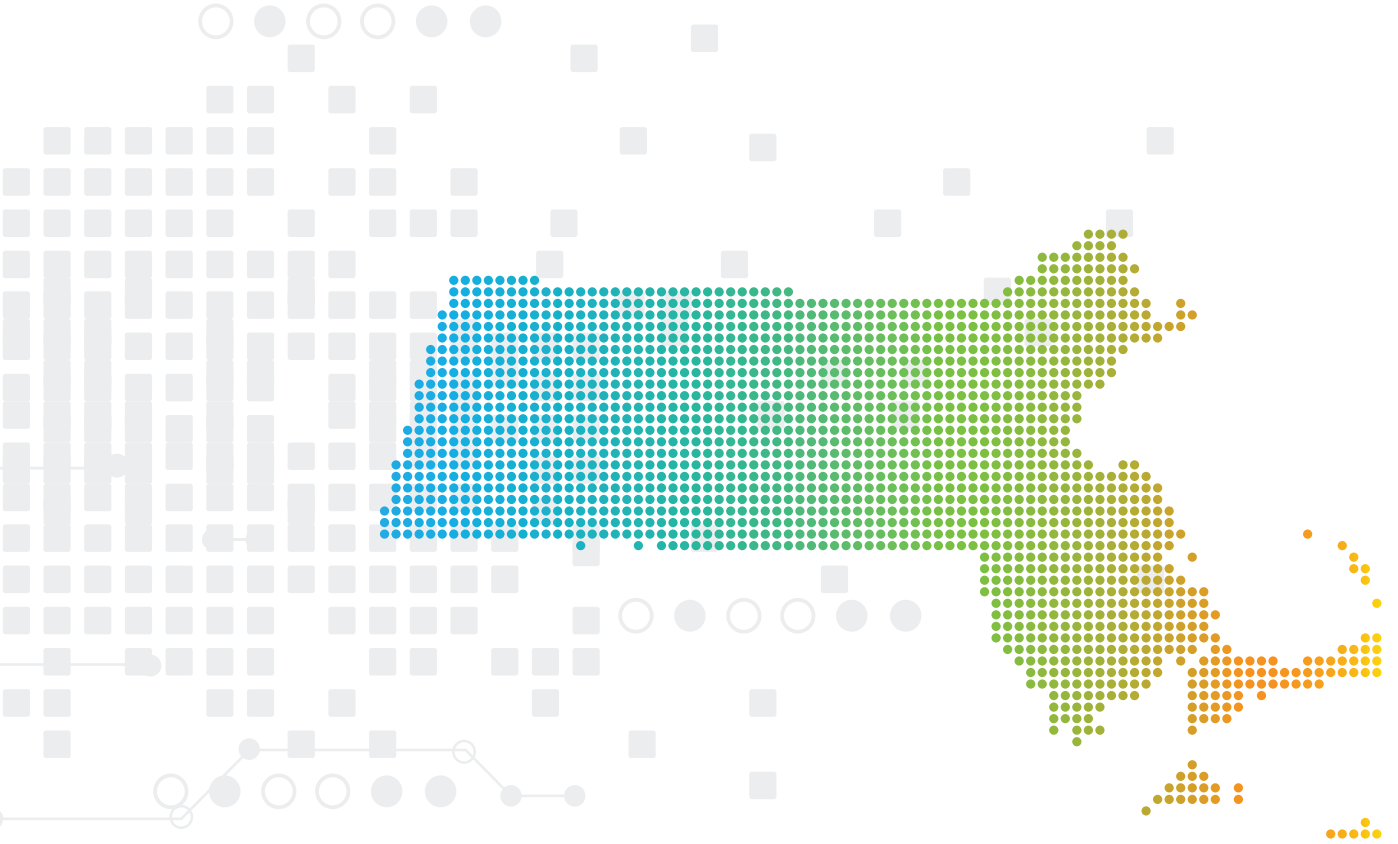

2015

MASSACHUSETTS CLEAN ENERGY INDUSTRY REPORT

[bw] RESEARCH PARTNERSHIP


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RESEARCH
PARTNERSHIP

ACKNOWLEDGMENTS

The annual Massachusetts Clean Energy Industry Report is the result of an extensive research process encompassing the breadth of the Commonwealth's growing and diverse clean energy sector. In 2015, this process included a survey of more than 1,450 respondents from across the spectrum of our clean energy economy. MassCEC would like to thank all participants for engaging with researchers to gather this important data and for their willingness to generously share their time and insights.

