" can quickly lose relevance or can be impossible to quantify.

This study attempts to estimate the number of green jobs in the Michigan economy using an employer survey. We also evaluate the characteristics of jobs in green-related industries and occupations using existing information resources. Some of the definitions used are below:

**Green Economy:** Industries that provide products or services related to renewable energy, increased energy efficiency, clean transportation and fuels, agriculture and natural resource conservation, and pollution prevention or environmental cleanup.

**Green Jobs:** Includes primary occupations engaged in generating a firm's green-related products or services, and the other support jobs created by the firm's green-related revenue.

**Green-related Industry:**

A detailed industry sector that is likely to contain firms that produce parts, components, products or services related to the green economy. Industries and firms were classified as green-related based on their primary product or service; not based on whether they were taking internal steps to use less energy or be more environmentally responsible.

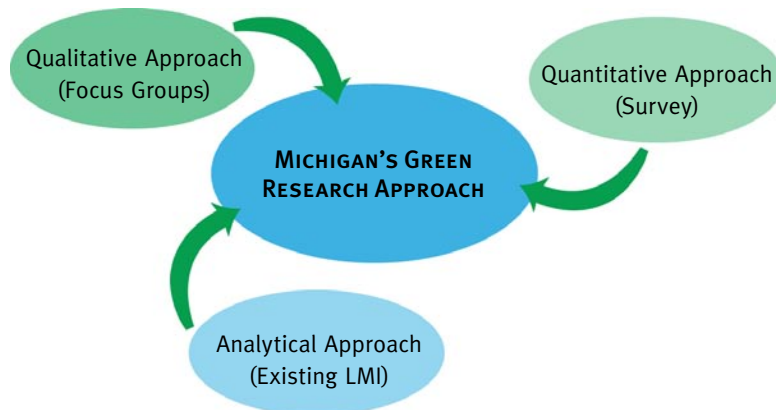
**Green-related Occupation:**

Job titles commonly utilized by green-related industries to produce products and services for the green economy. Green-related occupations can be found in a variety of educational and skill levels, such as:

- Scientists and engineers needed in energy research
- Skilled production workers utilized in a manufacturing setting
- Critical occupations at small start-up green firms, such as technical sales staff
- Construction laborers and skilled trades used in LEED construction projects

## Michigan's Research Approach

The Michigan Green Jobs Study uses a three-pronged approach to study green jobs in Michigan, which includes the following: 1) a quantitative approach, 2) an analytical approach, and a 3) qualitative approach. The quantitative approach was accomplished by the use of an employer survey, the analytical approach was done by merging labor market information and economic intelligence with survey results, and the qualitative approach used focus groups to add additional qualitative information on green-related workforce issues.



### Quantitative Approach – Michigan Green Jobs Survey

In the first quarter of 2009, the Michigan Department of Energy, Labor & Economic Growth (DELEG) conducted the Michigan Green Jobs Survey. This was the first actual attempt in Michigan to directly survey employers to measure the current number of Michigan green jobs.

The survey was a critical part of the research effort, because it quickly became apparent that it would not be possible to accurately estimate the current number of Michigan green jobs using existing information sources. The survey will also assist in identifying the share of jobs in detailed industries that are related to the green economy. The survey questions also allowed employers to classify their green workers by core green activity, and collected information regarding employer expectations of future employment levels, difficulty in hiring qualified workers, green occupations requiring unique skills, and employee training.

### Analytical Approach – Examination of Industries and Occupations

Since the employer survey content needed to be focused and targeted, the survey could not address many workforce questions regarding green industries

and occupations. As a result, the DELEG research team used existing labor market information resources to identify and study green-related industries and occupations. These resources allowed examination of the levels and trends of jobs in green-related sectors, the wage levels paid in green-related occupations, and the skills and educational requirements for certain green-related positions.

In addition to the research on industries and occupations, the research team identified over 350 green-related businesses across the state. These businesses were identified through Internet research, business resources, and public databases. As this section of the report reveals, this sample of firms, although small and not necessarily representative of the overall green economy, managed to record impressive job growth from 2005 to mid-2008 during a difficult period for the Michigan economy.

### Qualitative Approach – Michigan Focus Groups

Eight focus group sessions were conducted during February and March 2009 with employers, industry experts, and educators representing various segments of the green economy. These sessions, led by staff of DELEG and the Corporation for a Skilled Workforce,

were intended to collect qualitative information on key workforce issues facing each sector, such as finding skilled workers and identifying industry training needs. The other goal of these sessions was to promote collaboration among employers through the *Governor's Green Jobs Initiative*. Part of this initiative includes the formation of Green Sector Skills Alliances, which will be comprised of private employers, educational providers, and other stakeholders in the green economy. These alliances will be formed to jointly tackle key workforce issues. Focus groups were held in these general industry areas:

- Agriculture and Food Systems
- Environmental Resource Management
- Green Construction
- Recycling
- Solar
- Wind

## Existing Research Studies on Michigan Green Jobs

The Michigan DELEG research staff conducted an extensive review of existing studies on the green economy during the design phase of this study. In fact, our eventual employer survey instrument was adapted from a survey design developed by the State of Washington.<sup>2</sup>

A limited number of prior studies have been conducted to attempt to measure green employment in Michigan. Just three examples are listed below.

The Center for American Progress published in September 2008 a study entitled *Green Recovery – A New Program to Create Good Jobs and Start Building*

*a Low-Carbon Economy*. This study attempted to estimate the impact on Michigan of a \$3.1 billion investment in energy efficiency and renewable energy. This was to simulate Michigan's share of a potential national green investment in energy efficiency, mass transit and freight rail, smart grid, and wind, solar and bio-fuels. The study estimated the employment impact in Michigan at 61,394 new jobs in two years, but included both green and non-green jobs.

A second study that attempted to measure green jobs in Michigan was Global Insight's 2008 report done for The United States Conference of Mayors, entitled *U.S. Metro Economies - Current and Potential Green Jobs in the U.S. Economy*. The report estimated the number of current green jobs among Michigan metro areas to be 12,614, out of an estimated 751,051 jobs nationwide. The study also attempted to forecast green employment by state and estimated a potential job creation of 99,819 in Michigan by the year 2038. These job estimates were based on a set of assumptions of market forces, legislation, and local green initiatives in the U.S., and the job counts reflected direct and indirect green employment.

A third report, published in 2006 by the Renewable Energy Policy Project, was entitled *Component Manufacturing: Michigan's Future in the Renewable Energy Industry*. This study focused on the potential job impact of the manufacture of parts for renewable energy systems, such as wind, solar, geothermal, and biomass. It assumed an investment of \$160 billion in manufacturing industries over 10 years, and allocated shares of that investment to each state. The study estimated Michigan's job potential at 34,777 new jobs in green industries, with 70 percent in wind energy. No estimate of current Michigan green jobs was presented.



2 See 2008 Washington State Green Economy Jobs, Washington State Employment Security, January 2009

## CHAPTER I: MICHIGAN GREEN JOBS SURVEY RESULTS

A survey of employers was necessary in order to estimate the current number of green jobs in the Michigan economy. The Michigan Department of Energy, Labor & Economic Growth conducted a statewide employer survey during the first quarter of 2009. The sample of survey respondents, representing a broad spectrum of private industries, provided information on existing green jobs by detailed occupation in their respective firms. This section presents the survey results.

As Figure 1 indicates, an estimated 96,800 direct green jobs currently exist among Michigan private employers. Figure 1 also displays how those jobs are distributed among the five core green areas.<sup>3</sup> Green jobs accounted for 3.4 percent of total private employment in Michigan.<sup>4</sup> Further detailed survey results, including the primary industry sectors that generate green jobs, the occupational concentration of these jobs, and employers' future expectations regarding hiring, skills, and training are provided in the narrative that follows.

Most of the information collected in the survey reflects only "direct" green jobs; that is, employees whose primary function is the production of green-related products or services for a particular firm. However, the presence of green business activities in many of these firms also generates additional jobs at that particular firm for support employees. These support jobs may range from accounting staff to human services staff to clerical staff. For example, a manufacturing firm may have 20 machinists building wind turbine blades, as well as one accountant and two clerical positions that support the wind turbine

**FIGURE 1: SUMMARY OF MICHIGAN DIRECT GREEN JOBS BY CORE AREA**

Core Area	Total Direct Green Jobs	Percent Share of Total Direct Green Jobs
<b>TOTAL DIRECT GREEN JOBS</b>	<b>96,767</b>	<b>100.0%</b>
Clean Transportation and Fuels	39,317	40.6%
Increasing Energy Efficiency	22,236	23.0%
Pollution Prevention and Environmental Cleanup	12,345	12.8%
Agriculture and Natural Resource Conservation	11,986	12.4%
Renewable Energy Production	8,843	9.1%
Green Jobs Not Assigned to a Core Area	2,040	2.1%

Source: Michigan Department of Energy, Labor & Economic Growth

<sup>3</sup> All respondents did not report the number of green jobs by core area or by occupation. For this reason, table columns may not always sum to the total count of green jobs.

<sup>4</sup> As of February 2009, seasonally unadjusted private jobs for Michigan totaled 3,227,600 according to data from the Michigan Department of Energy, Labor & Economic Growth, Bureau of Labor Market Information and Strategic Initiatives, Current Employment Statistics program.

business. Without the wind turbine blade revenue, the three support jobs would not exist.

The survey asked firms to attempt to quantify the number of jobs they currently have that support their green business activities. The survey results show that the green economy may contribute an additional 12,300 support jobs to Michigan's economy.

### Survey Results: Direct Green Jobs by Core Green Area

As mentioned previously in the report, the primary purpose of the employer survey was to estimate the number of Michigan green jobs, due to the limitations of existing economic databases. Although Michigan industries are assigned codes using the North American Industrial Classification System (NAICS), this

#### THERE ARE 109,067 GREEN JOBS IN MICHIGAN

**Michigan boasts 109,067 total green jobs—both direct and support- among private sector employers.** There are 96,767 direct green jobs and 12,300 support green jobs. This is big news, but it also shows the huge potential for growth of the green economy. Michigan's overall private sector employment is 3.2 million; green jobs currently account for 3.4 percent of that total.

system has limits in the measurement of green jobs. For example, no single code or group of codes exists to isolate all firms producing components for the manufacture of wind turbines or solar panels.

Therefore, Michigan adapted a green job survey instrument developed by the state of Washington. The Michigan survey asked firms to not only specify occupations that were green-related, but to classify them into the following green "core areas":

- Agriculture and natural resource conservation
- Clean transportation and fuels
- Increasing energy efficiency
- Pollution prevention and environmental cleanup
- Renewable energy production

### Green Jobs Core Areas Definitions

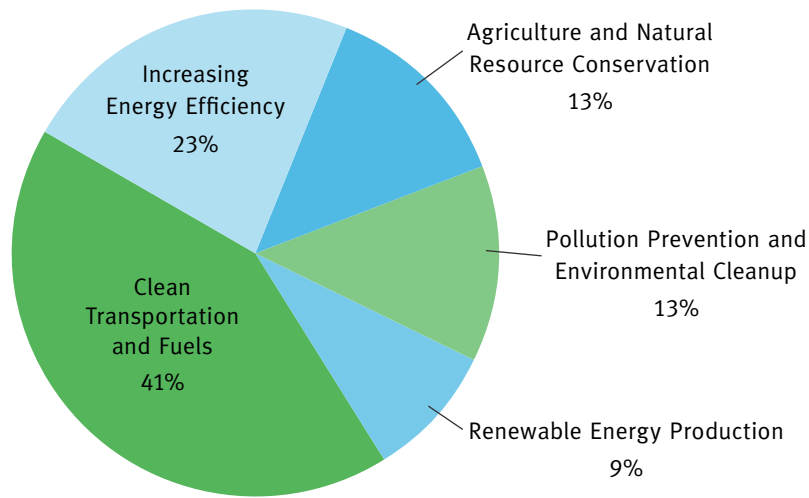
#### Agriculture and Natural Resource

**Conservation:** Natural resource conservation refers to products or services designed to help conserve, maintain, and improve natural resources and the environment. Certain "green" agricultural businesses provide necessary inputs for the production of biomass energy including: wood, agricultural crops and animal wastes. These "crops" can be viewed as renewable and sustainable if managed properly. Other examples include food systems, forest and land management, and organic farming. Sustainable agriculture and forestry are achieved by governmental and private industries adopting certain industry standards utilizing established best management practices.

**Clean Transportation and Fuels:** Clean transportation refers to the research, development, and production of new technologies for energy storage and alternative fuels, as well as the engineering of improved fuel efficiencies and emissions reductions. Examples of these activities include: advanced batteries, fuel cells, electric and hybrid vehicles, alternative fuels, public transit, and activities related to meeting fuel efficiency standards, and more.



**FIGURE 2: DISTRIBUTION OF DIRECT GREEN-RELATED JOBS BY CORE AREA**



Source: Michigan Department of Energy, Labor & Economic Growth

These categories add significantly more depth to the data, by contrasting the number of green jobs in Michigan in each of these core areas. These core areas illustrate the primary green business activities that generate jobs in the Michigan economy. Figure 2 presents the distribution of green jobs by core area according to the survey results.

As might be expected considering the importance of the auto industry in Michigan, the Clean Transportation and Fuels core area accounts for the largest number of the state's green jobs, roughly 39,300 or 41 percent. Nearly one-quarter of green jobs in the state were attributable to the Energy Efficiency core area, and most of these positions were associated with the state's construction industry.

The remaining third of green jobs was distributed among the other three core areas. Pollution Prevention & Environmental Cleanup and Agriculture and Natural Resource Conservation supplied about 12,000 green jobs each, while Renewable Energy chipped in nearly 9,000 green jobs.

### Green Jobs Core Areas Definitions

#### **Producing Renewable Energy:**

Renewable energy is energy generated from sustainable, natural resources—such as sunlight (solar), wind, water (hydro), geothermal heat, and biomass (wood and wood waste, agricultural and energy crops & associated residues, animal waste, municipal solid waste, food products & processing waste), that can be naturally regenerated in the short-term. Related businesses include those producing renewable energy as well as firms that produce and supply parts or equipment used in energy collection and distribution such as solar panels or wind turbines.

## Survey Results: Direct Green Jobs by Detailed Industry

Beyond the broader core areas identified by the survey, a key next step was to examine the primary industry sectors in Michigan that generate large

numbers or percentages of green jobs. All Michigan firms are classified by detailed industry using the NAICS coding system, and the survey results were tabulated by 3-digit NAICS industry. Figure 3 presents survey results on the primary industries that generate the largest numbers of Michigan green jobs.

**FIGURE 3: TOP MICHIGAN INDUSTRIES GENERATING THE LARGEST NUMBER OF DIRECT GREEN JOBS**

NAICS	Industry	Total Direct Green Jobs	Total Industry Employment	Green Jobs As % Of Industry Employment
336	Transportation Equipment Manufacturing	25,780	176,254	14.6%
541	Professional, Scientific, And Technical Services	22,178	241,786	9.2%
238	Specialty Trade Contractors	9,825	102,467	9.6%
236	Construction Of Buildings	3,571	34,423	10.4%
111	Crop Production	3,503	15,942	22.0%
423	Merchant Wholesalers, Durable Goods	2,793	94,879	2.9%
561	Administrative Services	2,698	258,314	1.0%
221	Utilities	2,608	20,518	12.7%
562	Waste Management And Remediation Services	2,168	11,410	19.0%
332	Fabricated Metal Manufacturing	1,995	78,488	2.5%
333	Machinery Manufacturing	1,664	68,848	2.4%
327	Nonmetallic Mineral Product Manufacturing	1,448	13,276	10.9%
334	Computer And Electronic Product Manufacturing	1,304	20,848	6.3%
322	Paper Manufacturing	1,100	13,317	8.3%
325	Chemical Manufacturing	1,024	27,876	3.7%
321	Wood Product Manufacturing	982	9,639	10.2%
237	Heavy And Civil Engineering Construction	903	16,826	5.4%
331	Primary Metal Manufacturing	863	23,587	3.7%
551	Management Of Companies And Enterprises	716	55,090	1.3%
811	Repair And Maintenance	656	36,951	1.8%
113	Forestry And Logging	415	1,400	29.7%

Source: Michigan Department of Energy, Labor & Economic Growth

A significant number of Michigan green jobs were generated by the manufacturing and construction-related sectors. Of the 21 industries in Figure 3, 13 were engaged in the production of goods, and the majority of those were concentrated in either manufacturing or construction. Michigan's auto sector led the way in the creation of green employment, as *Transportation equipment manufacturing* supplied about 27,800 jobs to the green economy. However, green jobs were found across a wide range of industries. About one-quarter of the top green job industries were service-based, including three of the top 10 industries. Professional, Scientific and Technical Services ranked second behind auto manufacturing with over 22,000 green jobs, accounting for roughly 23 percent of total Michigan green positions.

Figure 4, highlights the largest industries for each core area. In accordance with the economic makeup of Michigan, detailed industries in the Construction and Manufacturing sectors contribute a significant job share to several core areas. For the most part, green jobs in the core areas were highly concentrated in two or three industry sectors. Employment in Clean Transportation Fuels, the largest core area, was concentrated in two industries: *Transportation equipment manufacturing* and *Professional, scientific, and technical services*. These two industry sectors account for 97 percent of total Clean Transportation green jobs. Renewable Energy Production, the smallest core area, had the most dispersed employment. However, its top two industry sectors, *Specialty trade contractors* and *Nonmetallic mineral product manufacturing* still accounted for 27 percent of the core's total green employment.

In Figure 4, the Direct Green Jobs by Industry column indicates the total number of green jobs in that industry; the second column shows how many jobs from that industry are in a specific core area, and the third column reveals the percentage of total core area green jobs in a specific industry. *Crop production*, for instance, has a total of 3,503 green jobs, of which 3,295 are in the core area of Agriculture and Natural Resource Conservation. Therefore, the 3,295 core jobs in Crop production account for 27.5 percent of the 11,986 total green jobs in that core area.

As might be expected considering the importance of the auto industry in Michigan, the Clean Transportation and Fuels core area accounts for the largest number of the state's green jobs, roughly 39,300 or 41 percent.



Nearly one-quarter of green jobs- 22,236- in the state were attributable to the Energy Efficiency core area, and most of these positions were associated with the state's construction industry.



Renewable Energy Production has nearly 9,000 green jobs.

**FIGURE 4: LARGE INDUSTRIES BY CORE GREEN AREA**

NAICS	Industries within Core Area	Direct Green Jobs By Industry	Direct Green Jobs in Core Area	Percentage of Direct Green Jobs in Core Area
	<b>Agriculture and Natural Resource Conservation (all)</b>		<b>11,986</b>	
111	Crop Production	3,503	3,295	27.5%
561	Administrative Services	2,698	1,870	15.6%
541	Professional, Scientific, and Technical Services	22,178	1,776	14.8%
322	Paper Manufacturing	1,100	1,000	8.3%
321	Wood Product Manufacturing	982	223	1.9%
	<b>Clean Transportation and Fuels (all)</b>		<b>39,317</b>	
336	Transportation Equipment Manufacturing	25,780	25,142	63.9%
541	Professional, Scientific, and Technical Services	22,178	12,976	33.0%
	<b>Energy Efficiency (all)</b>		<b>22,236</b>	
238	Specialty Trade Contractors	9,825	7,470	33.6%
236	Construction of Buildings	3,571	2,462	11.1%
221	Utilities	2,608	2,405	10.8%
541	Professional, Scientific, and Technical Services	22,178	2,349	10.6%
423	Merchant Wholesalers, Durable Goods	2,793	1,436	6.5%
	<b>Pollution Prevention and Environmental Cleanup (all)</b>		<b>12,345</b>	
541	Professional, Scientific, and Technical Services	22,178	4,454	36.1%
562	Waste Management and Remediation Services	2,168	1,494	12.1%
423	Merchant Wholesalers, Durable Goods	2,793	932	7.5%
325	Chemical Manufacturing	1,024	833	6.7%
238	Specialty Trade Contractors	9,825	806	6.5%
	<b>Renewable Energy Production (all)</b>		<b>8,843</b>	
238	Specialty Trade Contractors	9,825	1,257	14.2%
327	Nonmetallic Mineral Product Manufacturing	1,448	1,132	12.8%
541	Professional, Scientific, and Technical Services	22,178	605	6.8%
562	Waste Management and Remediation Services	2,168	559	6.3%
321	Wood Product Manufacturing	982	471	5.3%

Source: Michigan Department of Energy, Labor & Economic Growth

Although, a few industry sectors dominate employment in the individual core areas, some industry sectors are vital to multiple segments of the green economy. For example, the *Professional, scientific and technical services* industry was prevalent across several core areas, and comprised the largest share (36 percent) of green jobs in Pollution Prevention and Environmental Cleanup. Additionally, the largest number of green jobs in *Professional, scientific, and technical services* was in the Clean Transportation and Fuels core area, with nearly 13,000 green positions. Another industry sector of note was *Specialty trade contractors*, which holds a significant share of green employment in three core areas. *Specialty trade contractors* engage in a wide variety of construction-related activities from site preparation to electrical work. Employment in this sector is highly concentrated in the Energy Efficiency core area with nearly 7,500 jobs or over one-third of the core area's green employment.

### Survey Results: Green Jobs by Detailed Occupation

As mentioned above, survey respondents were asked to specify the detailed occupational titles in their organization that work to provide goods or services in any of the green core areas. These responses were coded by Standard Occupation Code (SOC), and this information is particularly valuable. It provides for the first time actual Michigan survey-based estimates of the types of job titles most prevalent in the green economy, along with employment estimates in those occupations. Figure 5 lists the occupations in Michigan with the largest number of green jobs, according to the survey results.

Engineering occupations reported a significant share of green-related jobs in Michigan, accounting for about 24 percent of Michigan green employment. The largest occupation – Engineers (All Other) – included a variety of reported engineers that could not be specifically classified. Other key green-related engineering occupations included Mechanical engineers, Electrical engineers, and Environmental engineers. Engineering occupations can be found in each green core area and in many different industries.

### Green Jobs Core Areas Definitions

**Increasing Energy Efficiency:** Energy efficiency encompasses all changes that result in a reduction of the energy used for a given energy service (i.e., space heating, lighting, etc.) or level of activity. Examples include: insulation of a building can achieve the same desired temperature with less energy use; adopting green building design/LEED standards encourages downsizing or upgrading of HVAC, lighting and other energy systems, which reduces energy demand in the building; producing an energy efficient household appliance, such as a refrigerator or dryer, which delivers the same performance using less electricity; or providing engineering, consulting or research services on operations, materials, or technologies that improve energy efficiency.

**Pollution prevention and environmental cleanup:** Pollution prevention refers to products that are designed to have minimal impacts on human health and the environment, and services that eliminate or reduce the amount and toxicity of potentially harmful substances at their source. Businesses that provide services and/or products related to controlling industrial and commercial emissions, environmental remediation, waste treatment, recycling, water conservation and treatment, and brownfield redevelopment are examples in this area.

Production occupations were also common in the green economy. These production occupations represent about 28 percent of all green employment in Michigan. These include job titles such as *Assemblers and fabricators (All Other)*, *Production workers (All Other)*, *Machinists*, and *Power plant operators*. While the majority of these occupations are found in the automobile industry, many production

workers find employment in other sectors of the green economy including Renewable Energy Production and Pollution Prevention and Environmental Cleanup.

A variety of green jobs were reported among construction and maintenance occupations. Examples of green construction occupations included *Electricians*, *Carpenters*, and *Construction Managers*, while maintenance occupations included *Heating, air*

**FIGURE 5: OCCUPATIONS THAT GENERATE THE LARGEST NUMBER OF MICHIGAN DIRECT GREEN JOBS**

SOC	Occupation	Total Direct Green Jobs	Percent of Total Direct Green Jobs
	<b>Total, All Green Occupations</b>	<b>96,767</b>	<b>100.0%</b>
17-2199	Engineers (All Other)	11,397	11.8%
17-2141	Mechanical Engineers	6,809	7.0%
51-2099	Assemblers and Fabricators, All Other	3,980	4.1%
49-9021	Heating, Air Condition, & Refrig. Mech & Installers	3,444	3.6%
45-2092	Farmworkers & Laborers, Crop, Nursery, Greenhouse	3,303	3.4%
51-9199	Production Workers, All Other	3,002	3.1%
37-3011	Landscaping and Groundskeeping Workers	2,205	2.3%
49-9042	General Maintenance and Repair Workers	1,813	1.9%
47-2111	Electricians	1,705	1.8%
17-2071	Electrical Engineers	1,555	1.6%
51-4041	Machinists	1,541	1.6%
19-2041	Environmental Scientists & Specialists	1,525	1.6%
47-2061	Construction Laborers	1,473	1.5%
41-3099	Sales Representatives, Services, All Other	1,454	1.5%
51-8013	Power Plant Operators	1,215	1.3%
51-1011	First-Line Supervisors of Production Workers	1,170	1.2%
51-4031	Cutting, Punching, and Press Machine Setters, Oper	1,168	1.2%
47-2031	Carpenters	1,161	1.2%
11-9021	Construction Managers	1,113	1.2%
51-9061	Inspectors, Testers, Sorters, Samplers, and Weighers	1,061	1.1%
51-4111	Tool and Die Makers	1,048	1.1%
17-2081	Environmental Engineers	988	1.0%

Source: Michigan Department of Energy, Labor & Economic Growth



conditioning, & refrigeration mechanics and General maintenance and repair workers. Together, these two broad occupational groups represent about 19 percent of all green jobs in Michigan. Many individuals employed in these job titles are building energy efficient homes, offices, or factories or are retrofitting existing homes, offices, or factories to be more energy efficient.

Green jobs in Michigan are also generated for a variety of professional, technical, and scientific positions. These categories generated over 9,000 green jobs, or nearly 10 percent of the statewide

total. One example of such an occupation in Figure 5 is *Environmental scientists & specialists*.

In addition, agriculture-related jobs were also well identified as an important source of green jobs in Michigan. These occupations range from *Farmworkers and laborers* to *Landscaping and groundskeeping workers*. Agriculture-related occupations supplied an additional 8 percent of green jobs reported in the survey.

As with industries, occupations can also be ranked within the five core green areas. Figure 6, displays the distribution of green-related positions by core area.



A variety of green jobs were reported among construction and maintenance occupations. Examples of green construction occupations included Electricians, Carpenters, and Construction Managers, while maintenance occupations included heating, air conditioning, & refrigeration mechanics and general maintenance.

Engineering occupations reported a significant share of green-related jobs in Michigan, accounting for about 24 percent of Michigan green employment.



Production occupations were also common in the green economy, representing about 28 percent of all green employment. These include job titles such as Assemblers and fabricators (All Other), Production workers (All Other), Machinists, and Power plant operators.



**FIGURE 6: TOP FIVE LARGEST OCCUPATIONS BY CORE GREEN AREA**

SOC	Occupations Within Core Area	Direct Green Jobs by Occupation	Direct Green Jobs in Core Area	Share of Core Area Direct Green Jobs by Occupation
	<b>Agriculture and Natural Resource Conservation (all)</b>		<b>11,986</b>	
45-2092	Farmworkers and Laborers, Crop, Nursery, and Greenhouse	3,303	3,025	25.2%
37-3011	Landscaping and Groundskeeping Workers	2,205	1,915	16.0%
51-9199	Production Workers, All Other	3,002	487	4.1%
17-2081	Environmental Engineers	988	441	3.7%
19-2041	Environmental Scientists and Specialists	1,525	412	3.4%
	<b>Clean Transportation and Fuels (all)</b>		<b>39,317</b>	
17-2199	Engineers, All Other	11,397	10,540	26.8%
17-2141	Mechanical Engineers	6,809	6,119	15.6%
51-2099	Assemblers/Fabricators, All Other	3,980	3,544	9.0%
51-9199	Production Workers, All Other	3,002	1,326	3.4%
51-4041	Machinists	1,541	915	2.3%
	<b>Energy Efficiency (all)</b>		<b>22,236</b>	
49-9021	Heating, Air Conditioning, and Refrigeration Mechanics and Installers	3,444	2,834	12.7%
49-9042	Maintenance and Repair Workers, General	1,813	1,271	5.7%
51-8013	Power Plant Operators	1,215	1,045	4.7%
47-2031	Carpenters	1,161	985	4.4%
41-3099	Sales Representatives, Services, All Other	1,454	892	4.0%
	<b>Pollution Prevention and Environmental Cleanup (all)</b>		<b>12,345</b>	
19-2041	Environmental Scientists and Specialists	1,525	884	7.2%
17-2051	Civil Engineers	759	491	4.0%
19-4091	Environmental Science and Protection Technicians	771	487	3.9%
53-7081	Refuse and Recyclable Material Collectors	595	453	3.7%
11-9041	Engineering Managers	688	424	3.4%
	<b>Renewable Energy Production (all)</b>		<b>8,843</b>	
51-9011	Chemical Equipment Operators and Tenders	494	492	5.6%
49-9021	Heating, Air Conditioning, and Refrigeration Mechanics and Installers	3,444	434	4.9%
47-2111	Electricians	1,705	222	2.5%
51-4041	Machinists	1,541	166	1.9%
	<i>Data too few to classify fifth occupation</i>			

Source: Michigan Department of Energy, Labor & Economic Growth

**Clean Transportation and Fuels**— The prevalence of Michigan’s automobile industry is very evident from the green job titles in Clean Transportation and Fuels. The five largest occupations in this core area, accounting for nearly 60 percent of green jobs, represent a diverse range of educational requirements and skill sets. On the high end, Engineers require significant investments in education and training. Moderate-skill occupations such as Assemblers and fabricators and Production workers require less education, although do require moderate-term to long-term on-the-job training. Despite the declining recent trend in jobs in the Michigan auto industry, it is likely that the share of jobs in the industry that will be involved with the research, engineering, and production of fuel-efficient and alternative fuel vehicles will continue to grow.

**Energy Efficiency**— The majority of occupations in the Energy Efficiency core area are construction-related. Occupations such as *Heating, air conditioning, & refrigeration installers, Carpenters, and General maintenance and repair workers* are commonly needed in new building construction or retrofitting projects. Although not appearing in the top five job titles in Figure 6, many managerial and supervisory jobs are created in the Energy Efficiency core area due to the need to meet green-building quality standards.

**Agriculture and Natural Resource Conservation**— Michigan has a very significant agricultural sector and vast natural resources. Accordingly, many jobs in the Agriculture and Natural Resource Conservation core area can be found on Michigan farms and in Michigan’s national, state, and local parks. Occupations such as *Crop, nursery, and greenhouse workers* reflect the many jobs supplied by Michigan’s organic and sustainable agriculture segment. In contrast, a portion of jobs in occupations such as *Landscaping and groundskeeping workers* were identified in the survey as green, and make up a significant share of jobs in this core area. *Environmental engineers* contribute skilled green jobs in the area of Natural Resource Conservation.

**Pollution Prevention and Environmental Cleanup**— Occupations in *Pollution Prevention* and *Environmental Cleanup* range from the workers

### Which critical occupations are Michigan focus group employers finding hard to fill NOW?

- ✓ Energy Auditors – HERS Raters (Home Energy Rating System)
- ✓ Skilled Trades (All)
- ✓ Lead/Hazardous Materials Workers
- ✓ Accountants
- ✓ Wind Technicians
- ✓ Agri-Tourism Specialists
- ✓ Food Safety Specialists
- ✓ Aquaculturalists
- ✓ Urban Farmers
- ✓ Truckers
- ✓ PV Installers
- ✓ Heavy Equipment Operators
- ✓ AC/DC Electrical Workers
- ✓ HVAC (install and adapt for bio-mass systems)
- ✓ Plumbers
- ✓ Designers for PV, Wind, Solar applications
- ✓ Sales People with knowledge in green
- ✓ Semi-Conductor Engineers
- ✓ Vacuum Techs
- ✓ Purchasing/Procurement/Product Developers
- ✓ Qualified Tool Makers
- ✓ Management that can take advantage of government funding opportunities, understand new regulations impacted by new technologies

Source: Focus Groups with Michigan Employers, February – March, 2009

who operate recycling trucks to the scientists and engineers who research and develop pollution control equipment. About 22 percent of green occupations in this core area were generated in five job titles, including *Environmental scientists & specialists*, *Civil engineers*, *Environmental science & protection technicians*, *Refuse & material collectors*, and *Engineering managers*.

**Renewable Energy Production**—The most diverse set of occupations can be found in Michigan’s Renewable Energy production core area. A wide range of occupations contribute green jobs to this core area, such as engineers, technicians, mechanics and installers, and production staff. Jobs range from technical and professional jobs generated by alternative energy research, to skilled manufacturing positions involved with the production of products or parts for the alternative energy supply chain, to jobs for agricultural workers engaged in the production of agricultural inputs used in renewable energy.

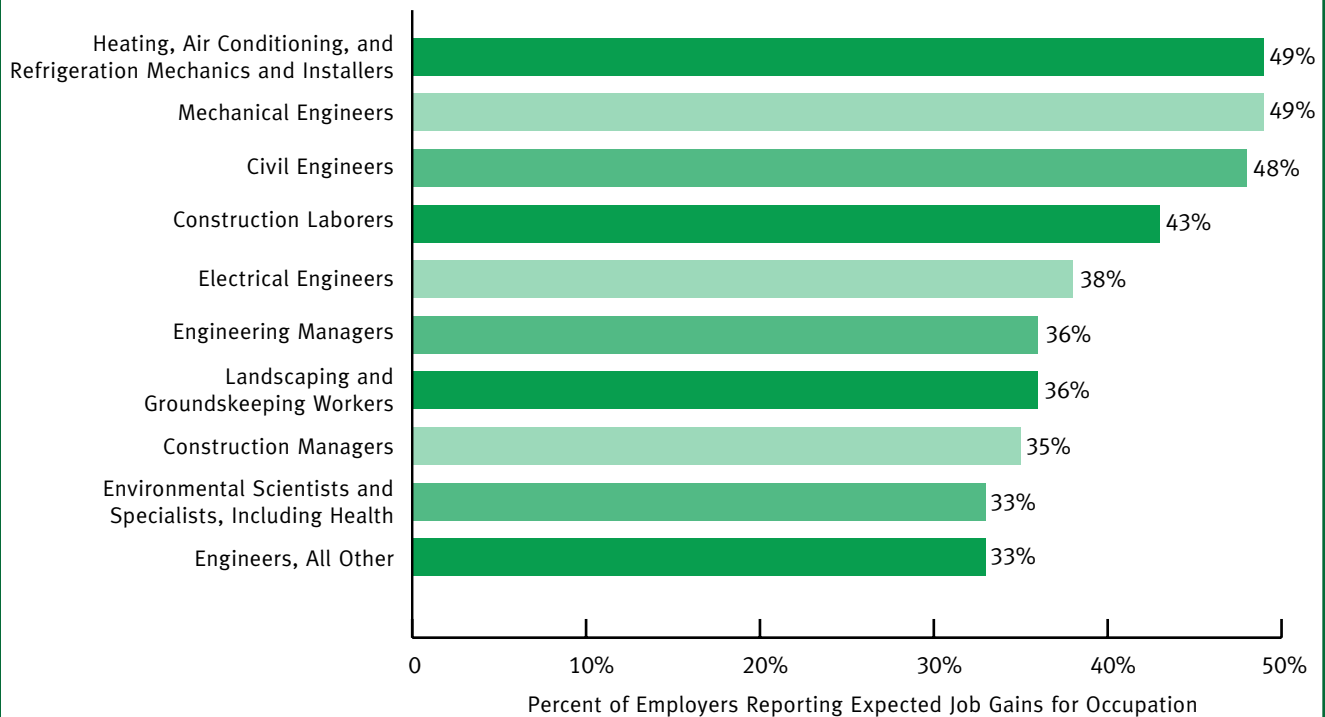
## Survey Results: Employer Expectations

Expectations of employers regarding current and future green-related workforce needs are a critical element in further understanding green jobs. Accordingly, the Department of Energy, Labor & Economic Growth asked employers in this survey questions regarding: (1) expected future job gains in green occupations, (2) expected difficulty filling future green job vacancies (3) whether occupations require unique skills when working on green projects (4) and the potential use of formal versus informal training for existing and new green workers.

## Hiring

Employers were asked to estimate for each current green occupation their expectation for employment in 2011. (Responses to this survey question were received from only a share of survey respondents). Figure 7 displays the specific occupations which an above-average share of employers anticipate

**FIGURE 7: SELECTED OCCUPATIONS WITH ABOVE-AVERAGE SHARE OF EMPLOYERS INDICATING LIKELY JOB EXPANSION 2009-2011**



Source: Michigan Department of Energy, Labor & Economic Growth

additional jobs in the next two years. This information does not represent actual employment forecasts, but does provide clues of occupations with some potential for future short-term employment gains.

These growth occupations represent a broad range of skill levels. There are mid to lower skilled occupations that require primarily on-the-job training, such as *heating, air conditioning, and refrigeration mechanics and installers, construction laborers, and landscaping and groundskeeping workers*. Many other job titles with solid employment expectations are high skill occupations, such as *engineering, management, and technical specialist positions*. These often require a four-year degree and several years of relevant work experience. Future green jobs will demand various levels of skills and training.

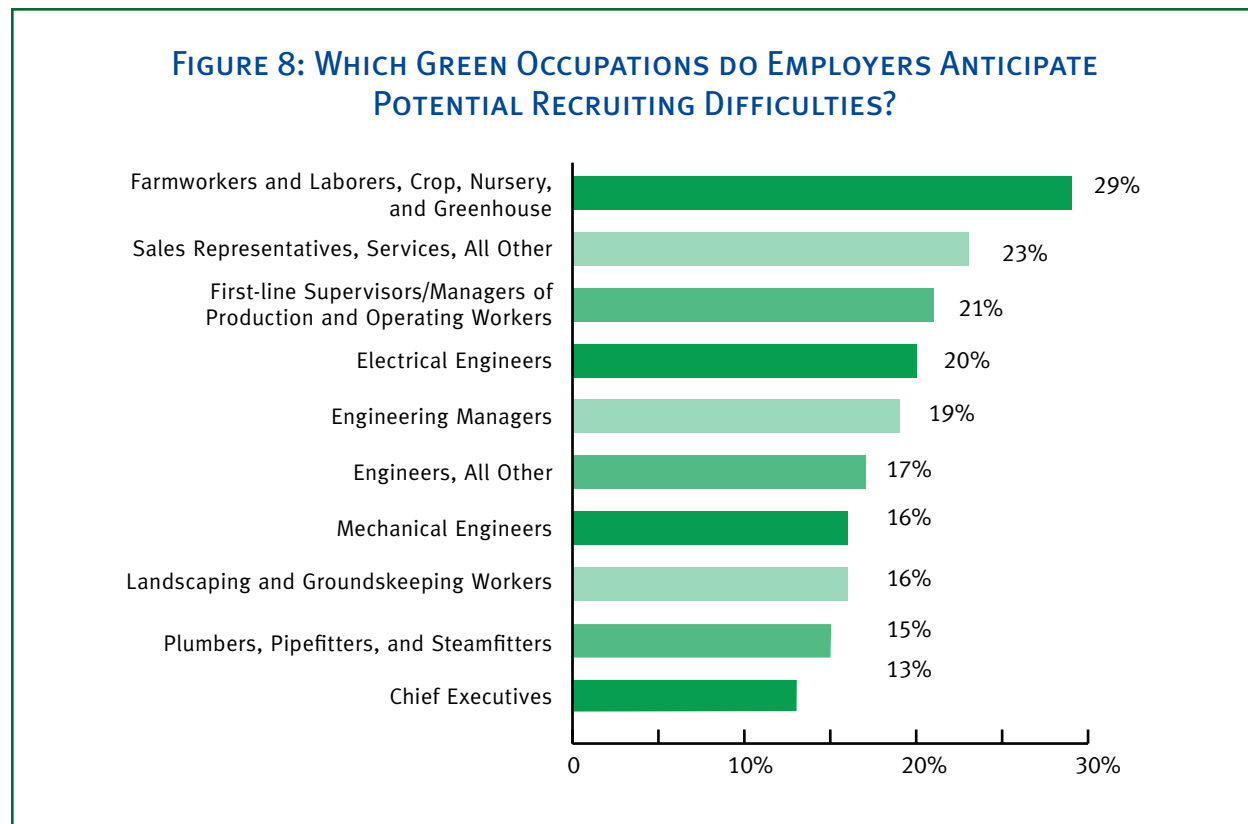
### Filling Vacancies

Employers indicated on the survey the green occupations in which they anticipate difficulty in filling future job vacancies. While differences exist among industries, it is possible to identify specific

occupations that employers believe will be especially hard-to-fill (see Figure 8 below). For the most part, occupations that require specialized skills, education, and experience will face the most difficulties. Engineers were heavily represented in this list. Sales, management, and construction trade job openings were also mentioned as potentially hard-to-fill.

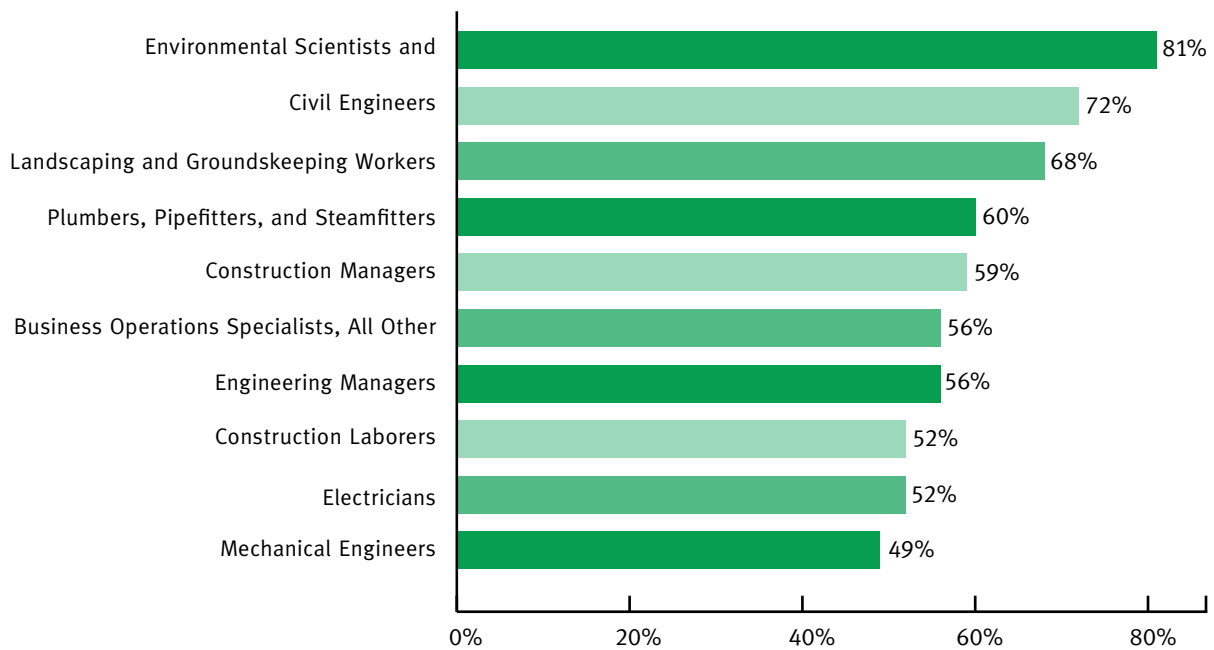
### Unique Skills

Employers were also asked to identify occupations that require unique skills when working on a “green project.” As Figure 9 below indicates, there were ten occupations that roughly 50-80 percent of responding employers highlighted as requiring unique skills for “green” projects. This has implications for training providers, as individual green occupations will differ in their need for specialized training. Some occupations will require very skilled workers, but the skill sets used by those workers on a “green” project will be very similar to the skills they will utilize when working on a “non-green” project. Occupations that utilize unique skills when applied to “green” projects



Source: Michigan Department of Energy, Labor & Economic Growth

**FIGURE 9: OCCUPATIONS THAT REQUIRE UNIQUE SKILLS FOR “GREEN PROJECTS”**

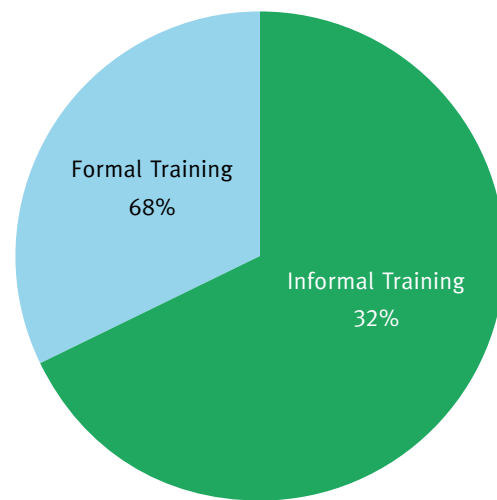


Source: Michigan Department of Energy, Labor & Economic Growth

are those that may need more specialized training. This has implications for incumbent workers who increasingly find themselves working on “green” projects, as well as potential new green workers hoping to transition from existing industries into the green economy.

Figure 9 lists the ten leading occupations that employers identify as needing unique skills when working on “green” projects. It appears that occupations that require significant levels of education or training are more likely to require specialized skills. Six of the leading occupations identified as requiring unique skills were professional or managerial positions.