The publication of this report would not be possible without the hard work and dedication of the following individuals:

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Sarah Lehmann, BW Research

RED WHITE BLUE STUDIO:

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MASSCEC:

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Each year, the Massachusetts Clean Energy Center (MassCEC) commissions an independent industry report that gives us the chance to examine the strides the clean energy sector has made over the past 12 months, and measures how investments in clean energy economic development are paying off for the Commonwealth.

The 2015 Massachusetts Clean Energy Industry Report finds strong and steady industry growth trends for the fifth consecutive year.

This past year, Massachusetts experienced the largest single-year of growth in the industry – at 11.9 percent – since MassCEC began tracking jobs data in 2010.

There are now 98,895 clean energy workers and 6,439 clean energy companies in Massachusetts – with clean energy employing residents of every county and jobs growing across every region of the Commonwealth.

The clean energy sector has added more than 40,000 jobs since 2010 – a growth rate of 64 percent over that time – and now represents 3.3 percent of the overall Massachusetts workforce. And these are well-paying jobs, with nearly three-quarters of full-time clean energy workers earning more than $50,000 per year – above the overall median wage of $44,678 for all jobs in Massachusetts.

The clean energy sector in Massachusetts is thriving and has grown to become an $11 billion industry, accounting for 2.5 percent of the Gross State Product.

Alongside steady, sustained job growth, there has been rapid growth in the installation of clean energy projects across the Commonwealth. Massachusetts reached a significant milestone in 2015, passing 1 gigawatt (GW) of installed renewable energy capacity adding much-needed diversity to Massachusetts' overall energy mix.

This diversification is part of the Baker-Polito Administration's goals of reducing costs to ratepayers while strengthening the Massachusetts clean energy economy and meeting statewide greenhouse gas emissions reduction requirements set forth under the Global Warming Solutions Act (GWSA).

Beyond just tracking yearly employment numbers, the Massachusetts Clean Energy Industry Report also tracks the overall state of the clean energy sector here in the Commonwealth. Known as the "gold standard" for clean energy job counting methodology, this report's methodology has been replicated in 10 other states – California, Florida, Illinois, Iowa, Missouri, Ohio, Pennsylvania, Rhode Island, Tennessee and Vermont.

This tool provides important information to help develop policies that support residents and businesses looking to adopt affordable clean energy and bolster the companies who deliver it. In the past, these results have helped to drive new workforce development and renewable energy initiatives like MassCEC's Clean Energy Internship Program and our efforts to increase the use of cost-effective clean heating and cooling technologies.

While five years of sustained growth in the clean energy sector is something to be proud of, we must continue to look to the future and find ways to build on these accomplishments to maintain Massachusetts' clean energy leadership.

The Baker-Polito Administration is committed to helping further this growth through the support of innovative companies, by training the next generation of clean energy workers and by making the economic and environmental benefits of clean energy easier and more affordable for Massachusetts residents, particularly those of low or moderate incomes.

Stephen Pike
Interim CEO, Massachusetts Clean Energy Center

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EXECUTIVE SUMMARY

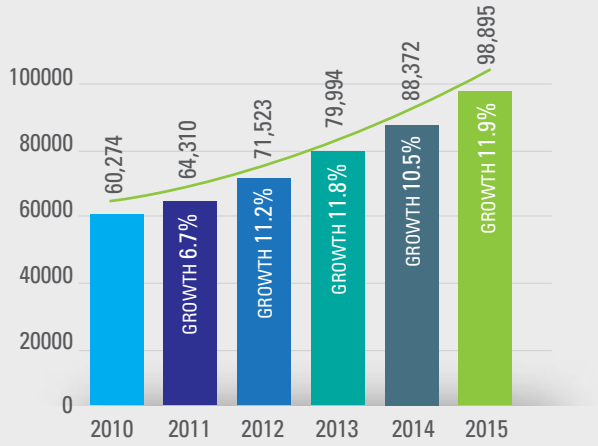
The Massachusetts clean energy industry has become a robust source of jobs and economic activity in the Commonwealth. The 2015 Massachusetts Clean Energy Industry Report, which is an annual accounting of the state's clean energy activity, illustrates a vibrant and diverse cluster of activities that has demonstrated remarkably strong and consistent growth over the past five years.

Five years ago, clean energy firms employed just over 60,000 workers. Today that number has soared to almost 99,000, an increase of 64%. Statewide renewable energy capacity passed 1 gigawatt in 2015, as both the number of renewable energy megawatts and installations have grown dramatically.

Clean energy employment and economic growth in Massachusetts has been sizable and steady, despite significant shifts in private investment, federal spending, world markets and regulatory policy.

The report's five key findings reflect a dynamic and growing industry from deployment to investment.

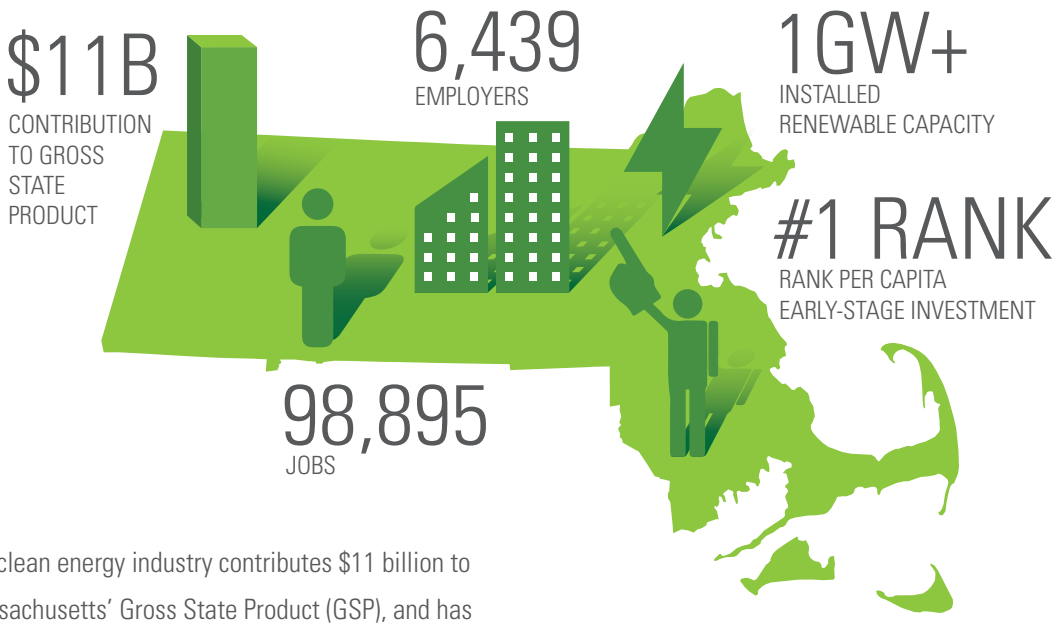
CLEAN ENERGY INDUSTRY EMPLOYMENT GROWTH, 2010-2015



The report's key findings include:

1. **1 GW** – Massachusetts surpassed 1 gigawatt (GW) of installed renewable energy capacity[1] in 2015.
2. **11.9%** – This year's annual employment growth of 11.9% is the largest increase of any year since the report's inception in 2010.
3. **64%** – The number of clean energy jobs has grown markedly – by 64% – since 2010, cumulatively adding almost 40,000 clean energy workers, bringing the statewide total to 98,895.
4. **$50,000** – These clean energy jobs pay well, with nearly three-quarters of full-time workers earning $50,000 or more annually, compared to a median wage of $44,678 for all jobs across Massachusetts.
5. **#1** – Massachusetts is #1 in attracting early-stage investments per capita, beating California by more than 149% on a per capita basis. Total public and private investment in the state's clean energy industry exceeded $549 million.