**FIGURE 10: ANTICIPATED TRAINING DEMAND: FORMAL VS. INFORMAL TRAINING**



Source: Michigan Department of Energy, Labor, and Economic Growth



## Training

In an attempt to measure the training needs of employers, the survey asked employers about the likely mix of training for their green-related workforce between:

- Formal training provided by community colleges or other training providers
- Informal training of staff on-the-job

The question sheds some light on the potential future green-related training capacity requirements in the state.

As Figure 10 illustrates, survey respondents indicated that roughly 68 percent of their future employee training needs may be conducted on-the-job. Although only about 32 percent of training needs may be formal, most of the individual industry sectors did report some expected utilization of formal training.

The information in this section would not have been possible without the participation of over 6,400 employers who took the time to respond to the Michigan Green Jobs Survey. This effort has given us the first set of survey-based estimates ever produced on Michigan's current levels of green jobs by detailed industry and occupation. However, the survey asked a limited number of questions and could not address some critical variables regarding the green workforce, such as recent employment trends, more details on industries and occupations, and key topics such as the wages, skills, and educational requirements for specific green-related jobs.

To address those issues, the remaining chapters in this report will supplement the information from the employer survey by incorporating existing sources of labor market information. The use of multiple information sources will provide the most comprehensive understanding of green jobs in Michigan.

### What training issues need to be resolved for Michigan employers?

“Old school methods for drawing and drafting need to be brought back. A lot of talent never develops because using computers prevents from some foundational skills from being developed.”

“Auto people are highly specialized but need to be cross trained in order to build an entire machine, not just a component.”

“Unions are still catching up to the new tech products. Training needs to get accelerated and inspectors need to learn along with the electricians.”

“Training for ‘green’ needs to start in high school. We need to re-emphasize shop and vocational classes in high schools.”

“It is important to go “Back-to-Basics” – STEM skills, electrical, mechanical skills, etc.. Fifty percent (50%) of persons applying to apprenticeships are rejected because they don’t meet the basic requirements of a GED/high school degree and sufficient algebra completion.”

Source: Focus Groups with Michigan Employers, February – March, 2009

## CHAPTER II: GREEN-RELATED INDUSTRIES IN THE MICHIGAN ECONOMY

The information from the survey on green jobs is critical because it represents the first attempt to collect data directly from employers on the number of current green jobs in the Michigan economy. However, employer surveys need to be concise and focused to reduce reporting burden, so a number of additional issues regarding green jobs were not addressed in the survey questionnaire.

These additional issues include:

### INDUSTRY INFORMATION

- ✓ Is there a way to shed light on recent employment trends among firms in the green economy or among industries that appear related to the green economy?
- ✓ Which broad green-related industry clusters provide the most total jobs, display competitive employment performance, or may have been more stable recently in terms of job trends?
- ✓ Which green-related industry sectors pay above-average wages?

### OCCUPATIONAL INFORMATION

- ✓ Can a set of green-related occupations be identified? If so, what are the basic characteristics of these jobs?
- ✓ Which green-related occupations are large enough in Michigan to produce multiple annual job openings?
- ✓ What are examples of high-wage green-related occupations?
- ✓ Are there green-related job titles available in the Michigan economy for persons with differing educational/training backgrounds? Do career ladders exist in the green economy?
- ✓ What are some of the key skills and knowledge sets needed in certain green-related occupations?

The following section contains information on “green-related industries.” These are industries identified by our research staff as sectors most likely to provide green jobs. The purpose of the section is to highlight the economic characteristics of these industries such as wage levels, employment trends, employment concentration, and competitive employment performance. The remaining chapters on green-related firms and occupations will round out the report by providing additional complementary information not obtained from the employer survey.

To understand the following section on “green-related industries”, it is important to define this term and distinguish it from the green jobs estimates generated by the employer survey.

### Green-related Industry Analysis – Understanding the Data

There are several advantages gained by examining the green economy through industry employment data. The Quarterly Census of Employment and Wages (QCEW) program provides a wealth of information



on detailed industries including the number of firms, employment levels and trends, and wages. For this report, the primary advantage of the QCEW data is that it can provide these variables for detailed industries related to the green economy.

A few caveats should be mentioned before attempting to examine industry information. In the section that follows, the term “green-related industry” will be used extensively. It is defined as follows:

### GREEN-RELATED INDUSTRY—

A detailed industry sector that is likely to contain firms that produce parts, components, products or services related to the green economy. The green economy includes activities such as renewable energy, energy efficiency, clean transportation and fuels, agriculture and natural resources, and pollution prevention and environmental cleanup.

However, the identification of these green-related industries was not easy or straightforward. This is primarily because the NAICS classification system is not specific enough to identify specific green sectors. There is no single NAICS code or set of codes to capture all firms involved in wind energy, solar energy, or research into alternative fuels.

As a result, many of the green-related industries we selected for this chapter of the study are only partially “green”. However, analyzing this set of green-related industries is important, because these are the some of the industry sectors that could benefit most from an expansion of the Michigan green economy. The results of our initial employer survey and future surveys will help us to eventually refine this list to identify the share of jobs in each green-related industry that is **truly** “green”.

What this also means is the employment trends in these green-related sectors must be evaluated with caution. Since many are only partially related to green activities, the employment trends displayed are impacted by many factors beyond the green economy.

For example, while the construction industry holds a good number of jobs related to energy efficiency (a green core area), the recent national recession and housing market crash has adversely affected all employment in that sector. The same is true of the automobile industry. Even though engineers in the auto industry are increasingly focused on technology development to improve the fuel efficiency of vehicles, the enormous job cuts in the overall Michigan auto sector will obscure any job gains among green workers in the industry.

Our research staff used multiple resources to compile a list of green-related industries (please see the Appendix for a complete list of these sectors).

- A literature review was conducted of available studies on the topic of industries and the green economy. Each research report was examined for specific industry titles mentioned as being “green-related”.
- Michigan worked closely with a consortium of labor market research organizations in several other states on the topic of defining industries and occupations related to the green economy. Green-related industry job listings compiled by the states of Washington and Pennsylvania were reviewed.
- Specific Michigan firms related to the green economy were identified, and a sample of these firms was reviewed to identify their industry codes.
- Michigan research staff conducted a comprehensive review of the NAICS coding system for industries that appeared to be “green-related”.
- The list of green-related industries was vetted by a team of state government and private industry representatives.

## Employment in Michigan’s Green Clusters

The set of green-related detailed industries identified in this report account for over one in ten of Michigan’s total private jobs. These detailed industries were classified into seven broad clusters for this analysis. These include five clusters common with the core areas in the green employer survey,

and two additional categories, *Miscellaneous Green Manufacturing* and *Engineering, Testing, and Consulting Services*. The seven clusters are:

- Agriculture and Natural Resource Conservation
- Clean Transportations and Fuels
- Engineering, Testing, and Consulting Services
- Increasing Energy Efficiency
- Miscellaneous Green Manufacturing
- Pollution Prevention and Environmental Cleanup
- Renewable Energy Production

The Miscellaneous Green Manufacturing cluster includes manufacturing industry sectors that do not solely focus on one area of the green economy. A prime example would be firms in the business of *Measuring and controlling device manufacturing*. This industry is engaged in the production of controlling and measuring devices that have a wide range of applications - from measuring output of renewable energy plants to monitoring factories with the goal of preventing pollution. There were several manufacturing industries similar to this example involved in various aspects of the green economy, so the creation of a separate green manufacturing cluster was essential.

The *Professional, scientific, and technical services* industry provided a similar challenge. It is highly likely that firms in this broad industry provide services in a wide array of green-related activities; and the sector as a whole does not neatly fit in any of the original clusters. Therefore, the research team developed the Engineering, Testing, and Consulting Services cluster, which contains many industries that provide professional services across the green economy.

In total, 118 green-related industries were identified and assigned to a specific green cluster based on each detailed industry's associated activities, products, and services. Figure 11 displays the top five industries with the highest employment for each of the green-related segments.

Increasing Energy Efficiency was the largest green cluster, accounting for about 118,000 jobs, or 31 percent of total employment in Michigan's green-related industries. This industry segment is highly

concentrated in construction, which accounts for nearly 77 percent of employment. It is appropriate that the construction industry comprises the majority of the Increasing Energy Efficiency cluster, since current actions in energy efficiency, to a large extent, deal with updating building structures.

Clean Transportation and Fuels stands as the second largest core cluster in terms of employment, accounting for 28 percent of total green-related employment or 109,000 jobs overall. The Clean Transportation and Fuels segment is comprised of detailed industries primarily in auto manufacturing and mass transit. Michigan's concentration of auto jobs dominates this cluster, and manufacturing industries overall account for 97 percent of cluster jobs.

Engineering, Testing, and Consulting Services was the third largest green cluster, comprising 22.1 percent of total green-related employment and employing over 85,000 workers. All the industry sectors within this green segment reside in the *Professional, scientific, and technical services* sector, which provides specialized expertise, such as research and legal advice, to a variety of private and public clients.

Pollution Prevention and Environmental Cleanup ranked fourth in jobs among the green core segments, accounting for six percent of total green-related employment. However, nearly half of total employment in this cluster was concentrated in *Waste Management and Remediation Services*, which deals with the collection, disposal, and treatment of waste materials.

Miscellaneous Green Manufacturing provided over 19,000 jobs, or nearly five percent of total green-related employment in Michigan. This category includes manufacturing industries engaged in producing a diverse set of products, ranging from wood to organic chemicals.

Renewable Energy Production provided over 18,000 jobs, or just 4.7 percent of green-related employment. Detailed industries in *Utilities and Manufacturing*, focused in the areas of electricity generation and distribution, comprised the majority of the Renewable Energy Production cluster, accounting for about 60 percent of employment.

**FIGURE 11: EMPLOYMENT IN SELECT GREEN-RELATED INDUSTRIES/CLUSTERS, MICHIGAN 2008 Q2**

NAICS	Cluster / Industry	2008 Q2 Employment	Share of Cluster	Share of Total Green-Related Employment
<b>Increasing Energy Efficiency</b>		<b>117,828</b>		<b>30.6%</b>
238212	Electrical Contractors and Other Wiring Installation Contractors – Nonresidential	16,306	13.8%	4.2%
238222	Plumbing, Heating, and Air-Conditioning Contractors – Nonresidential	13,719	11.6%	3.6%
236220	Commercial and Institutional Building Construction	13,362	11.3%	3.5%
238221	Plumbing, Heating, and Air-Conditioning Contractors – Residential	9,690	8.2%	2.5%
236118	Residential Remodelers	8,462	7.2%	2.2%
<b>Clean Transportation and Fuels</b>		<b>109,044</b>		<b>28.3%</b>
336111	Automobile Manufacturing	40,875	37.5%	10.6%
336399	All Other Motor Vehicle Parts Manufacturing	21,494	19.7%	5.6%
336350	Motor Vehicle Transmission and Power Train Parts Manufacturing	15,371	14.1%	4.0%
336360	Motor Vehicle Seating and Interior Trim Manufacturing	12,367	11.3%	3.2%
336312	Gasoline Engine and Engine Parts Manufacturing	10,543	9.7%	2.7%
<b>Engineering, Testing, and Consulting Services</b>		<b>85,293</b>		<b>22.1%</b>
541330	Engineering Services	38,734	45.4%	10.1%
541380	Testing Laboratories	19,869	23.3%	5.2%
541712	R & D in the Physical, Engineering, and Life Science (except biotech)	16,409	19.2%	4.3%
541614	Process, Physical Distribution, and Logistics Consulting Services	4,029	4.7%	1.0%
541620	Environmental Consulting Services	1,893	2.2%	0.5%
<b>Pollution Prevention and Environmental Cleanup</b>		<b>22,994</b>		<b>6.0%</b>
562111	Solid Waste Collection	4,374	19.0%	1.1%
423930	Recyclable Material Merchant Wholesalers	4,364	19.0%	1.1%
237110	Water and Sewer Line and Related Structures Construction	3,494	15.2%	0.9%
238911	Site Preparation Contractors	3,326	14.5%	0.9%
562910	Remediation Services	2,059	9.0%	0.5%
<b>Miscellaneous Green Manufacturing</b>		<b>19,033</b>		<b>4.9%</b>
325211	Plastics Material and Resin Manufacturing	6,651	34.9%	1.7%
322121	Paper (except Newsprint) Mills	2,463	12.9%	0.6%
334513	Instruments Manufacturing for Measuring & Controlling Industrial Process Variables	1,999	10.5%	0.5%
321920	Wood Container and Pallet Manufacturing	1,619	8.5%	0.4%
334419	Other Electronic Component Manufacturing	1,245	6.5%	0.3%
<b>Renewable Energy Production</b>		<b>18,139</b>		<b>4.7%</b>
237130	Power and Communication Line and Related Structures Construction	4,311	23.8%	1.1%
221210	Natural Gas Distribution	3,117	17.2%	0.8%
321113	Sawmills	2,021	11.1%	0.5%
221122	Electric Power Distribution	1,554	8.6%	0.4%
113310	Logging	1,313	7.2%	0.3%

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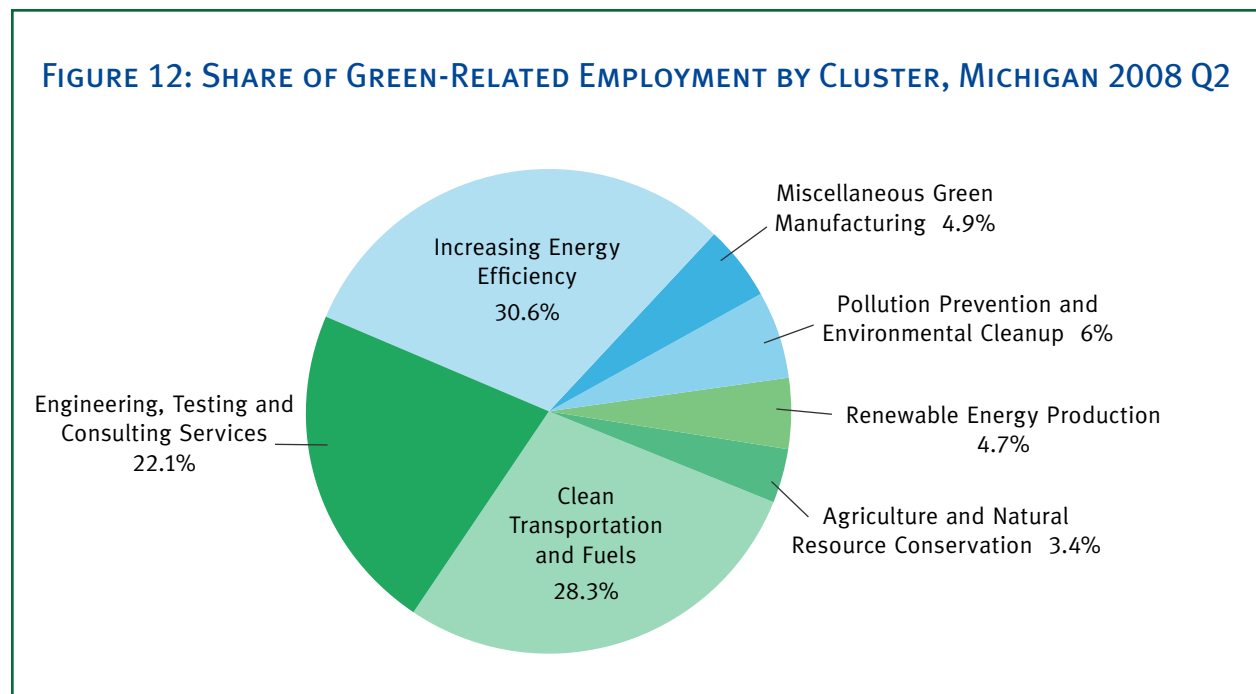
**FIGURE 11: EMPLOYMENT IN SELECT GREEN-RELATED INDUSTRIES/CLUSTERS, MICHIGAN 2008 Q2**

NAICS	Cluster / Industry	2008 Q2 Employment	Share of Cluster	Share of Total Green-Related Employment
Agriculture and Natural Resource Conservation		13,024		3.4%
111422	Floriculture Production	4,900	37.6%	1.3%
111421	Nursery and Tree Production	4,504	34.6%	1.2%
813312	Environment, Conservation and Wildlife Organizations	1,264	9.7%	0.3%
111998	All Other Miscellaneous Crop Farming	602	4.6%	0.2%
712190	Nature Parks and Other Similar Institutions	524	4.0%	0.1%
Total Green Related Employment		385,355		

Source: Michigan Department of Energy, Labor & Economic Growth

Agriculture and Natural Resource Conservation was the smallest green segment, with only 3.4 percent (13,000 employees) of total green-related jobs. (It is important to note that the Quarterly Census of Employment and Wages program (QCEW), that generates this employment data, does not capture self-employed workers, which is a significant component in agriculture). Two industries in this green segment stood out: *Floriculture production* and *Nursery tree production* comprised 72.2 percent of total employment in the cluster. Many of the industry sectors in this area are engaged in crop production, which is very sensitive to seasonal variations.

**FIGURE 12: SHARE OF GREEN-RELATED EMPLOYMENT BY CLUSTER, MICHIGAN 2008 Q2**



Source: Michigan Department of Energy, Labor & Economic Growth



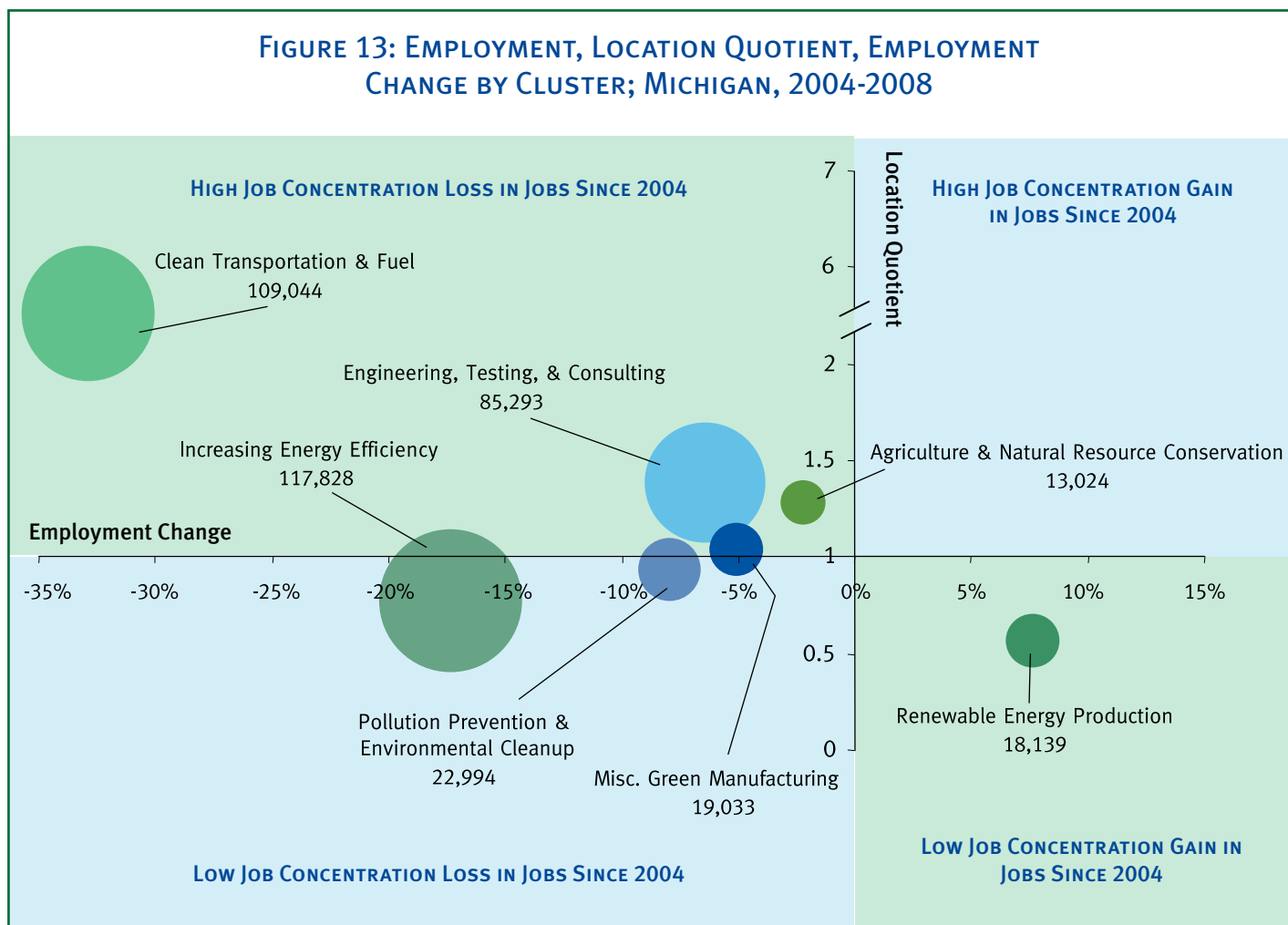
## Broad Cluster Analysis – Location Quotients

An analysis of green-related industries in Michigan can be put into perspective by comparing statewide results to national norms. By deriving location quotients for each of Michigan’s seven green-related industry clusters, it is possible to compare base employment and industrial activity across regions. A state’s location quotient is determined by comparing the share of employment in a particular industry or cluster to the share of employment in that same industry in the national economy. A location quotient greater than 1.0 for a detailed industry signals that an area has a concentration of jobs above the national average in that industry. Four out of Michigan’s seven broad green-related clusters have location quotients

greater than 1.0 (Figure 13). Each of the four clusters witnessed losses in employment from 2004 to 2008. The only broad cluster to gain in employment over that time, Renewable Energy Production, had a relatively low concentration of employment in Michigan.

Many green-related industries suffered job loss from 2004 to 2008, as did the broader Michigan economy. However, a handful of detailed green-related sectors in Michigan are not only relatively highly concentrated in terms of jobs, but also managed to record employment growth from 2004 to 2008. *Process & logistics consulting* firms, which offer operating advice and assistance in areas such as manufacturing operations improvement, productivity, production planning, and quality assurance, were 44 percent more concentrated in Michigan than in

**FIGURE 13: EMPLOYMENT, LOCATION QUOTIENT, EMPLOYMENT CHANGE BY CLUSTER; MICHIGAN, 2004-2008**



Source: Michigan Department of Energy, Labor & Economic Growth

the United States in the second quarter of 2008. Employment in this industry was up nearly four percent since 2004. Firms in the business of *Industrial design services* have also recorded employment expansion since 2004, and are highly concentrated in the Michigan economy (Figure 14). Taken as a whole, the green-related industries selected for this study comprise a higher share of total jobs in Michigan than is true of the national economy.

As was previously mentioned, it should be noted that not all jobs in these green-related sectors are currently generated by the green economy. *However, if green business expands in the state, many existing Michigan firms in these sectors could have the expertise to diversify into green business activities.*

### Job Change in Green-Related Industries

In recent years, Michigan's economy has been impacted by significant levels of job loss. Between the second quarter of 2004 and 2008, private payroll jobs in Michigan experienced a decline of 5.4 percent. Following the state's trend, total jobs in this set of green-related industries jobs also contracted during this time, falling at a faster rate of 18.5 percent. However, this is an imperfect gauge of the status of green-related employment, since many of the job cuts in these industries had nothing to do with the green economy, but merely reflect that many green-related jobs are in the *manufacturing* and *construction* industry sectors. *These are the very sectors most impacted by recent job loss, due to the deterioration of the auto industry and the collapse of the housing market.*

Despite these data limitations, Figure 15 displays some relevant results. This chart contrasts the percentage point change in employment for all seven green-related clusters, from 2004 to 2008. Despite the recent decline of total jobs in green-related industries, three of the clusters have outperformed the change in total state payroll jobs. The Agriculture and Natural Resource and the Miscellaneous Green Manufacturing segments declined more slowly than total jobs, at -2.1 percent and -5.1 percent, respectively.

A relative bright spot is Renewable Energy Production, which showed a growth rate of 7.1 percent during this period of economic slowdown. The bulk of this growth is fueled by two industries, *Power and*

### RENEWABLE ENERGY—

The Renewable Energy Production cluster showed a growth rate of 7.1 percent during this period of economic slowdown.



*communication line and related structures construction (+996 jobs) and Semiconductor and related device manufacturing (+835 jobs).* Establishments that produce solar and fuel cells may be classified in the *Semiconductor and related device manufacturing* industry.

The majority of the job losses stemmed from two core areas: Clean Transportation and Fuels, and Increasing Energy Efficiency. Not surprisingly, there is a high concentration of manufacturing and construction sectors in these two clusters.

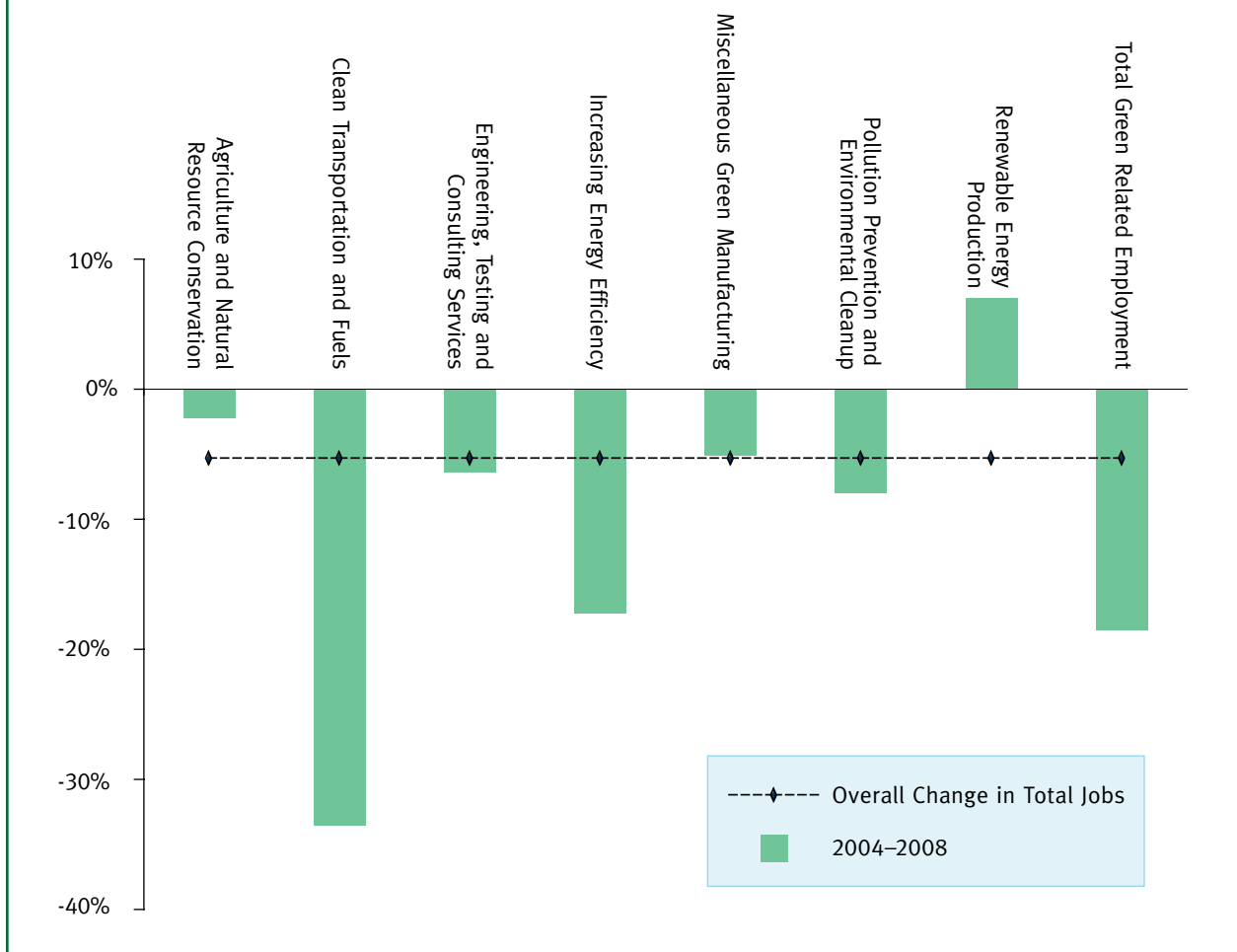
About one-third of the total green-related industries exhibited job gains over this period. Figure 16 shows a selection of specific green-related industries that exhibited gains in employment between the 2<sup>nd</sup> quarter of 2004 and 2008, with the Renewable Energy Production industries mentioned above leading the growth. A diverse set of green-related industry sectors displayed job growth, from *Recyclable material merchant wholesalers* – which deals with the distribution of industrial scrap and other recyclable materials – to firms involve in providing *Environmental consulting services*. The growth of the green economy spans an array of industry sectors.

**FIGURE 14: CLUSTER AND SELECT INDUSTRY EMPLOYMENT, LOCATION QUOTIENT, EMPLOYMENT CHANGE; MICHIGAN, 2004-2008**

Cluster / Industry		Location Quotient	2008 Q2 Emp	'04-'08 Emp Change
Agriculture & Natural Resource Conservation		1.28	13,024	-2.2%
111422	Floriculture Production	2.72	4,900	0.3%
712190	Nature Parks	2.04	524	8.5%
Clean Transportation & Fuels		5.45	109,044	-33.6%
Engineering, Testing, & Consulting		1.38	85,293	-6.4%
541330	Engineering Services	1.36	38,734	-1.4%
541380	Testing Laboratories	4.36	19,869	-11.7%
541614	Process & Logistics Consulting	1.44	4,029	3.8%
541712	R&D in the Physical, Eng., Life Sciences	1.29	16,409	-10.4%
Increasing Energy Efficiency		0.77	117,828	-17.2%
327215	Glass Product Manufacturing	3.45	5,061	-15.1%
327993	Automatic Environmental Control Mfg.	1.42	998	-5.5%
541420	Industrial Design Services	4.91	2,039	53.7%
Miscellaneous Green Manufacturing		1.03	19,033	-5.1%
325211	Plastics Material & Resin Mfg.	3.64	6,651	-0.5%
325311	Measuring and Controlling Devices	1.14	1,114	-5.6%
Pollution Prevention & Environmental Cleanup		0.94	22,994	-8.0%
221320	Sewage Treatment Facilities	1.54	357	-1.4%
423930	Recyclable Materials Merchant Wholesalers	1.21	4,364	10.1%
562111	Solid Waste Collection	1.20	4,374	9.8%
562112	Hazardous Waste Collection	2.76	650	-14.2%
562219	Other Non-hazardous Waste Treat. & Disp.	3.11	1,462	2.8%
562998	All Other Misc. Waste Management Services	1.19	479	-10.3%
Renewable Energy Production		0.57	18,139	7.1%
221119	Other Electric Power Generation	1.04	314	-9.5%
486210	Pipeline Transportation of Natural Gas	1.16	909	-9.0%
All Green-Related Clusters		1.21	385,355	-18.5%

Source: Michigan Department of Energy, Labor & Economic Growth

**FIGURE 15: CHANGE IN EMPLOYMENT FOR GREEN-RELATED CLUSTERS, MICHIGAN 2004 TO 2008**



### Michigan’s Competitive Employment Performance in Green-related Industries

A few green-related industries have grown more rapidly in Michigan than in the United States. To better understand this, we take up a measure of *Competitive Employment Performance*. This variable measures the level of local job growth in an industry which is above the increase that would have been realized had that local industry simply matched the national industry trend. *Competitive Employment Performance* sectors include statewide industries that are adding jobs faster in Michigan than nationally, and may indicate that an industry sector enjoys a regional competitive advantage. Figure 17 identifies a few green-related sectors in which job gains in Michigan have outpaced national trends.

Areas of relative strength for Michigan’s green-related industries were concentrated in the Increasing Energy Efficiency, Miscellaneous Green Manufacturing, and Renewable Energy Production clusters. The single best *Competitive Employment Performance* industry in Michigan included firms in the business of producing *Semiconductor and related devices*. From the second quarter of 2004 to the same quarter in 2008, this industry added 835 jobs in Michigan. During the same period, the industry nationally shed an estimated 11,500 jobs. It is likely that Michigan’s comparatively good performance reflects growth of employment in solar manufacturing whereas the larger national reduction of jobs reflects primarily non-green production cutbacks, such as chips for computers.

**FIGURE 16: EMPLOYMENT GROWTH IN MICHIGAN'S GREEN RELATED INDUSTRIES, 2004-2008**

NAICS	NAICS Title	2004 Q2	2008 Q2	# Change	% Change
237130	Power and Communication Line and Related Structures Construction	3,315	4,311	996	30.0
334413	Semiconductor and Related Device Manufacturing	325	1,160	835	256.9
541420	Industrial Design Services	1,327	2,039	712	53.7
423930	Recyclable Material Merchant Wholesalers	3,962	4,364	402	10.1
813312	Environment, Conservation and Wildlife Organizations	904	1,264	360	39.8
334419	Other Electronic Component Manufacturing	958	1,245	287	30.0
541620	Environmental Consulting Services	1,732	1,893	161	9.3
541690	Other Scientific and Technical Consulting Services	884	1,013	129	14.6
335122	Commercial, Industrial, and Institutional Electric Lighting Fixture Manufacturing	284	353	69	24.3

Source: Michigan Department of Energy, Labor & Economic Growth

**FIGURE 17: JOB CHANGE AND COMPETITIVE EMPLOYMENT PERFORMANCE FOR GREEN CLUSTERS AND SELECT INDUSTRIES; MICHIGAN, 2004-2008**

Cluster / Industry	Jobs 2004	Jobs 2008	Change in Jobs	MI Percent Change	U.S. Percent Change
<b>Increasing Energy Efficiency</b>					
541420 Industrial Design Services	1,327	2,039	712	53.7%	37.4%
333415 Air-Conditioning, Heat, Refrigeration Equip.	2,235	2,539	304	13.6%	-1.8%
<b>Miscellaneous Green Manufacturing</b>					
334419 Other Electronic Component Manufacturing	958	1,245	287	30.0%	9.4%
326113 Unlaminated Plastics Film & Sheet	642	751	109	17.0%	-10.8%
<b>Pollution Prevention &amp; Environmental Cleanup</b>					
562920 Materials Recovery Facilities	59	133	74	125.4%	34.4%
<b>Renewable Energy Production</b>					
237130 Power & Communication Line Construction	3,315	4,311	996	30.0%	24.9%
334413 Semiconductor and Related Devices	325	1,160	835	256.9%	-5.2%

Source: Michigan Department of Energy, Labor & Economic Growth

## Wages in Green-related Industry Clusters

The total impact of green-related industries is not limited to their direct employment numbers. Wages paid across specific industries provide a good deal of information about prospects for growth and offers clues about what kind of potential total impact a particular industry has on the economy in terms of disposable income and spending. If a particular industry pays above-average wages, it is important to recognize the impact that industry has on the local economy, well beyond the direct jobs supplied.

The table below presents average industry wages for Michigan green-related industries from the Quarterly Census of Employment & Wages (QCEW) program. This data reflects overtime pay and bonuses, and reflects the wages earned by all workers in these industries, not just green-related workers. Each of these sectors obviously employs a mix of occupations, earning high, moderate, and low earnings level. However, despite these data limitations, the wage data for industries likely to employ green workers shows that many pay above average wage levels.

The table below offers a broad view of the seven green-related industry clusters identified earlier in the report, and provides some general insight into the potential relative wage impacts of segments of the green economy.

As Figure 18 illustrates, the wage impact of this set of green-related industries is much higher on average than those industries not associated with the green economy. As of the second quarter 2008, the Engineering, Testing and Consulting Services cluster paid the highest wages per worker on an annualized basis. Workers across a variety of occupations within these industries made roughly \$81,900 per year on average, nearly double the overall private average of \$42,200. This is not surprising considering that many businesses within this group employ workers with extensive technical and scientific knowledge in industries such as *Testing laboratories, Research and development, and Engineering and environmental consulting.*

In fact, aside from Agriculture and Natural Resource Conservation, all green-related industry groups provide above-average industry wage rates. Clean Transportation and Fuels was a very close second with wages almost 90 percent higher than average, due to payroll generated by the Michigan auto industry. And, despite the high average wages displayed by the top two clusters, Pollution Prevention and Environmental Cleanup, which ranked second to last, averaged a 12.5 percent premium over total private wages per worker.

**FIGURE 18: TOTAL PAYROLLS AND PER-WORKER AVERAGES IN GREEN-RELATED CLUSTERS**

Cluster Description	Total Wages (Annualized)	Per Worker Wages (Annualized)	Comparison with Private Sector Average Wage
Engineering, Testing and Consulting Services	\$6,984,542,112	\$81,889	+ \$39,722
Clean Transportation and Fuels	\$8,644,817,928	\$79,278	+ \$37,112
Miscellaneous Green Manufacturing	\$1,157,841,632	\$60,833	+ \$18,667
Renewable Energy Production	\$1,022,781,804	\$56,386	+ \$14,219
Increasing Energy Efficiency	\$5,927,686,336	\$50,308	+ \$8,141
Pollution Prevention and Environmental Cleanup	\$1,091,248,976	\$47,458	+ \$5,291
Agriculture and Natural Resource Conservation	\$307,752,536	\$23,630	-\$18,537

Source: Michigan Department of Energy, Labor & Economic Growth



## Wages in Detailed Green and Green-related Industries

The wages in the broad clusters serve to provide a general overview of green-related industry wages. However, more detailed information on specific green and green-related industries can be gleaned from the QCEW data as well. The table below provides a look at the top 15 three-digit NAICS industries ranked in terms of their share of overall green jobs (according to the results from the survey) and the average weekly wages (from the QCEW) paid in each industry overall (not just to green workers).

As Figure 19 indicates, green-related industries hold the potential for workers to earn positive wage rates. Thirteen of the top 15 broad industries in

terms of green jobs paid more than the private sector average weekly wage of \$811, while ten were well above this average (at least \$100 per week more). Furthermore, eight of the top 15 green industries paid more than \$1,000 per week, or over \$50,000 per year.

The highest paying of the industries that generate many green jobs was *Utilities*, which averaged roughly \$1,480 per week per worker in the second quarter 2008. Close behind it were the *Transportation equipment manufacturing* (\$1,421), *Professional and technical services* (\$1,341), and *Chemical manufacturing* (\$1,335) industries.

Though manufacturing industries account for many of the highest-paying green-related sectors, opportunities to make decent wages in the green

**FIGURE 19: AVERAGE WEEKLY WAGES PER WORKER IN TOP GREEN JOB INDUSTRIES\***

3-digit NAICS	Industry Name	Average Industry Weekly Wages	Share of Total Green Jobs
336	Transportation Equipment Manufacturing	\$1,421	26.6%
541	Professional and Technical Services	\$1,341	22.9%
238	Specialty Trade Contractors	\$885	10.2%
236	Construction of Buildings	\$873	3.7%
111	Crop Production	\$414	3.6%
423	Merchant Wholesalers, Durable Goods	\$1,202	2.9%
561	Administrative Services	\$568	2.8%
221	Utilities	\$1,480	2.7%
562	Waste Management and Remediation Services	\$922	2.2%
332	Fabricated Metal Product Manufacturing	\$888	2.1%
333	Machinery Manufacturing	\$1,095	1.7%
327	Nonmetallic Mineral Product Manufacturing	\$1,059	1.5%
334	Computer and Electronic Product Manu.	\$1,066	1.3%
322	Paper Manufacturing	\$969	1.1%
325	Chemical Manufacturing	\$1,335	1.1%
	Average Industry Weekly Wage	\$811	

\*Share of total green jobs derived from DELEG employer survey. Average wages come from QCEW program, and reflect all jobs in the industry, not just green jobs.

Source: Michigan Department of Energy, Labor & Economic Growth

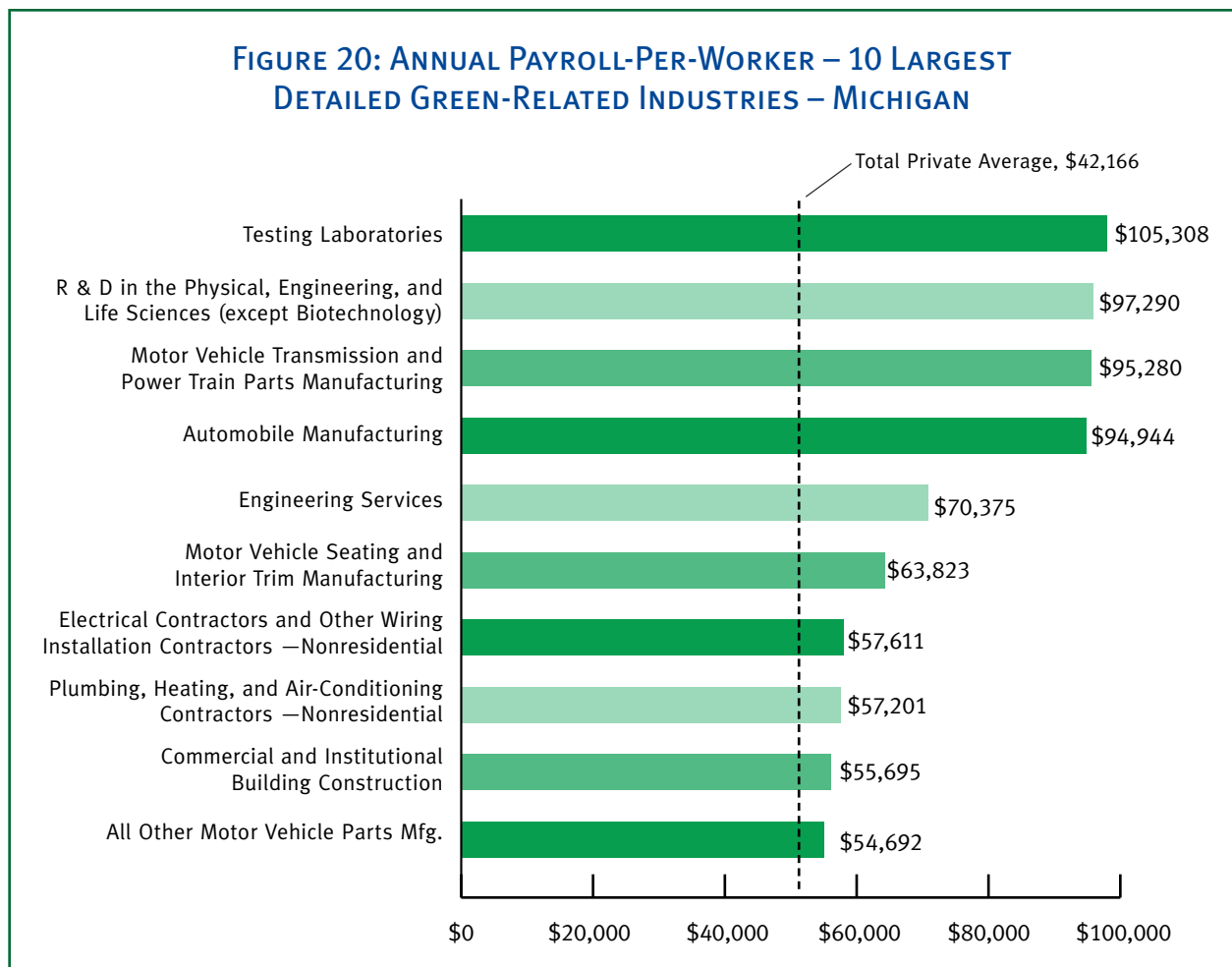
economy cover a wide range of broader two-digit NAICS sectors as well. The eight \$1,000-plus industries were spread across four different broad sectors: manufacturing, professional and technical services, utilities and wholesale trade. These sectors offer a good deal of variety by occupation and cover a wide range of interests and skill sets.

Consistent with the analysis of green-related clusters, the agriculture-related industry in this list, *Crop production*, had the lowest average wage at only \$414 per week. *Administrative and support services* is another detailed industry that provides many green jobs (2.8 percent of total green), but paid notably less than average (\$568 weekly). Aside from these exceptions, however, the top industries in terms of

actual green jobs clearly hold the potential to impact the economy beyond direct employment by providing notable income to workers.

Figure 20 provides wage data on a more detailed set of green-related industries than the broader sectors shown in Figure 19.

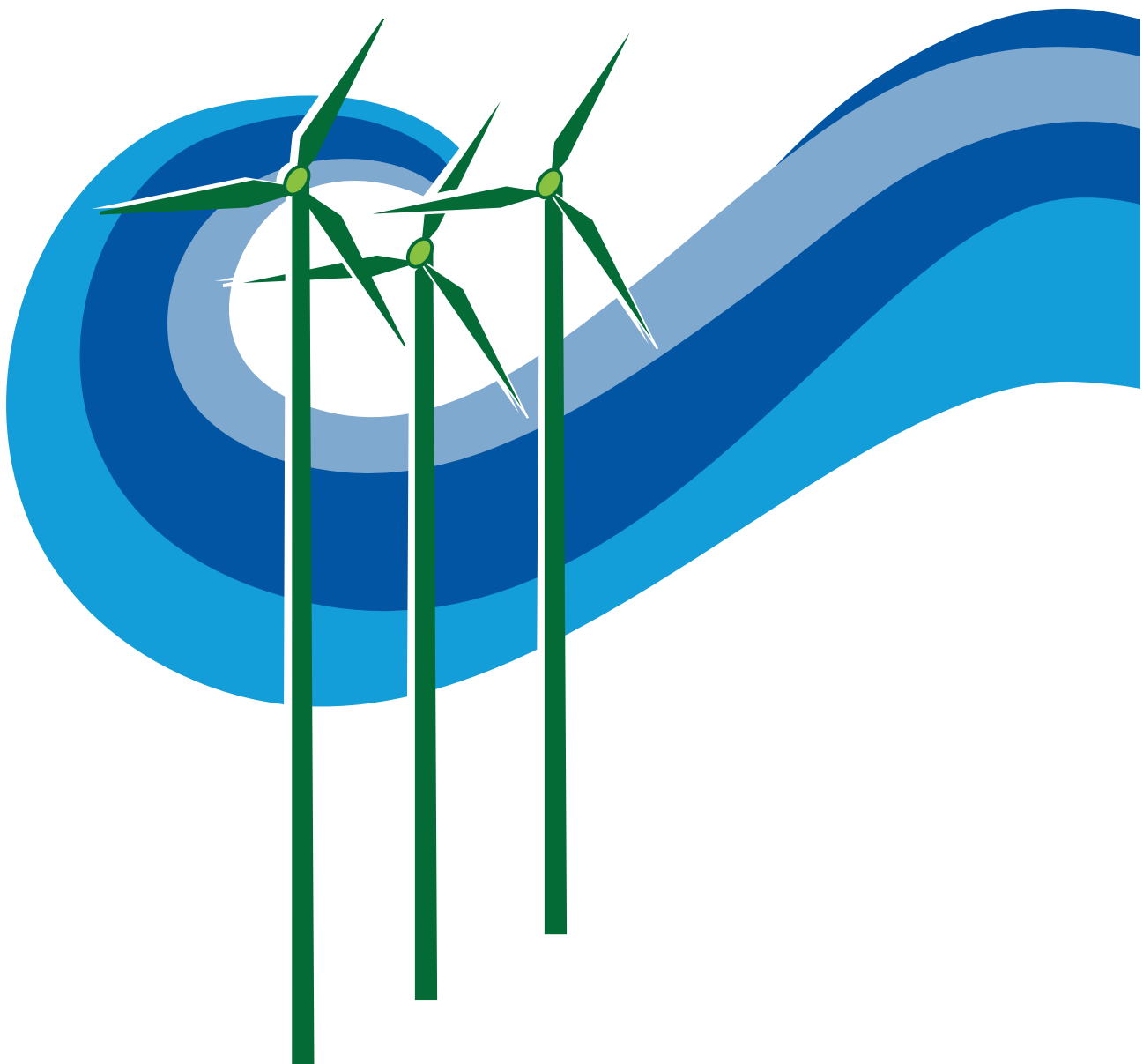
The industries in Figure 20 represent the ten largest green-related sectors in terms of aggregate employment size (total jobs, not necessarily just green jobs). Each of these detailed industries has an average weekly wage in excess of the private industry average. This is an important indicator in that large industries generate large numbers of job openings, and these industries also tend to pay above average wages.



Source: Michigan Department of Energy, Labor & Economic Growth

Industries such as *Testing laboratories* and *Research and development in the physical, engineering, and life sciences*, pay particularly high average wages, and are examples of green-related sectors that are part of the knowledge economy. These sectors contain jobs requiring extensive education in mathematics, science, and

physics. However, positive wages are also likely to be available in industries requiring less extensive education such as *Plumbing and heating contractors* and *Electrical contractors*. Workers in these and other green-related sectors will still need extensive specific skills training, which will contribute to their ability to earn positive wages.



## CHAPTER III: TRACKING JOB TRENDS AMONG GREEN-RELATED FIRMS

The preceding section attempted to illustrate the current state of the green economy in Michigan by examining the potential industrial makeup of green-related jobs. This approach, however, has limitations, as many green-related industry sectors are only partially “green”, and contain numerous jobs unrelated to the green economy.

This section takes an alternative approach, by focusing on a sample of specific companies known to be related to the green economy. By examining employment trends among these firms, we hope to shed more direct light on possible recent trends in the broader Michigan green economy.

Our research staff identified a sample of 358 firms in Michigan believed to be related to the green economy. This list was compiled from business directories, extensive Internet research, and other business resources.

The next step was to compile employment data on these firms from the Quarterly Census of Employment and Wages (QCEW) database.

### Understanding the Data

An analysis of green-related business trends at the firm level offers a number of insights that the preceding chapters did not. The large DELEG employer survey did not collect historical employment data, so it could not address green-related employment trends over time. The analysis of green-related NAICS industry sectors offers some employment trend analysis, but this approach is limited because several broad industries are impacted by many economic factors unrelated to the green economy.

This section will present information on employment trends from the 358 green-related firms we have identified. The advantage of this procedure is that these firms are more closely related to the green economy. The limitation of this approach is the relatively small number of firms identified. There is no way to ensure with certainty that this sample of 358 green-related companies is representative of all green firms in Michigan. The small sample size also limits

the depth of analysis that can be offered in terms of industry and regional job trends.

### Job Trends among Green-Related Firms

Between the second quarter 2005 and the second quarter 2008, the sample of 358 green-related firms in Michigan added more than 2,500 jobs in Michigan, an impressive employment expansion of 7.7 percent. This small segment of the green economy far outpaced employment trends for the economy as a whole. During this same period, total private employment in Michigan declined an estimated 5.4 percent.

With some exceptions, it is possible to aggregate the 358 green firms, using their respective industry codes, into some of the same green-related clusters discussed in prior sections of this report (see Figure 21). As Figure 21 indicates, job growth is evident among these firms in several of these broad clusters.

For example, sample firms in the *Renewable Energy Production* sector added nearly 1,900 jobs from 2005 to 2008, a growth rate of 30.4 percent. Those firms in the sample identified as *Miscellaneous Green Manufacturers* recorded job expansion of 3.6 percent over this period, an increase of over 140 jobs. Sample firms in the *Energy Efficiency* cluster also registered a job gain of 2.4 percent, or nearly 300 additional positions.

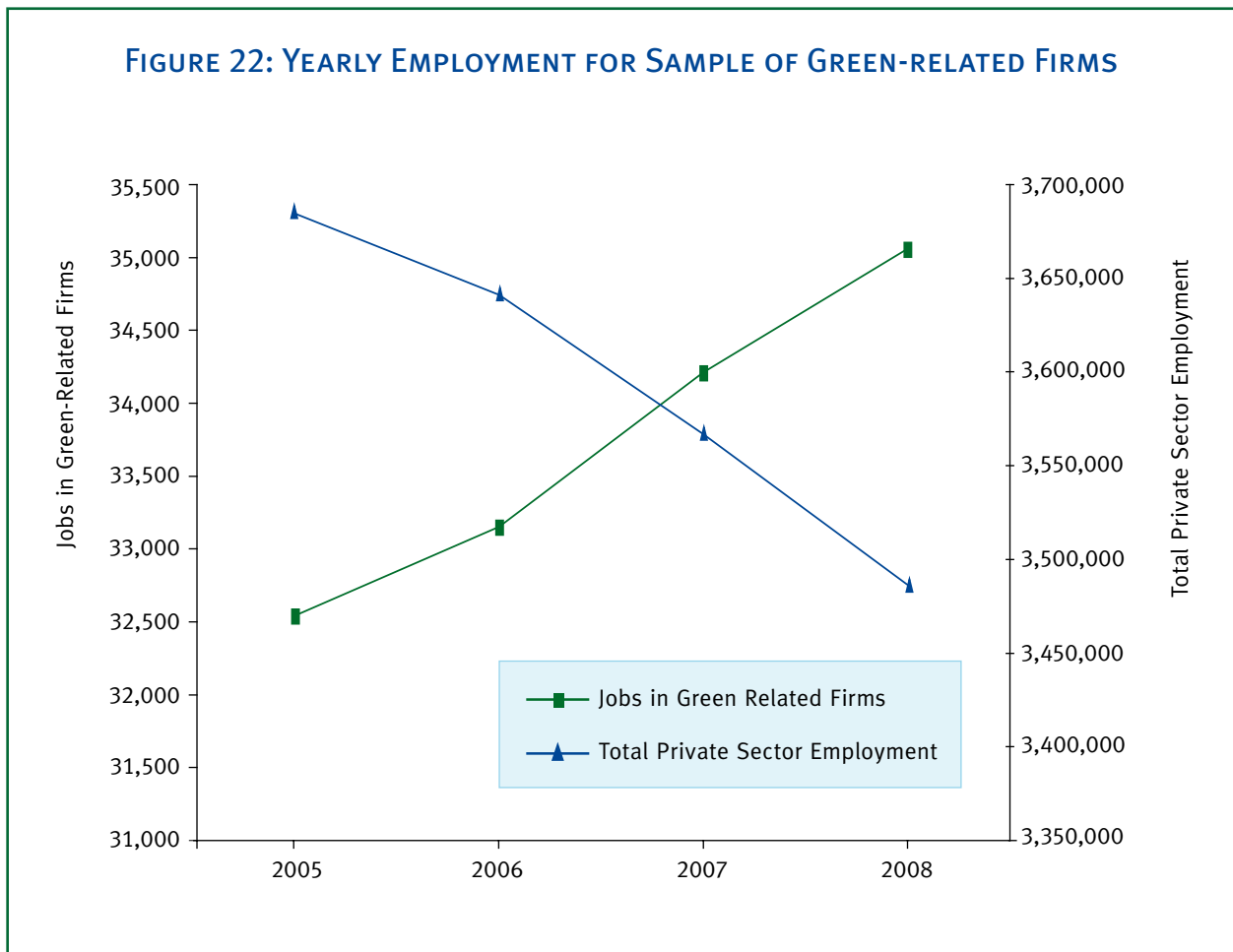
The job growth that this group of green firms has enjoyed since 2005 is the result of a series of year-over-year employment gains (see Figure 22). While private industry jobs in Michigan declined annually from 2006-2008, this subset of green-related firms accomplished the reverse, adding employment each year over this period.

**FIGURE 21: EMPLOYMENT TRENDS FOR 358 GREEN-RELATED FIRMS, BY CLUSTER**

Cluster	2005 Jobs	2008 Jobs	Emp. Change	% Change
Total Private Employment	3,683,821	3,485,775	-198,046	-5.4%
358 Green-Related Firms	32,533	35,049	2,517	7.7%
Clean Transportation and Fuels	5,363	5,321	-42	-0.8%
Increasing Energy Efficiency	12,041	12,334	293	2.4%
Miscellaneous Green Manufacturing	3,926	4,068	142	3.6%
Renewable Energy Production	6,243	8,138	1,895	30.4%
Other	4,960	5,188	228	4.6%

*\*Employment data reflect 2nd quarters of 2005 and 2008*  
 Source: Michigan Department of Energy, Labor & Economic Growth

**FIGURE 22: YEARLY EMPLOYMENT FOR SAMPLE OF GREEN-RELATED FIRMS**

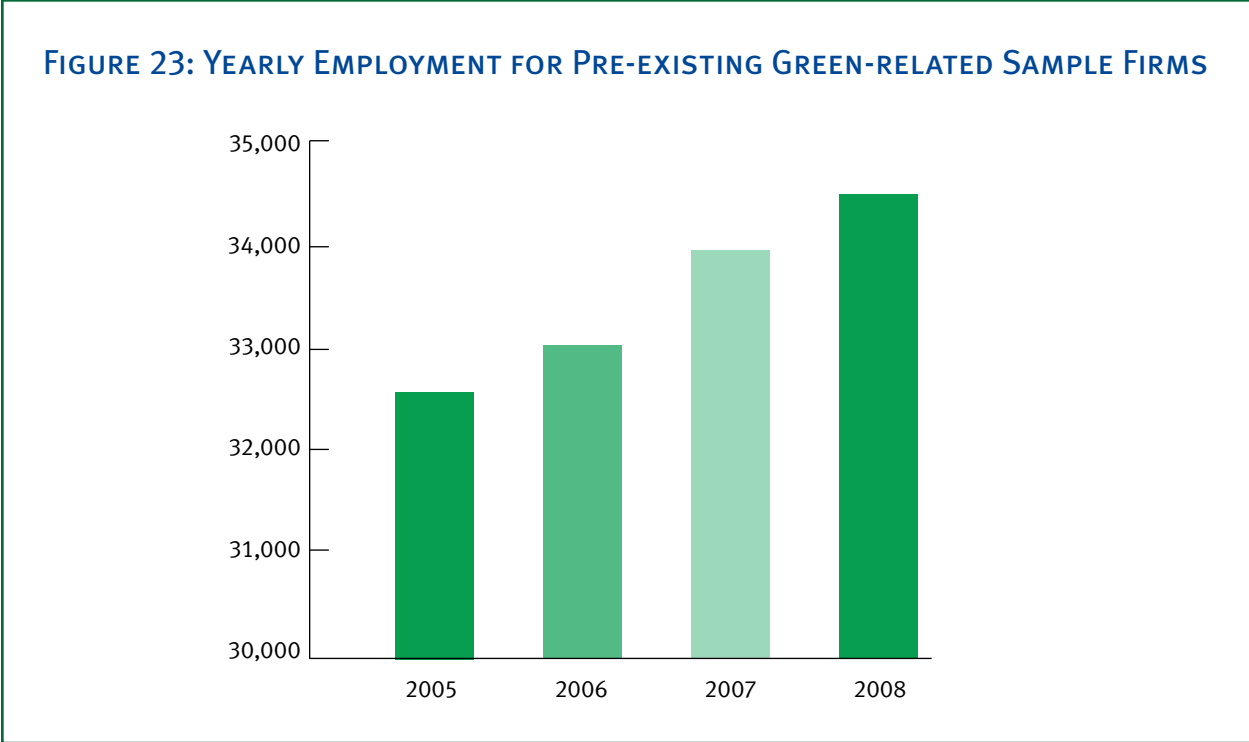


Source: Michigan Department of Energy, Labor & Economic Growth

It is true that much of the job expansion illustrated in Figure 21 occurred among a limited number of green-related companies that added large numbers of new jobs. Another key factor that explains the relatively positive employment trends among this group of firms is the emergence of new green-related businesses since 2005. Many of these new business establishments are small but have successfully added or retained jobs through the second quarter of 2008.

In fact, of the 358 green firms that we identified, over 70 appeared to be newly created since 2005, accounting for nearly 600 jobs by the second quarter of 2008. However, it is notable that employment trends over this period were also positive for the non-startup businesses in the green-related sample. Employment levels for pre-existing green-related businesses in the sample (those in the database from 2005-2008) was also up by over 1,900 since the second quarter of 2005, an increase of nearly six percent. Over 180 of those firms expanded or kept employment levels even, while roughly 100 firms reduced employment.

**NEW GREEN FIRMS—**  
One fifth of green firms in the sample were new firms since 2005, suggesting strong entrepreneurial activity.



Source: Michigan Department of Energy, Labor & Economic Growth



## Comparison to Michigan Broad Industry Sectors

The sample of 358 green-related firms identified for this analysis have outperformed many of Michigan's most prominent industry sectors in terms of job creation. The primary Michigan growth sector over this period was health care, which registered solid job expansion of 6.3 percent since the second quarter of 2005. This increase actually fell short of the 7.7 percent growth realized by this small sample of green-related businesses (see Figure 24). A number of the identified firms are concentrated in the areas of construction and manufacturing, industries that have experienced heavy employment losses of late. In spite of this, broadly speaking, this sample of green-related firms was able to outpace overall job trends recorded in Michigan across all major industry sectors.

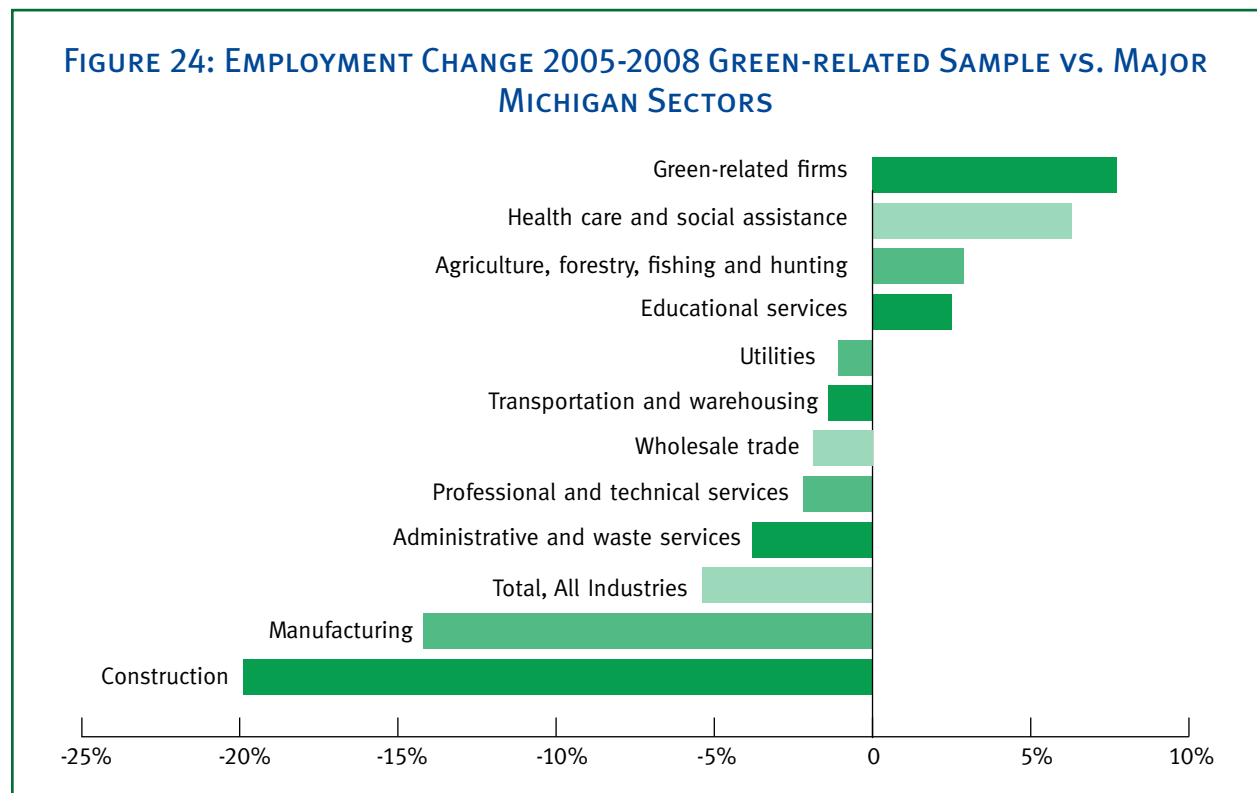
As stated before, this is a small sample and may not be representative of the overall Michigan green economy. However, the data suggests the

possibility that green-related firms may have been more successful in adding and retaining jobs at least through the second quarter of 2008, which was a very difficult period for the state economy.

## Green-related Firm Sample by Industry

Due to the relatively small sample size, it is difficult to discuss in detail the industrial makeup of the 358 green firms represented in this analysis without breaching the confidentiality of the selected firms. However, given the nature of data produced by the Quarterly Census of Employment & Wages, it is possible to make some broad statements.

The largest share of employment among the sample of green firms was in the area of *Professional, scientific and technical services* (NAICS 541), which accounted for one-fifth of employment in 2008. Much of the green-related work being done in this industry is scientific research and development in a variety of topics, including alternative energy, reductions in energy use, alternative fuels, and clean transportation.



Source: Michigan Department of Energy, Labor & Economic Growth

The employment data in Figure 25 for NAICS 541 does not include the green-related research and development establishments associated with the domestic nameplate automakers, which have recorded significant job loss during the current restructuring of the automobile industry.

Given the state's concentration of auto jobs, it is not surprising that a large number of jobs among these green-related sample firms were found in the *transportation equipment manufacturing* sector.

These firms are primarily auto suppliers, whose products and services have steadily evolved towards technologies that contribute towards increased fuel efficiency and the use of lighter weight components.

Below, Figure 25 highlights the primary industry sectors represented by our small sample of green-related firms. Other major industries in the sample not shown in Figure 25 include the appliance, chemical, and furniture manufacturing sectors.

**FIGURE 25: SAMPLE OF GREEN-RELATED FIRMS BY INDUSTRY**

NAICS	Industry	2005 Jobs	2008 Jobs	Emp. Change	% Change
358	Green-related Firms	32,533	35,049	2,517	7.7%
541	Professional, Scientific, and Technical Services	6,672	7,129	457	6.8%
336	Transportation Equipment Manufacturing	5,268	5,207	-61	-1.2%
423	Merchant Wholesalers, Durable Goods	2,602	2,231	-371	-14.3%
333	Machinery Manufacturing	1,402	1,679	278	19.8%
334	Computer and Electronic Product Manufacturing	809	1,497	688	85.0%

Source: Michigan Department of Energy, Labor & Economic Growth



## CHAPTER IV: MICHIGAN GREEN-RELATED OCCUPATIONS

We now turn in this section to discuss a set of occupations related to the green economy. The employer survey discussed in Chapter I is a key source of occupational information, as it for the first time estimates the number of green jobs in detailed occupations in the Michigan economy. It also addresses questions regarding employer expectations regarding short-term hiring, difficulty in hiring, and unique skills.

However, existing information sources on occupations will be utilized in this section to address some additional issues not addressed by the employer survey. These sources will allow us to outline topics such as forecast job growth, the level of annual job openings, wages, educational/training requirements, potential career ladders, and skills.

### Characteristics of Occupations

Understanding the characteristics of green occupations is extremely important. When people talk about career options, they usually refer to occupations or job titles. An understanding of which occupations are considered green-related will help workforce developers and educators focus on those job titles, to ensure that the state workforce is equipped with the requisite skills for employment in the green economy. Basic information on the characteristics of green-related occupations will also assist potential jobseekers in making informed decisions about selecting and training for green jobs. Occupational information will also be vital to the economic development community, as the attraction and retention of green employers often hinges on demonstrating the quantity and quality of the regional labor pool for green jobs.

### Identifying Green Related Occupations

As previously discussed, the Michigan Department of Energy, Labor & Economic Growth has defined five broad green sectors including (1) renewable energy, (2) energy efficiency, (3) clean transportation and fuels, (4) agriculture and natural resources

conservation, (5) and pollution prevention and environmental cleanup. A green occupation, therefore, is a job title that is directly associated with one of these core areas. Green occupations can be found across the spectrum of broad occupational categories, such as professional workers with specific skill sets directly needed by green-related firms; production, maintenance, and transportation occupations; critical occupations for small start-up green-related firms, such as sales engineers or technical sales representatives; and jobs in teaching or training that will be needed to prepare the future green-related workforce.

In finalizing the list of occupations for consideration in this section, our research team performed an extensive literature review of current green job studies, reviewed prominent occupations in green industries using US staffing patterns, evaluated lists compiled by other state research groups on green-related occupations, and attended focus groups with green-related employers and training providers. Michigan research staff also established a set of assumptions to guide our decision-making on classifying job titles as green-related, and conducted an intensive review of the complete Standard Occupational Classification (SOC) system to identify detailed green-related occupations.

It is important to note that occupations that are mainly secondary and support in nature, and that do not require special “green-related” skills sets, (such as accountants and human resource workers), will not be included in the analysis in this section.

Through this process, 105 green-related occupations were identified (See the Appendix for the complete list of job titles). Certainly, not all jobs in these occupations are generated by green employers, but evaluating the employment and training requirements, wage rates, skill requirements, and forecast demand for these careers is important in fully understanding the characteristics of the green workforce.

## Forecasts for Green-Related Occupations

Every two years, the Michigan Department of Energy, Labor & Economic Growth produces occupational employment forecasts. These forecasts use employment levels in a base year and project employment forward ten years; currently, the forecasts are based in 2006 and span through 2016. The projections use as inputs several factors including; population trends; labor force trends; industry trends, developments, and outlook; and various macroeconomic variables.

According to these projections, job levels among green-related occupations are expected to grow by

6.4 percent between 2006 and 2016. Over this period, green-related occupations should produce nearly 12,000 openings each year; 3,300 openings due to new job growth and 8,700 openings in replacement positions. The table below highlights green-related occupations that are expected to provide many employment opportunities to properly trained workers by 2016.

While many green occupations are new and emerging, the bulk of future job opportunities will naturally occur among the largest Michigan green careers. These large occupations generate significant numbers of job openings on an annual basis. As Figure 26 demonstrates, there are several examples of high and mid-skill green-related job titles that provide large numbers of annual job openings.

Of course, job openings occur for two primary reasons, actual expansion of jobs in an occupation and the need to replace existing workers who permanently leave an occupation. Although growth openings are important, in most occupations the majority of annual job openings address the need to replace existing workers who vacate jobs due to retirements, career changes, or other reasons.

**FIGURE 26: GREEN-RELATED OCCUPATIONS PROJECTED TO OFFER MANY OPENINGS THROUGH 2016**

SOC	Occupational Title	Employment		Annual Openings		
		2006	2016	Total	Growth	Replacement
37-3011	Landscaping and Grounds Workers	33,380	38,160	918	477	441
17-2112	Industrial Engineers	22,290	26,480	955	418	537
47-2111	Electricians	24,000	25,070	725	107	618
17-2141	Mechanical Engineers	24,730	25,970	660	124	536
47-2031	Carpenters	31,710	33,710	629	200	429
47-2061	Construction Laborers	27,240	29,330	414	209	205
11-9041	Engineering Managers	9,720	10,570	282	85	197
47-1011	First Line supervisors, Construction trades	13,920	14,770	280	86	194
17-2051	Civil Engineers	6,190	6,870	231	68	163
49-9021	HVAC Mechanics and Installers	8,230	8,890	210	66	144

Source: Michigan Department of Energy, Labor & Economic Growth



Analyzing openings resulting from growth and replacement needs are both important.

In addition to analyzing occupations with a large number of job openings, it is also useful to look at job titles expected to post large job growth rates. Figure 27 displays some of the green-related occupations in Michigan with above-average rates of forecast employment growth.

The high-growth jobs in Figure 27 represent a mix of occupations by employment size and educational requirement. A few have a large employment base, such as *Industrial engineers* and *Landscaping and groundskeeping workers*. Engineering occupations, professional jobs, and mid-skill mechanic and laborer positions are all represented among the green-related jobs with above-average expected job

growth. The green economy is expected to create new job opportunities for workers willing to invest in appropriate educational and skills training, such as *Surveyors* and *Environmental engineers*.

## Green Occupations: Educational & Training Requirements

Green-related jobs should provide opportunities for jobseekers with a variety of backgrounds, skills, and levels of educational attainment. That is, not all green jobs are high skill research positions; to the contrary, many green jobs require mid-level skills or only moderate educational attainment or on-the-job training. The chart below highlights some selected occupations with high growth rates that require various educational levels.

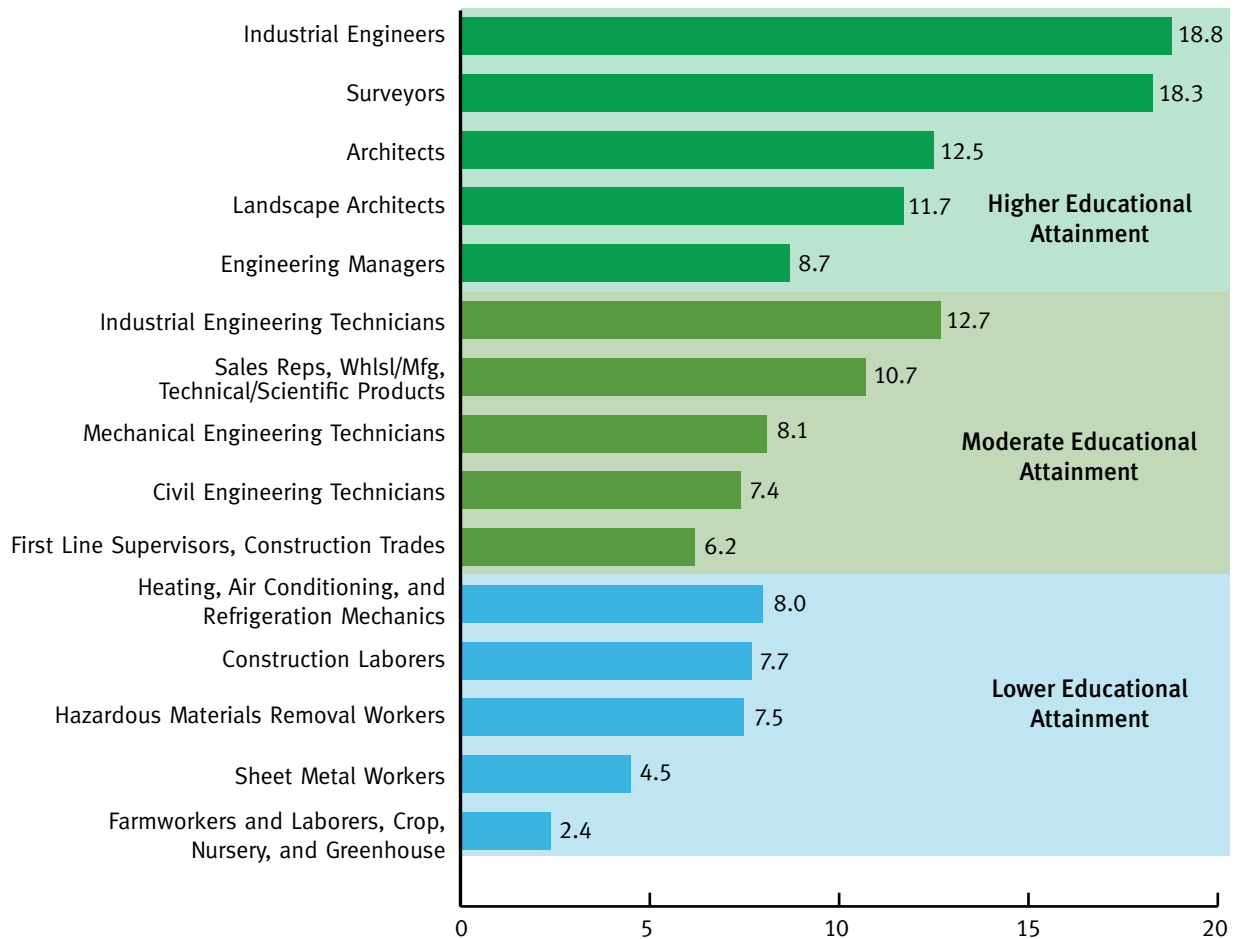
As Figure 28 demonstrates, there are likely to be green-related occupations with above average employment demand in each broad level of educational attainment and training. However, it is also generally the case that occupations requiring higher levels of education, tend to have above-average expected job growth rates. Among all green-related occupations, those requiring more educational background should see better growth prospects between 2006 and 2016. In fact, the median anticipated growth rate for lower educational attainment occupations is just 3.8 percent compared

**FIGURE 27: GREEN-RELATED OCCUPATIONS EXPECTED TO SEE HIGH GROWTH THROUGH 2016**

SOC	Occupational Title	Employment		Change	
		2006	2016	#	%
17-2112	Industrial Engineers	22,290	26,480	4,190	18.8
17-1022	Surveyors	1,230	1,450	220	18.3
37-3011	Landscaping and Grounds Workers	33,380	38,160	4,780	14.3
17-2081	Environmental Engineers	1,860	2,100	240	13.2
17-1011	Architects	2,860	3,220	360	12.5
17-1012	Landscape Architects	690	770	80	11.7
17-2051	Civil Engineers	6,190	6,870	680	11.0
17-2041	Chemical Engineers	1,050	1,160	110	10.5
49-9041	Industrial Machinery Mechanics	10,200	11,170	970	9.5
11-9121	Natural Sciences Managers	460	510	50	9.5

Source: Michigan Department of Energy, Labor & Economic Growth

**FIGURE 28: GREEN-RELATED OCCUPATIONS EXPECTED TO SEE HIGH GROWTH THROUGH 2016**



Source: Michigan Department of Energy, Labor & Economic Growth

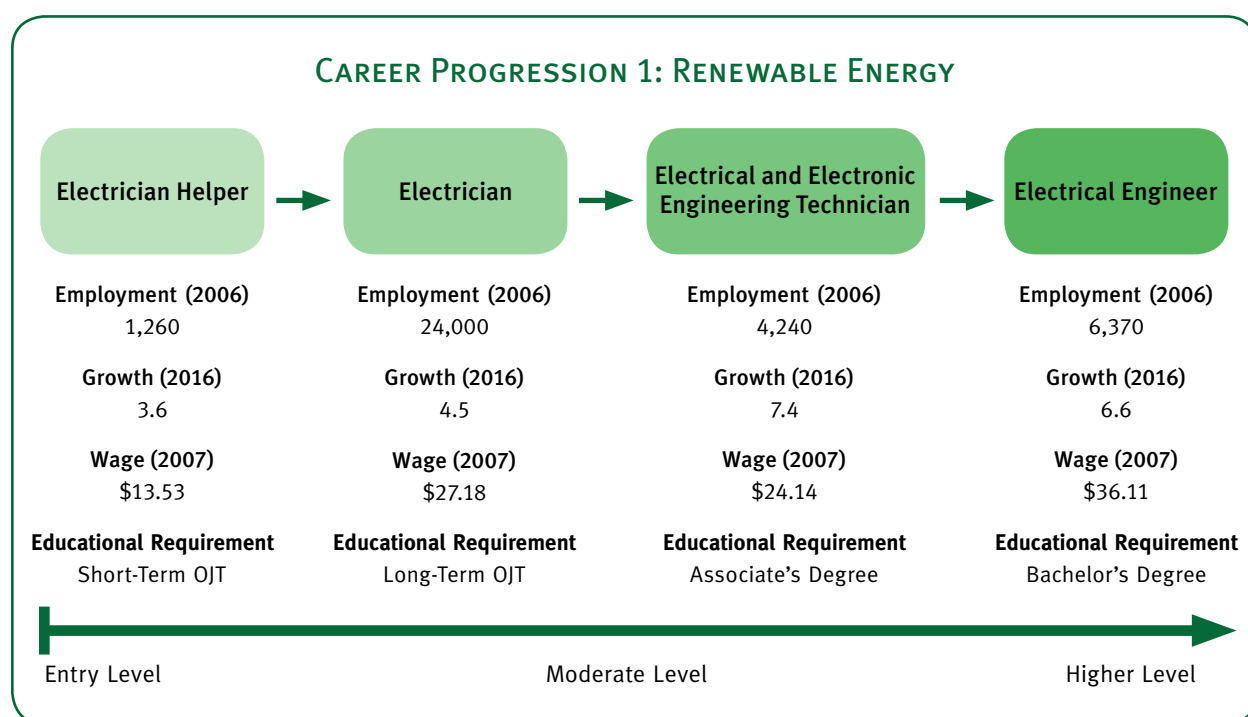
to 7.4 percent for moderate educational requirement jobs and 9.0 percent for high educational attainment positions.

As noted above, green-related occupations offer opportunities to job seekers with various educational backgrounds and with diverse skill sets. In addition to providing opportunities to many candidates, this also means that green-related jobs offer the potential for workers in entry level positions to advance to intermediate and potentially higher skill green jobs. That is, successful job candidates can enter one green-related occupation and begin to climb a career ladder to other, higher skill positions.



## Green Occupations: Career Progression

As demonstrated in the following five sample career progression examples, workers in green occupations can move up a career by completing additional academic training, job training, or licensing. The following career progressions are examples of potential career changes over time in each of the five green economy clusters. These are meant to be illustrative of an example of a career progression; certainly there are many career progressions possible in any one core area.



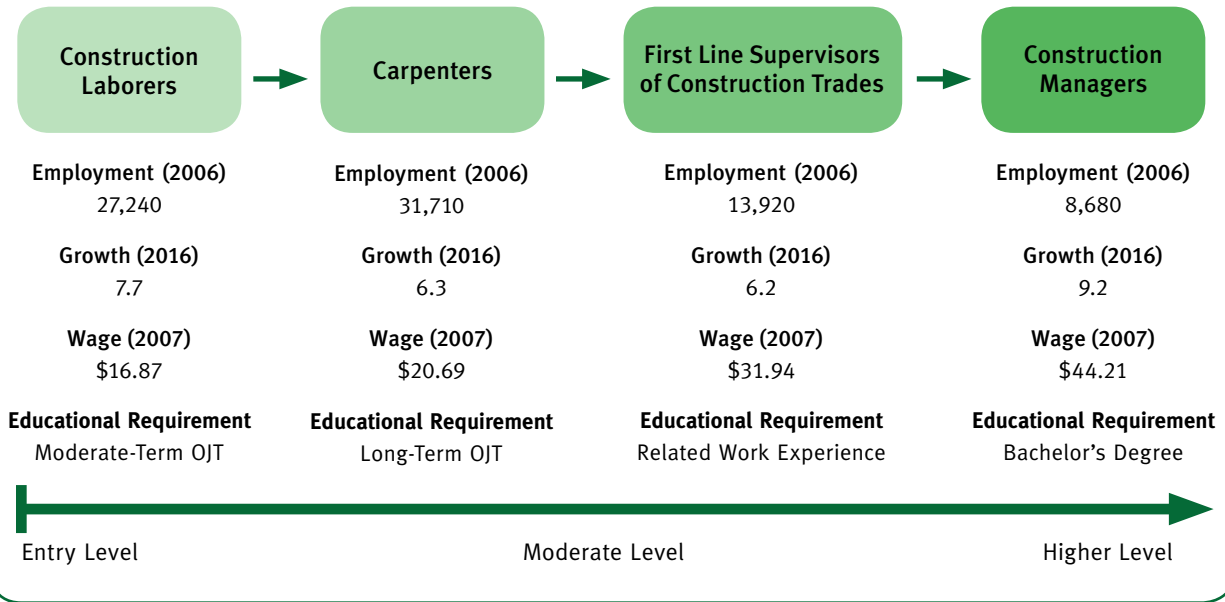
### Career Progression 1: Renewable Energy

As suggested above, an electrician helper could take classes beyond high school or participate in training through an employer toward a journeyman card in the electrician trade. The electrician could then, if desired, work toward an associate's degree (or a bachelor's degree). This credential, combined with past work experience, could produce a competitive candidate for a position as an electric or electronic engineering technician (or an electrical engineer). While electricians are shown as having a higher average hourly wage than individuals with associate degrees, it should be noted that the growth rate for the latter is much higher, besides being a good step in progressing to the highest paying job in this example, the electrical engineer.

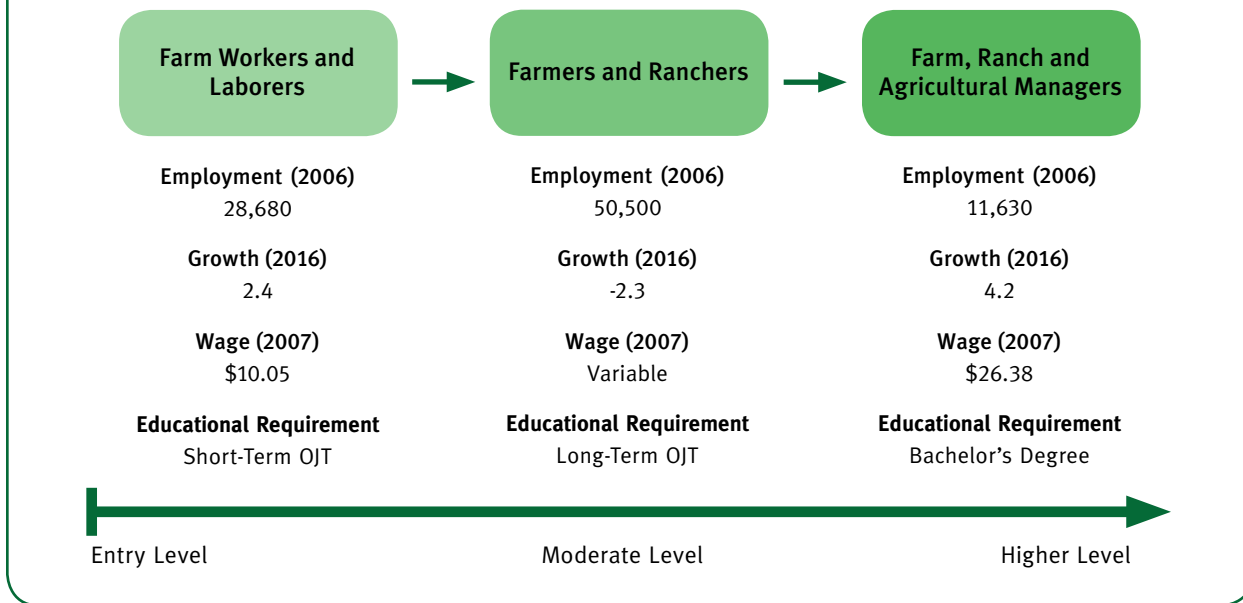
### Career Progression 2: Energy Efficiency

On a green-construction site, a construction laborer may begin to obtain many construction-related and green-related skills. This worker could elect to enter a construction trade such as a carpenter. After additional work experience this tradesperson may have the necessary skills to apply for a position as a first-line supervisor. With additional formal education, he or she could become a construction manager.

### CAREER PROGRESSION 2: ENERGY EFFICIENCY



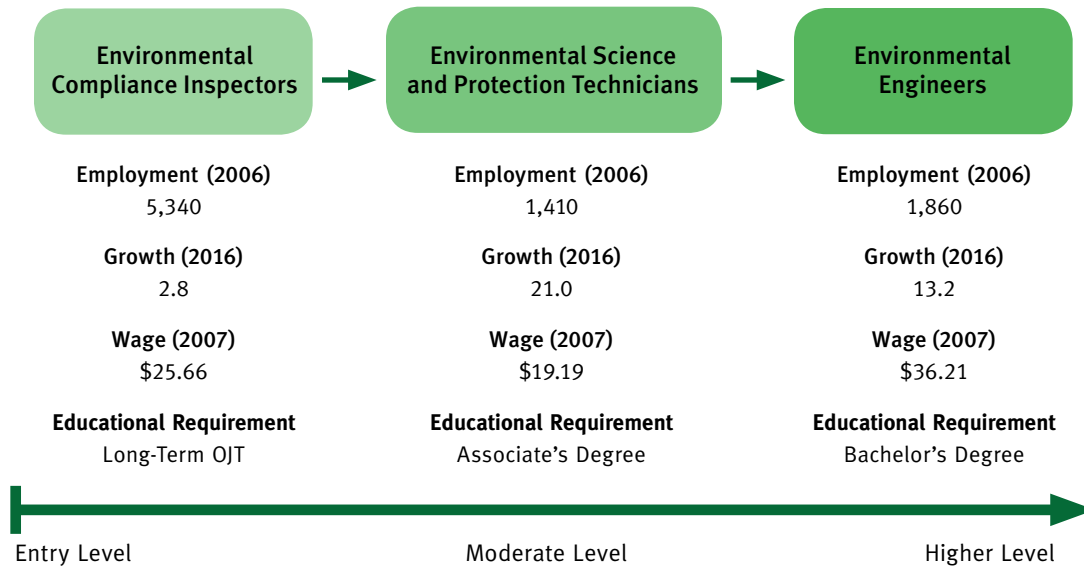
### CAREER PROGRESSION 3: AGRICULTURAL AND NATURAL RESOURCES CONSERVATION



### Career Progression 3: Agricultural and Natural Resources Conservation

The demand for farm workers and laborers with green knowledge and skills may increase as the demand for sustainable agriculture and organic methods increases. With additional years of training and work experience, laborers can take on the responsibilities of owning and operating their own farms, ranches, greenhouses, or nurseries. Eventually, upon acquiring a bachelor's degree, workers in this career progression could access supervisory or management positions that direct and coordinate the activities of workers engaged in agricultural crop production.

## CAREER PROGRESSION 4: POLLUTION PREVENTION AND ENVIRONMENTAL CLEANUP



### Career Progression 4: Pollution Prevention and Environmental Cleanup

By inspecting and investigating sources of pollution, environmental compliance inspectors learn how to protect the public and the environment. An associate's degree allows a person to conduct laboratory and field tests to determine the level and sources of pollution as an environmental science and protection technician, while a bachelor's degree allows him or her to perform engineering duties in the prevention, control, and remediation of environmental health hazards. As with the first career progression, the associate degree level pays a lower average wage than the entry level, but it is growing at a substantially faster rate.

### Career Progression 5: Clean Transportation and Fuels

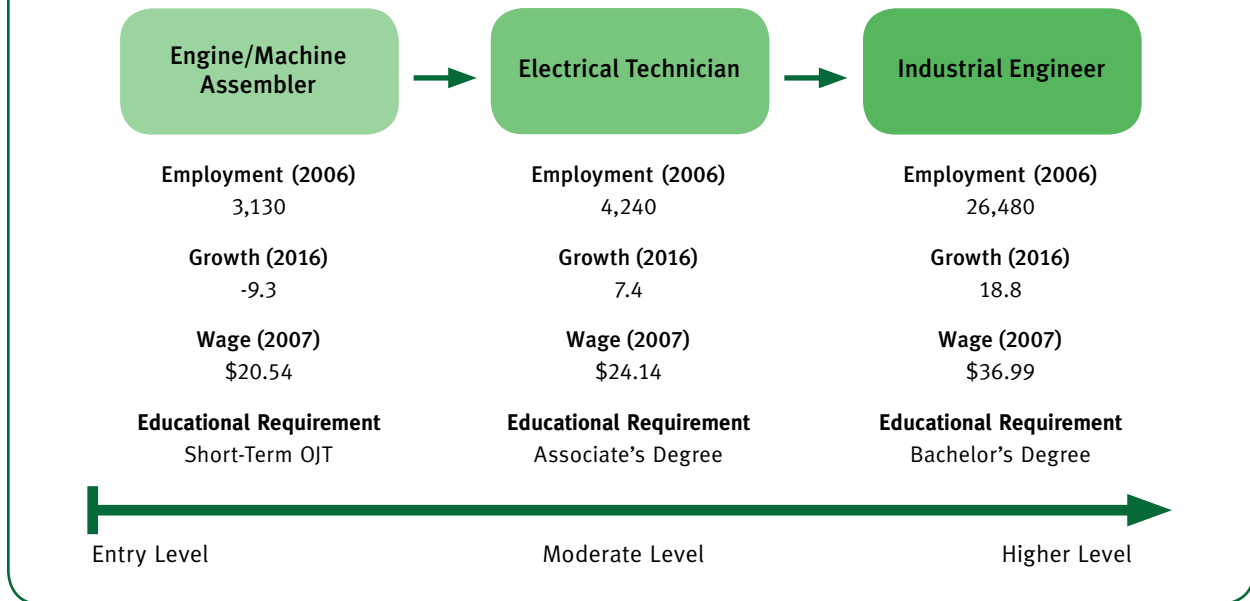
No career progression may be as timely and appropriate as the potential occupational progression below. In this example, a dislocated auto worker enrolls in a two-year institution and earns an associate's degree to become an electrical technician. This credential plus prior work experience could make this person a relatively attractive job candidate. With additional education to earn a bachelor's degree, the

individual may have the requisite skills to become an industrial engineer. Dislocated workers may be eligible for job training assistance through the Governor's *No Worker Left Behind Initiative*, through a corporate re-training fund, through a union re-training fund, or through all three.

Today, many dislocated workers are faced with the difficult decision to keep looking for a job utilizing their existing skill sets or to update their skills and find employment in a cutting-edge, growing field. Green-related occupations do exist that build upon existing skill sets held by many Michigan manufacturing workers who have lost jobs during the current economic downturn.

As the sample career progressions illustrate, an expansion of the green economy in Michigan may have the benefit of providing the opportunity to many Michigan workers to get in the ground floor in a green-related job, and then gradually invest in training opportunities to move up a career ladder. The incentives for an individual worker from this progression can be substantial, in reducing spells of unemployment, obtaining skills needed in a potential growth industry, achieving personal goals, or earning a higher wage. As the next section shows, there is a very strong relationship between increased investments in human capital and an increased wage.

## CAREER PROGRESSION 5: CLEAN TRANSPORTATION AND FUELS



### Green Occupations: Wages

Workers employed in green-related occupations can expect to receive a wide range of wages. This is natural, considering the wide range of education and skills required of green occupations. One way to analyze the wages paid to various occupations is to look at a sample of select green-related occupations that pay a high wage, moderate wage, and lower wage.

The occupations displayed in Figure 29 represent a diverse range of careers ranging from Engineers to Ranchers to Recyclable material collectors. All these occupations have at least one thing in common: they are green-related. However, there are key differences between the types of occupations listed. One distinction is the complexity and variety of tasks workers in these occupations can expect to perform while on the job. For instance, lower wage occupations typically involve hands-on production of a green-related product or service. Moderate wage jobs often involve a wider range of tasks, including the skilled production of green-related products or services, product installation, and the maintenance of plants and buildings where green products and

services are produced. Higher wage occupations, like engineers and managers, may be involved in the processes and planning of high-skill green-related product development.

Moderate and lower skills occupations, despite a modest entry-level wage, can serve as a gateway to a green career. Dislocated workers from Michigan industrial jobs may have skill sets needed in certain green-related occupations.

Figure 30 suggests a strong positive correlation between higher levels of educational attainment and higher wages. Green-related occupations that require higher levels of education pay, on average, \$15 per hour more than green-related occupations that require lower levels of education. The occupations in Figure 30, below, highlight wage rates among selected green occupations with various educational requirements.

As Figure 30 shows, as educational requirements for jobs increase, so do general wage levels. While this trend is true for the selected occupations in Figure 30, it is also true for green-related occupations as a whole. For example, the median wage for green-related job titles requiring a bachelor's degree or higher is \$33.62, compared to \$22.59 for green jobs

**FIGURE 29: SELECT HIGH, MEDIAN, AND LOW WAGE GREEN OCCUPATIONS**

Wage	SOC	Occupations	Employment	Hourly Wage	Annual Salary
<b>Higher</b>	11-9041	Engineering Managers	9,720	\$52.93	\$110,090
	11-9021	Construction Managers	8,680	\$44.21	\$91,950
	41-9031	Sales Engineers	3,870	\$40.33	\$83,900
	41-4011	Technical and Scientific Products Sales Representatives	11,280	\$37.61	\$78,230
	17-2141	Mechanical Engineers	24,730	\$37.02	\$77,010
<b>Moderate</b>	47-2111	Electricians	24,000	\$27.18	\$56,530
	17-3023	Electrical and Electronic Engineering Technicians	4,240	\$24.14	\$50,210
	49-9021	Heating, Air Conditioning, and Refrigeration Mechanics	8,230	\$22.22	\$46,230
	11-9011	Farm, Ranch, and Other Agricultural Managers	11,630	\$26.38	\$54,870
	47-2152	Plumbers, Pipefitters, and Steamfitters	15,060	\$26.08	\$54,240
<b>Lower</b>	47-2061	Construction Laborers	27,240	\$16.87	\$35,100
	53-7081	Refuse and Recyclable Material Collectors	3,350	\$15.36	\$31,960
	51-2022	Electrical and Electronic Equipment Assemblers	5,290	\$14.51	\$30,170
	37-3011	Landscaping and Groundskeeping Workers	33,380	\$11.71	\$24,350
	45-2092	Farmworkers and Laborers, Crop, Nursery, and Greenhouse Workers	28,680	\$10.05	\$20,900

Source: Michigan Department of Energy, Labor & Economic Growth

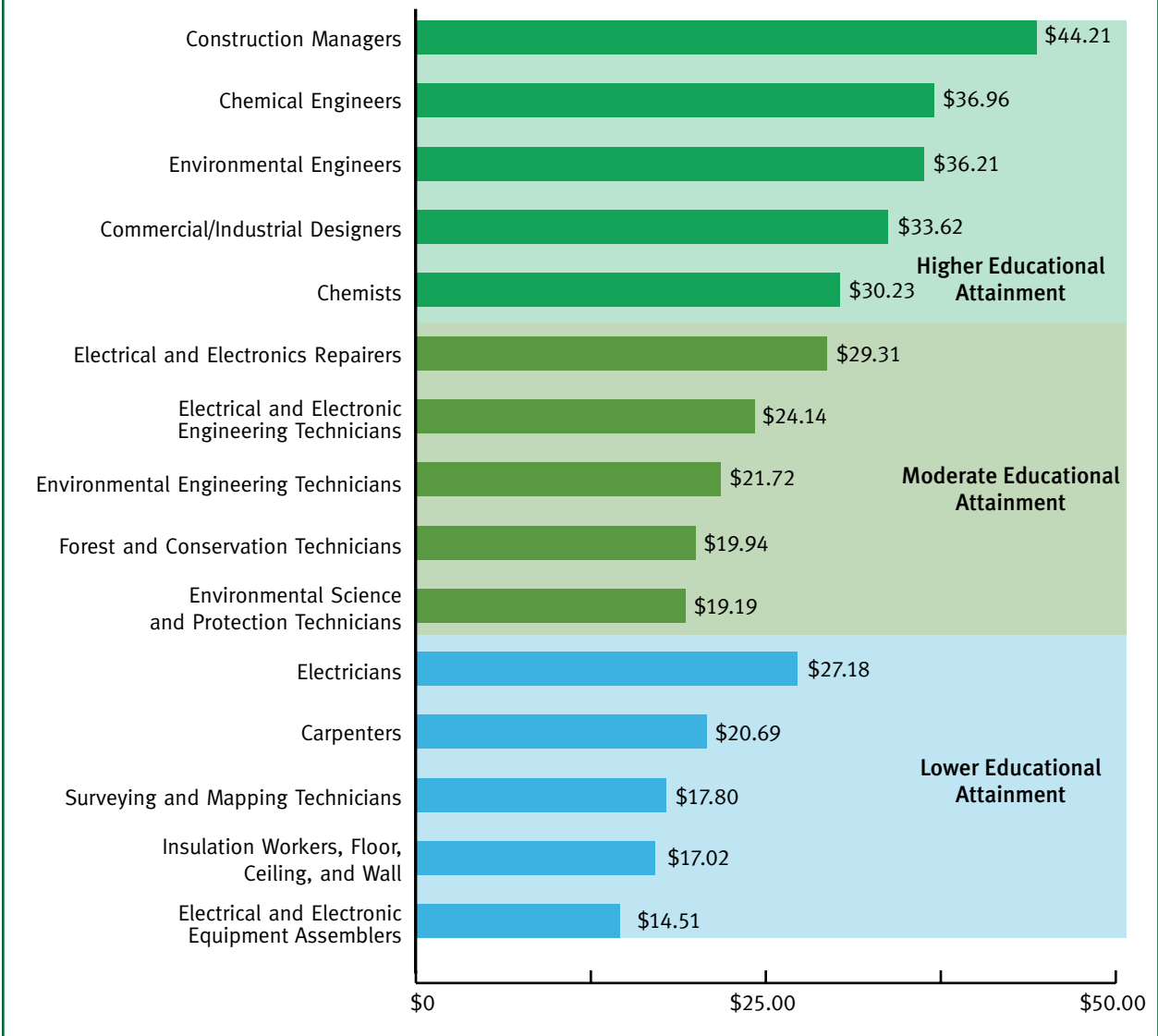
requiring an associate’s degree, vocational training, or significant work experience and \$20.22 for green-related workers with lower levels of educational attainment.

These averages clearly demonstrate the wage premium for 4-year degree jobs, and yet the roughly \$20 average wage for other green-related jobs is still quite high. This is because many of the green-related occupations selected for this analysis that do not require a 4-year degree still require postsecondary education or extensive on-the-job training. It is these skill requirements that can impact wage rates. Additionally, many of these moderate skill green-related occupations are in the construction and manufacturing industries, sectors that generally produce above average wage rates.

### Green Occupations: Critical Skills and Knowledge Sets

What about the skills and knowledge components of green-related occupations? The results of the focus groups can help us answer this question. Focus group employers emphasized that a certain green context will be needed in a variety of jobs. Focus group employers frequently said that their current workers need more green knowledge, reinforcing the idea that unique green skills are an incremental, necessary addition to a worker’s current skill set in most cases. This finding implies that employees who increasingly find themselves working on “green” projects may require additional training, either in the workplace, or through formal educational opportunities, and

**FIGURE 30: EDUCATIONAL ATTAINMENT AND OCCUPATIONAL WAGES IN GREEN OCCUPATIONS**



Source: Michigan Department of Energy, Labor & Economic Growth



potential new workers hoping to transition from existing industries into the green economy may need to secure additional education before making that transition. The survey finding that managers of all sorts and business specialists will require green skills reinforces the point that a general understanding of the green context is necessary for successful execution of green projects. For example, focus group employers in construction described the need for a site supervisor to understand the general green context of working on a LEED building, while crew members involved in rehabilitation or restoration work needed to change patterns of behavior when required to salvage or save working appliances such as sinks for recycling, rather than putting them in the dumpster.

**Despite the need for some specialized skills, employers have stressed that workers still need the basics. Green skills are an overlay of new skills and knowledge; and learners cannot access the new knowledge without the requisite foundation. Many green jobs are current jobs with an additional green focus; far fewer green jobs are a full new set of knowledge and skills.**

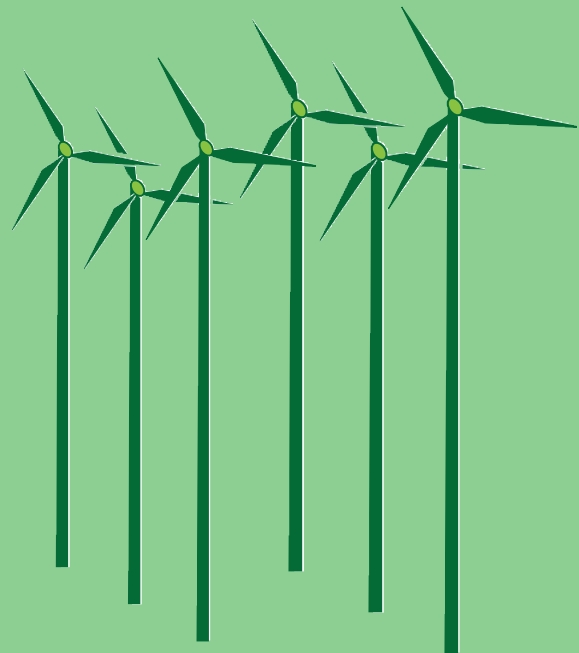
In addition, since many employers indicated in the focus groups that they were looking for skills such as communication, bookkeeping, marketing, and other core business functions, their talent demands encompass a much more diverse set of skill sets. Employers in the agriculture and sustainable food systems focus groups explicitly referenced the business skill sets farmers need to produce, package, and sell their goods, such as accounting, marketing, food safety regulations, and financing.

Another way to help understand the skills and knowledge workers need in the green economy is to look at a few specific green-related occupations and their key skills and knowledge sets from the O\*NET skills database.<sup>5</sup> The tables present several relevant labor market indicators for each occupation. The occupations highlighted in the boxes below represent green-related job titles with various skill and knowledge levels.

**Green “practices”** are ways of working that minimize damage to the environment (e.g., minimizing material waste, picking up all construction waste at a job site, and taking waste to recycling).

**Green “knowledge”** is understanding concepts such as which materials can be recycled in which ways, awareness of opportunities to implement green practices, and the ability to apply concepts to new situations.

**Green “skills”** are those which actively contribute to environmental improvement, such as energy auditing, installing insulation, working with new materials, and so forth.



<sup>5</sup> A skill or knowledge is labeled “Highly Important” if the O\*NET ranking index is between 70 and 100; “Important” if between 60 and 69; and “Somewhat Important” if the index was below 60.

Engineering Teachers	
2006 Employment:	1,360
Anticipated Growth:	17.5%
Annual Openings:	47
2007 Wage:	Variable
<b>Educational Requirement:</b> Doctoral degree	
Critical Skills	
Critical Thinking	Highly Important
Active Learning	Highly Important
Mathematics	Highly Important
Science	Highly Important
Speaking	Highly Important
Critical Knowledge	
Critical Knowledge	Highly Important
Engineering and Technology	Highly Important
English Language	Highly Important
Education and Training	Highly Important
Physics	Highly Important

Environmental Engineers	
2006 Employment:	1,860
Anticipated Growth:	13.2%
Annual Openings:	79
2007 Wage:	\$36.21
<b>Educational Requirement:</b> Bachelor's degree	
Critical Skills	
Reading Comprehension	Highly Important
Speaking	Highly Important
Active Learning	Highly Important
Critical Thinking	Highly Important
Writing	Highly Important
Critical Knowledge	
Engineering and Technology	Highly Important
Design	Highly Important
Customer and Personal Svc.	Highly Important
Physics	Highly Important
Chemistry	Highly Important

The first two boxes, above, reflect occupations with above average educational requirements. These are examples of the so-called “knowledge” jobs that are a key component of the green economy. They also have several advanced skill and knowledge areas that are highly important for success in these occupations. In both instances, these occupations pay a high wage and are expected to see impressive growth rates. It is important to note, however, that these higher-level green-related occupations require significant investments in education and professional development.

The next two boxes, right, reflect mid-level positions requiring on-the-job training. As expected, the mix of key skill and knowledge sets differ from many of the green-related jobs requiring college degrees. They also contain more of a mix of skills and knowledge ranked by the O\*NET system from “Highly Important” through “Somewhat Important”. In both instances, these occupations pay a moderate to high wage and are expected to see average growth rates and a medium level of annual openings.

These occupations can also be distinguished from the occupations above because they do not require as significant an investment in education and training. Workers can attain the requisite skills for employment in these occupations through worksite-based training.

The last box features a typical occupation in the automotive industry, assemblers and fabricators. This occupation pays a solid wage, but is expected to see very negative job loss of -16.3 percent from 2006-2016. Many of these positions are traditional production occupations . . . the kind of jobs Michigan has been rapidly losing. Former workers in these occupations will be considering alternative career options in Michigan, and many may already have some basic skills that could be used when transitioning into a green-related occupation. In some instances, displaced workers from these occupations may have resources available to them to assist in the pursuit of additional on-the-job training, an associate’s degree from a local community college, or a bachelor’s degree from a university.

Sheet Metal Workers	
2006 Employment:	4,960
Anticipated Growth:	4.5%
Annual Openings:	145
2007 Wage:	\$24.59
<b>Educational Requirement:</b> Long-term on-the-job training	
Critical Skills	
Mathematics	Highly Important
Active Listening	Highly Important
Equipment Selection	Important
Installation	Important
Coordination	Important
Critical Knowledge	
Mechanical	Highly Important
Mathematics	Highly Important
Building and Construction	Important
Design	Somewhat Important
Production and Processing	Somewhat Important

Construction Laborers	
2006 Employment:	27,240
Anticipated Growth:	7.7%
Annual Openings:	415
2007 Wage:	\$16.87
<b>Educational Requirement:</b> Moderate-term on-the-job training	
Critical Skills	
Active Listening	Important
Coordination	Important
Equipment Selection	Important
Speaking	Important
Instructing	Somewhat Important
Critical Knowledge	
Building and Construction	Highly Important
Design	Important
Mathematics	Important
Mechanical	Somewhat Important
Public Safety and Security	Somewhat Important

Assemblers and Fabricators	
2006 Employment:	39,100
Anticipated Growth:	-16.3%
Annual Openings:	812
2007 Wage:	Variable
<b>Educational Requirement:</b> Variable on-the-job training	
Examples of Critical Skills	
Quality Control Analysis	Highly Important
Operation Monitoring	Highly Important
Repairing	Important
Troubleshooting	Important
Active Listening	Important
Examples of Critical Knowledge	
Mechanical	Highly Important
English Language	Highly Important
Education and Training	Important
Production and Processing	Somewhat Important
Design	Somewhat Important



Potential Transitional Careers for Dislocated Assemblers and Fabricators
Sheet Metal Workers
Construction Laborers
Roofers
Chemical Equipment Operators
Grounds Maintenance Workers
Farmworkers and Laborers
Electrical / Electronic Equipment Assemblers
Semiconductor Processors
Electrician Helpers
Engine / Machine Assemblers
Hazardous Materials Removal Workers



## Which critical knowledge and skill sets are Michigan focus group employers saying are hard to find?

- ✓ Safety knowledge
- ✓ Mechanical aptitude
- ✓ Ability to do non-computerized drawing (manual)
- ✓ Ability to read blueprints
- ✓ Know “what” to draw as well as “how” to draw
- ✓ Basic machine design skills
- ✓ Adaptability
- ✓ Understanding green standards and guidelines
- ✓ Material recycling awareness
- ✓ Systems Specialization (solar, wind, geo-thermal, rain water, etc...)
- ✓ Environmental impact knowledge
- ✓ MIOSHA Training
- ✓ Communication skills
- ✓ Marketing and general business management skills
- ✓ Visual relationship aptitude
- ✓ ISO 14000 certified

Source: Focus Groups with Michigan Employers,  
February – March, 2009



## CONCLUSION

The results of the Michigan Green Jobs Study reveal the vast potential awaiting Michigan and its residents as we transform to a green economy. We defined green jobs as those direct and support jobs that are related to a firm's green related revenue. We found through our analytical approach that, even in the downturn in Michigan's economy over the last four years, some specific industries are continuing to show substantial job growth.

Our finding that a subset of green related firms experienced job growth rates in excess of other broad industry sectors like healthcare, strongly suggests (but does not guarantee) that green related firms, especially those in the renewable energy area, are well positioned to ride through the economic downturn and help drive the green economy growth in Michigan. And we hear from our Michigan employers through the survey these key facts:

- There are 109,067 green jobs in Michigan- both direct and support jobs.
- 40% of direct green jobs are in Clean Transportation and Fuels, and engineers are a major occupational force in this area.
- Green skills are a vital additional skill set needed by employees, but many jobs are ripe for transitioning to becoming "greener," along with the workers in those jobs.

The results of this study provide a comprehensive baseline from which to measure Michigan's green economy growth. It is to that future we now turn.

### Public Policy and Green Jobs

While it is impossible to determine the exact relationship between public policy and job creation, recent developments at the local, state and national levels may accelerate Michigan's already healthy green job growth in the coming months.

- Michigan's adoption of a renewable portfolio standard is likely to increase investment in alternative energy production. Already, the

state has seen an increase in interest in manufacturing wind turbines in Michigan.

- The requirement within the recent energy legislation that the state's regulated utilities spend an increasing portion of their revenues on energy efficiency measures for their industrial, commercial and residential customers will create a fund of \$275 million for energy efficiency work by 2012.
- The Michigan Legislature has enacted incentives for advanced energy storage, strongly supporting development of a concentrated development of that industry in the state. Already, several firms in this field have made commitments to locate and grow in Michigan.
- DELEG has launched a \$6 million Green Jobs Initiative, focused on helping industries cited in this report develop the workforce skills they will need to succeed.
- Substantial components of the American Reinvestment and Recovery Act provide funding to accelerate development of green jobs spanning renewable energy production, increasing energy efficiency of buildings, and developing new energy transmission grids.

### What the Future Holds:

The opportunity to create new Michigan jobs rests overwhelmingly with the clean energy, green-collar economy. With our advanced manufacturing expertise, our depth of engineering talent, and our local access

to original equipment manufacturers (OEMs) and suppliers, we are poised to create tens of thousands of good-paying green jobs for Michigan workers.

In November 2008, Governor Granholm reorganized what was Michigan's Department of Labor and Economic Growth into the new Department of Energy, Labor & Economic Growth, a move that boldly underscored the Governor's desire to create a strategic alliance uniting energy, workforce and economic growth. By realigning energy resources under DELEG and redefining the Director as the Chief Energy Officer for the State, the Governor put additional emphasis on reinvigorating this segment of Michigan's economy.

### Renewable Energy Area

In the renewable energy sector, Michigan has the potential to become a regional and global powerhouse in wind turbine manufacturing. With Michigan's engineering expertise and modernized machining, our state is uniquely positioned to meet the booming global demand for wind turbines and wind turbine components. Michigan is already a leader in the area of solar technology, but these companies currently ship most of their product overseas. DELEG's goal is for Michigan to capture the entire value chain for solar, including development, advanced manufacturing of solar arrays and panels, project development and design, and all aspects of solar deployment.

### Energy Efficiency

Investments in energy efficiency represent a major opportunity for Michigan to create jobs, save money, and reduce our reliance on fossil fuels. In fact, energy efficiency creates more jobs per dollar than fuel-based solutions. By replacing traditional fossil fuel energy, Michigan's energy efficiency program will save Michigan over \$3 billion in electricity costs over the next 20 years and help to avoid the need for construction of additional baseload power plants.

### Batteries

Advanced energy storage, and in particular the production of lithium ion batteries for cars, holds enormous potential for job creation in Michigan. While Asian firms currently have a head start in the advanced battery market, Michigan is rapidly becoming a center for advanced energy storage innovation aimed at, among other things, electrifying the automobile. We can get Michigan moving again by growing this sector, and by connecting an appropriately trained workforce to these high-tech green jobs.

We know that the powerful combination of policy efforts and private sector activity will be vital to Michigan's future. The determination, energy, and passion for the future that our businesses, workers, and educational institutions provide are the building blocks of this exciting transformation.

#### FOR MORE INFORMATION—

BUREAU OF LABOR MARKET INFORMATION  
& STRATEGIC INITIATIVES  
LABOR MARKET ANALYSIS SECTION  
3032 W. GRAND BOULEVARD, SUITE 9-100  
DETROIT, MI 48202  
(313) 456-3100  
[WWW.MICHIGAN.GOV](http://WWW.MICHIGAN.GOV)



# APPENDIX 1 - SURVEY

## STATE OF MICHIGAN GREEN JOBS SURVEY



### ABOUT THE SURVEY

The State of Michigan strives to diversify its economy through business development in new sectors such as renewable energy and energy efficiency. This effort includes supporting development of business sectors and jobs in areas such as wind energy, biofuels, solar energy, energy efficiency, and other "green-related" sectors.

The Michigan Department of Energy, Labor & Economic Growth has been directed to conduct this survey to determine the current number of jobs in these sectors, and also among businesses that **supply parts, components, products, or services** to support these sectors. The survey will identify jobs that produce goods or services related to any of the following five core green-related activities:

1. Producing renewable energy
2. Increasing energy efficiency
3. Clean transportation and fuels
4. Agriculture and natural resource conservation
5. Pollution prevention and environmental cleanup

Please see the enclosed handout that gives specific definitions of these sectors and examples of the green-related jobs they supply.

If your firm conducts "green-related" business activities **that produce goods or supply services** related to any of these five core areas, please complete the information below and continue to page two. If not, please fill out Section 1 and Section 2 below and return using the postage-paid envelope.

### DIRECTIONS AND SURVEY RESPONSE OPTIONS

- Please direct this survey to your operations manager or human resources department.
- Include information about the Michigan business location listed in the lower left-hand corner of this form.
- All information will be treated confidentially.
- Return the survey in the enclosed postage-paid envelope, or
  - Fax both sides to (800) 794-6424, or
  - Contact us toll free at (888) 587-3282 to report by telephone or receive answers to your questions.
  - Questions can also be emailed to us at [greenjobssurvey@michigan.gov](mailto:greenjobssurvey@michigan.gov)
- To ensure inclusion of your information, please respond to this survey by February 27, 2009.

### Section 1

Do you or any of your staff work to provide goods or services in any of the above five core green-related areas?

\_\_\_\_\_ Yes Please complete Sections 2-3 on this page and Sections 4-5 on the reverse side.

\_\_\_\_\_ No Please provide us with contact information below in Section 2, and mail survey in postage paid envelope, or fax survey back to (800) 794-6424.

### Section 2

#### CONTACT PERSON

Name: \_\_\_\_\_

Title: \_\_\_\_\_

Telephone: ( ) \_\_\_\_\_

Date: \_\_\_\_\_

Contact Name  
Trade Name, Unit Description  
Address  
Address 2  
City, State, Zip

Survey ID #:

### Section 3

#### PLEASE REPORT FOR THE MICHIGAN BUSINESS LOCATION SHOWN IN THE LOWER LEFT-HAND CORNER OF THIS FORM

How many employees do you currently have at this location in Michigan? \_\_\_\_\_

How many of these are employees whose primary function is the production of "green-related" products and services? \_\_\_\_\_

How many of these are employees who hold support jobs for your "green-related" business activities? \_\_\_\_\_

How many of these are employees engaged in business functions *unrelated* to your "green" business activities? \_\_\_\_\_

### THANK YOU FOR PARTICIPATING!

Michigan Department of Energy, Labor & Economic Growth  
Bureau of Labor Market Information & Strategic Initiatives  
3032 West Grand Boulevard, Suite 9-100  
Detroit, MI 48202

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# STATE OF MICHIGAN GREEN JOBS SURVEY

Survey ID #: \_\_\_\_\_



Total Number of Workers in Michigan and Job Titles Related to Five Core Areas			Core Areas for Green Jobs								
			1 Producing Renewable Energy	2 Increasing Energy Efficiency	3 Clean Transportation and Fuels	4 Agriculture and Natural Resource Conservation	5 Pollution Prevention and Environmental Cleanup	Total number of workers you expect to employ in this occupation in two years (By the year 2011)	Do you anticipate difficulty recruiting future qualified workers for this green-related occupation?	Are there any unique skills required for this occupation when working on "green-related" projects?	
Job Title Related to Core Area	Total Number of Workers in Job Title	Number of Workers in this Core Area	Number of Workers in this Core Area	Number of Workers in this Core Area	Number of Workers in this Core Area	Number of Workers in this Core Area	Number of Workers	Yes	No	Yes	No
Example: <i>Civil Engineer</i>	3	2					1				

*If more space is needed, please photocopy this page, or call 888-587-3282 for additional copies.*

**SECTION 5 Employee Training**

- Some green-related employees may require job training. Please estimate what percentage of employee training for your "green-related" workers will be:
  - Formal training provided by community colleges or outside training providers. \_\_\_\_\_ percent
  - Informal training of staff on the job. \_\_\_\_\_ percent

## APPENDIX 2 - SURVEY METHODOLOGY

### Sample Selection:

The sampling frame for the survey was the Quarterly Census of Employment and Wages (QCEW) database. This database contains Michigan companies liable under the Unemployment Insurance Compensation system.

The sampling frame was further limited to private establishments in 691 6-digit NAICS codes. These 6-digit NAICS industries included a subset of 118 green-related industry sectors identified by the research team. 46 broad and detailed industries were excluded

from the sampling frame based on an expected lack of green-related employment.

The sample was divided into strata. This stratification was conducted by 3-digit NAICS code, by seven Michigan regions, and by seven employment size classes. Firms within each stratum were selected through random sampling except establishments with 250+ employees. These were selected with certainty and had a selection probability of 1.0.

### Survey Data Collection

The survey instrument was mailed to 13,303 private employers in Michigan in the first quarter of 2009. Employers who did not respond to the survey mailing were contacted by telephone to collect survey responses. Data collection reflected in the survey estimates was conducted over a six week time period.

### Estimate Production

Employers reported employment by job title by core green activity area (see copy of survey form in Appendix). These job titles were coded by occupation using the Standard Occupational Classification system.

Once coded, survey responses were weighted based on each stratum's share of sample units to total universe establishments, and then multiplied by a non-response adjustment factor. These adjustments converted survey counts of green jobs by job title into estimates of total green jobs by occupation.

Sample Summary	Number of Establishments
Population of Establishments	121,279
Final Sample Size	13,303
Number of Firms in-Sample	13,132
<b>Total in and out of Sample, by Reason</b>	
Reason Code	Number of Establishments
Responses	6,434
Refuse to respond	94
Invalid Addresses	3
Out of Business	86
Out of State	6
Nonresponse	65
Unusable Response	9
Inactive	2
<b>Response Rate</b>	
Number of Firms in Sample	13,132
Total Response	6,434
Response Rate	49.0%
<b>Percentage of Establishments with or without green jobs</b>	
With Green Jobs	10.4%
Without Green Jobs	89.6%

## APPENDIX 3 - DEFINITION OF GREEN JOBS AND CORE AREAS SENT TO EMPLOYERS

### State of Michigan Green Jobs Survey Definitions

The green economy is comprised of businesses that offer products or services related to renewable energy, increased energy efficiency, clean transportation and fuels, agriculture and natural resource conservation, and pollution prevention or environmental cleanup.

Green jobs include primary occupations engaged in the production of green-related products or services, and support jobs created by green-related revenue.

#### POTENTIAL CORE GREEN-RELATED ACTIVITIES

- Producing renewable energy, renewable energy parts and equipment, or supplying related products or services.
  - o Renewable energy is energy generated from sustainable, natural resources that can be naturally regenerated in the short-term, such as:
    - ◆ Sunlight (solar)
    - ◆ Wind
    - ◆ Water (hydro)
    - ◆ Geothermal heat
    - ◆ Biomass (wood and wood waste, agricultural and energy crops & associated residues, animal waste, municipal solid waste, food products & processing waste)
  - o Related businesses include those:
    - ◆ Producing renewable energy
    - ◆ Firms that make or supply parts or equipment used in energy collection and distribution, such as solar panels or wind turbines
    - ◆ Conducting research and development on renewable energy technologies, or providing consulting assistance to renewable energy providers
- Increasing energy efficiency
  - o Energy efficiency encompasses all changes that result in a reduction of the energy used for a given energy service (i.e., space heating, lighting, etc.) or level of activity. Examples include businesses involved with:
    - ◆ Insulation of residential and commercial buildings
    - ◆ Retrofitting of homes to reduce energy consumption
    - ◆ “Green” building design or implementing LEED standards
    - ◆ Downsizing or upgrading of HVAC, lighting and other energy systems in buildings, which reduces energy demand
    - ◆ Production of energy efficient household appliances, such as a refrigerator or dryer
    - ◆ Providing engineering, consulting or research services on operations, materials, or technologies that improve energy efficiency
- Clean transportation and fuels
  - o Clean transportation refers to the research, development, and production of new technologies for energy storage and alternative fuels, as well as the engineering of improved fuel efficiencies and emissions reductions. Examples of these activities include:
    - ◆ Advanced batteries
    - ◆ Fuel cells
    - ◆ Electric and hybrid vehicles
    - ◆ Alternative fuels
    - ◆ Public transit
    - ◆ Activities related to meeting fuel efficiency standards, and more.

- Agriculture and natural resource conservation
  - o Agriculture and natural resource conservation refers to products or services designed to help conserve, maintain, and improve natural resources and the environment.
  - o Low carbon agriculture consists of agricultural technologies that produce energy with little or no CO<sub>2</sub> emissions, and can also include other conservation practices that help remove CO<sub>2</sub> or related emissions from the atmosphere.
 

Examples include:

    - ◆ No till conservation tillage
    - ◆ Organic farming
    - ◆ Community supported agriculture (CSA)
    - ◆ Methane capture in animal and/or food waste management
    - ◆ Planting trees or grasses
  - o Natural resource conservation includes businesses involved with:
    - ◆ Forest and land management
    - ◆ Water conservation
    - ◆ Environmental consulting services
    - ◆ Environment, conservation, and wildlife organizations
- Pollution prevention and environmental cleanup
  - o Pollution prevention refers to products that are designed to have minimal impacts on human health and the environment, and services that eliminate or reduce the amount and toxicity of potentially harmful substances at their source.
 

Examples include:

    - ◆ Controlling industrial and commercial emissions
    - ◆ Water treatment
    - ◆ Recycling center operation
    - ◆ Waste treatment
  - o Environmental cleanup consists of businesses that provide services or products related to:
    - ◆ Environmental remediation
    - ◆ Brownfield redevelopment
    - ◆ Hazardous waste cleanup
    - ◆ Wetlands restoration

## APPENDIX 4 - LIST OF GREEN RELATED INDUSTRIES REFLECTED IN CHAPTER II

NAICS	Industry Title
111110	Soybean Farming
111140	Wheat Farming
111150	Corn Farming
111421	Nursery and Tree Production
111422	Floriculture Production
111991	Sugarbeet Farming
111998	All Other Miscellaneous Crop Farming
113110	Timber Tract Operations
113210	Forest Nursery/Gathering Forest Products
113310	Logging
115114	Postharvest Crop Activities (except Cotton Ginning)
115310	Support Activities for Forestry
221111	Hydroelectric Power Generation
221119	Other Electric Power Generation
221121	Electric Bulk Power Transmission
221122	Electric Power Distribution
221210	Natural Gas Distribution
221310	Water Supply and Irrigation Systems
221320	Sewage Treatment Facilities
221330	98145.452
236115	New Single-Family Housing Construction (except Operative Builders)
236116	New Multi-Family Housing Construction (except Operative Builders)
236117	New Housing Operative Builders
236118	Residential Remodelers
236210	Industrial Building Construction
236220	Commercial and Institutional Building Construction
237110	Water and Sewer Line and Related Structures Construction
237130	Power and Communication Line and Related Structures Construction
238151	Glass and Glazing Contractors - Residential
238152	Glass and Glazing Contractors - Nonresidential
238161	Roofing Contractors -Residential
238162	Roofing Contractors -Nonresidential



NAICS	Industry Title
238171	Siding Contractors - Residential
238172	Siding Contractors - Nonresidential
238211	Electrical Contractors and Other Wiring Installation Contractors - Residential
238212	Electrical Contractors and Other Wiring Installation Contractors - Nonresidential
238221	Plumbing, Heating, and Air-Conditioning Contractors - Residential
238222	Plumbing, Heating, and Air-Conditioning Contractors - Nonresidential
238311	Drywall and Insulation Contractors - Residential
238312	Drywall and Insulation Contractors - Nonresidential
238911	Site Preparation Contractors
321113	Sawmills
321911	Wood Window and Door Manufacturing
321920	Wood Container and Pallet Manufacturing
321999	All Other Miscellaneous Wood Product Manufacturing
322121	Paper (except Newsprint)
325199	All Other Basic Organic Chemical Manufacturing
325211	Plastics Material and Resin Manufacturing
325311	Nitrogenous Fertilizer Manufacturing
326113	Unlaminated Plastics Film and Sheet (Except Packaging)
327215	Glass Product Manufacturing Made of Purchased Glass
327993	Mineral Wool Insulation Materials Manufacturing
332321	Windows and Doors, Metal, Manufacturing
333411	Air Purification Equipment Manufacturing
333414	Heating Equipment except Warm Air Furnaces
333415	Air-Conditioning, Warm Air Heating Equip., & Commercial & Industrial Refrigeration Equip.
333611	Turbine Generator and Generator Set Units
334413	Semiconductor and Related Devices
334419	Other Electronic Component Manufacturing
334512	Automatic Environmental Control Manufacturing
334513	Industrial Process Variable Instruments
334519	Measuring and Controlling Devices
335110	Electric Lamp Bulb and Part Manufacturing
335121	Residential Electric Lighting Fixtures Manufacturing
335122	Commercial, Industrial, and Institutional Electric Lighting Fixture Manufacturing
335129	Other Lighting Equipment Manufacturing
335221	Household Cooking Appliance Manufacturing
335222	Household Refrigerator and Home Freezer Manufacturing
335224	Household Laundry Equipment Manufacturing
335228	Other Major Household Appliance Manufacturing
335311	Power Distribution and Specialty Transformer Manufacturing

NAICS	Industry Title
335312	Motor and Generator Manufacturing
335313	Switchgear and Switchboard Apparatus Manufacturing
335314	Relay and Industrial Control Manufacturing
335911	Storage Battery Manufacturing
335999	All Other Miscellaneous Electrical Equipment Component Manufacturing
336111	Automobile Manufacturing
336311	Carburetor, Piston, Piston Ring, and Valve Manufacturing
336312	Gasoline Engines and Engine Parts
336350	Motor Vehicle Transmission & Power Train Components
336360	Motor Vehicle Seating and Interior Trim
336391	Motor Vehicle Air-Conditioning Manufacturing
336399	All Other Motor Vehicle Parts Manufacturing
336412	Aircraft Engine and Engine Parts Manufacturing
336991	Motorcycle, Bicycle and Parts Manufacturing
423610	Electrical Apparatus and Equipment, Wiring Supplies Wholesalers
423930	Recyclable Materials Merchant Wholesalers
482111	Line-Haul Railroads
485111	Mixed Mode Transit Systems
485113	Bus Transit Systems
485119	Other Urban Transit Systems
485210	Interurban & Rural Bus Transportation
485999	All Other Transit & Ground Passenger Transportation
486210	Pipeline Transportation of Natural Gas
541310	Architectural Services
541320	Landscape Architectural Services
541330	Engineering Services
541360	Geophysical Surveying and Mapping Services
541370	Other Surveying and Mapping Services
541380	Testing Laboratories
541420	Industrial Design Services
541614	Process and Logistics Consulting Services
541618	Other Management Consulting Services
541620	Environmental Consulting Services
541690	Other Technical Consulting Services
541712	Research and Development in the Physical, Engineering, and Life Sciences (except Biotechnology)
562111	Solid Waste Collection
562112	Hazardous Waste Collection
562119	Other Waste Collection

NAICS	Industry Title
562211	Hazardous Waste Treatment and Disposal
562212	Solid Waste Landfills
562219	Other Nonhazardous Waste Treatment and Disposal
562910	Remediation Services
562920	Materials Recovery Facilities
562998	All Other Miscellaneous Waste Management Services
712130	Zoos and Botanical Gardens
712190	Nature Parks and Other Similar Institutions
813312	Environment, Conservation and Wildlife Organizations

## APPENDIX 5 - LIST OF GREEN RELATED OCCUPATIONS REFLECTED IN CHAPTER IV

SOC	Occupational Title
11-9011	Farm, Ranch, and Other Agricultural Managers
11-9012	Farmers and Ranchers
11-9021	Construction Managers
11-9041	Engineering Managers
11-9121	Natural Sciences Managers
13-1041	Environmental Compliance Inspectors
17-1011	Architects, Except Landscape and Naval
17-1012	Landscape Architects
17-1021	Cartographers and Photogrammetrists
17-1022	Surveyors
17-2021	Agricultural Engineers
17-2041	Chemical Engineers
17-2051	Civil Engineers
17-2071	Electrical Engineers
17-2072	Electronics Engineers, Except Computer
17-2081	Environmental Engineers
17-2111	Health and Safety Engineers, Except Mining Safety Engineers and Inspectors
17-2112	Industrial Engineers
17-2131	Materials Engineers
17-2141	Mechanical Engineers
17-3022	Civil Engineering Technicians
17-3023	Electrical and Electronic Engineering Technicians
17-3025	Environmental Engineering Technicians

SOC	Occupational Title
17-3026	Industrial Engineering Technicians
17-3027	Mechanical Engineering Technicians
17-3031	Surveying and Mapping Technicians
19-1012	Food Scientists and Technologists
19-1013	Soil and Plant Scientists
19-1023	Zoologists and Wildlife Biologists
19-1031	Conservation Scientists
19-1032	Foresters
19-2031	Chemists
19-2032	Materials Scientists
19-2041	Environmental Scientists and Specialists, Including Health
19-2042	Geoscientists, Except Hydrologists and Geographers
19-2043	Hydrologists
19-3051	Urban and Regional Planners
19-3092	Geographers
19-4011	Agricultural and Food Science Technicians
19-4031	Chemical Technicians
19-4091	Environmental Science and Protection Technicians, Including Health
19-4093	Forest and Conservation Technicians
25-1031	Architecture Teachers, Postsecondary
25-1032	Engineering Teachers, Postsecondary
25-1041	Agricultural Sciences Teachers, Postsecondary
25-1042	Biological Science Teachers, Postsecondary
25-1051	Atmospheric, Earth, Marine, and Space Sciences Teachers, Postsecondary
25-1052	Chemistry Teachers, Postsecondary
25-1053	Environmental Science Teachers, Postsecondary
25-1054	Physics Teachers, Postsecondary
25-1064	Geography Teachers- Postsecondary
25-9021	Farm and Home Management Advisors
27-1021	Commercial and Industrial Designers
33-2022	Forest Fire Inspectors and Prevention Specialists
33-3031	Fish and Game Wardens
37-3011	Landscaping and Groundskeeping Workers
37-3013	Tree Trimmers and Pruners
37-3019	Grounds Maintenance Workers, All Other
41-4011	Sales Reps, Whlsl/Mfg, Technical/Scientific Products
41-9031	Sales Engineers
45-2011	Agricultural Inspectors
45-2041	Graders and Sorters
45-2092	Farmworkers and Laborers, Crop, Nursery, and Greenhouse
45-2099	Agricultural Workers, All Other

SOC	Occupational Title
45-4011	Forest and Conservation Workers
45-4021	Fallers
45-4022	Logging Equipment Operators
45-4023	Log Graders and Scalers
47-1011	First Line supervisors, Construction trades
47-2031	Carpenters
47-2061	Construction Laborers
47-2111	Electricians
47-2121	Glaziers
47-2131	Insulation Workers, Floor, Ceiling, and Wall
47-2132	Insulation Workers, Mechanical
47-2152	Plumbers, Pipefitters, and Steamfitters
47-2181	Roofers
47-2211	Sheet Metal Workers
47-3013	Helpers - Electricians
47-4011	Construction and Building Inspectors
47-4041	Hazardous Materials Removal Workers
47-4071	Septic Tank Servicers and Sewer Pipe Cleaners
49-2095	Electrical and Electronics Repairers, Powerhouse, Substation, and Relay
49-3043	Rail Car Repairers
49-3091	Bicycle Repairers
49-3093	Tire Repairers and Changers
49-9021	Heating, Air Conditioning & Refrigeration Mechanics & Installers
49-9041	Industrial Machinery Mechanics
49-9051	Electrical Power-Line Installers and Repairers
51-2022	Electrical and Electronic Equipment Assemblers
51-2031	Engine and Other Machine Assemblers
51-8012	Power Distributors and Dispatchers
51-8013	Power Plant Operators
51-8021	Stationary Engineers and Boiler Operators
51-8031	Water and Liquid Waste Treatment Plant and System Operators
51-8091	Chemical Plant and System Operators
51-8092	Gas Plant Operators
51-9011	Chemical Equipment Operators and Tenders
51-9141	Semiconductor Processors
53-3021	Bus Drivers, Transit and Intercity
53-4011	Locomotive Engineers
53-4021	Railroad Brake, Signal, and Switch Operators
53-4031	Railroad Conductors and Yardmasters
53-6051	Transportation Inspectors
53-7081	Refuse and Recyclable Material Collectors

DELEG is an equal opportunity employer/program. Auxiliary aids, services and other reasonable accommodations are available upon request to individuals with disabilities.