MASSACHUSETTS BY THE NUMBERS



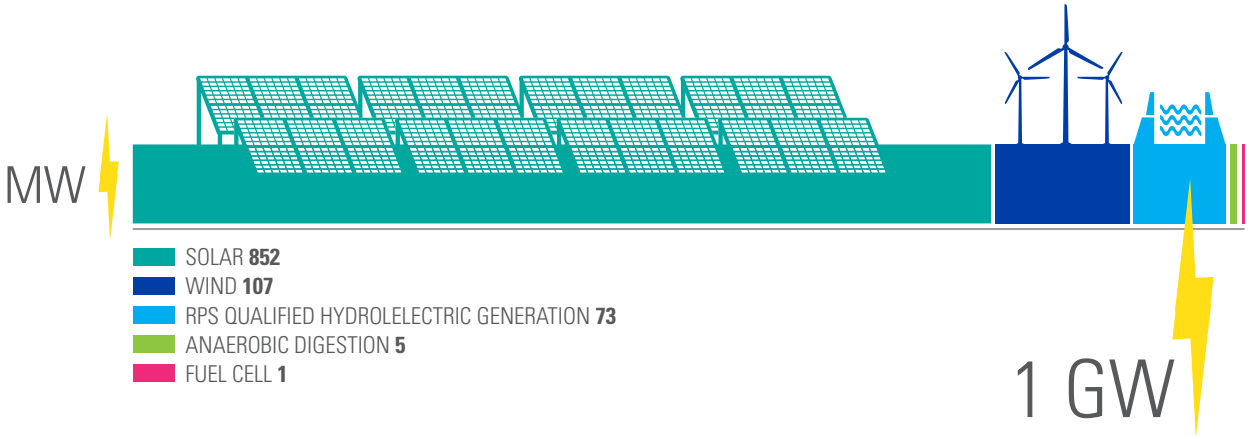
The clean energy industry contributes $11 billion to Massachusetts' Gross State Product (GSP), and has grown by $900 million since May 2014. The industry now represents a 2.5% share of the entire Massachusetts economy and clean energy employees now account for 3.3% of the state's labor market.[2] In just the last 12 months, the sector grew 11.9%, generating 10,500 new jobs.

Clean energy industry growth has added more than 1,500 new employers statewide since 2010. Steady annual growth between 7% and 12% over the last five years amounts to a sector that supports 98,895 workers across 6,439 establishments. This growth occurred despite fluctuations in public and private investment, energy prices and overall economic and employment growth across the Commonwealth and beyond.

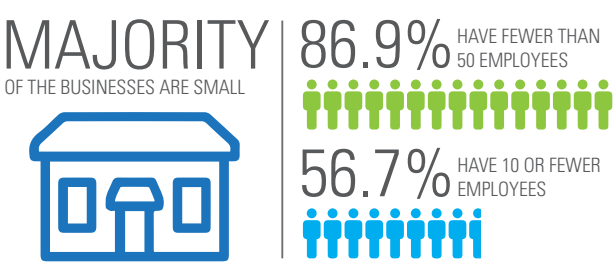
Other major findings of the report include:

DEPLOYMENT DRIVES JOB GROWTH

- Renewable energy establishments employ 26,850 clean energy workers, a 28% employment increase since 2014. Massachusetts installed 269 megawatts (MW) of new solar capacity in 2014, representing a 19% increase in installed capacity since 2013.[3]
- Clean energy deployment has increased across all subsectors,[4] outpacing both overall employment and overall economic growth statewide. Annual renewable electricity installations alone grew from approximately 430 in 2010 to nearly 8,900 in 2014, and passed the 1 GW cumulative installed capacity mark in 2015.[5]
- Between 2013 and 2015, battery electric vehicles and plug-in hybrid vehicles on Massachusetts roads increased by 170%. There are nearly 5,000 electric vehicles in Massachusetts as of March 2015. Alternative Transportation contributes more than $577 million to GSP.



CLEAN ENERGY BUSINESSES DO MORE THAN JUST INSTALLATION



- Clean energy encompasses multiple technologies in the entire value chain of activities: manufacturing, engineering and research, sales and distribution, installation, finance, legal or other professional services. Renewable energy is the fastest growing segment, experiencing 28% employment growth over the past 12 months.

THE MAJORITY OF BUSINESSES ARE SMALL

- More than 56% of firms have ten or fewer permanent employees and 87% have fewer than 50 employees.[6]

EMPLOYMENT GROWTH IS STATEWIDE AND IN EVERY COUNTY

- Central and Northeastern Massachusetts employ 17,500 and 47,000 workers and expanded by double digits (13.6% and 16.8%, respectively). Southeastern and Western Massachusetts employ 22,500 and 12,000 workers, growing by 6.7% and 2.7%, respectively.

THE REPORT METHODOLOGY HAS SET THE STANDARD FOR OTHER STATES

- Ten other states (California, Florida, Illinois, Iowa, Missouri, Ohio, Rhode Island, Tennessee, Pennsylvania and Vermont) have replicated and adopted the methodology used to generate the data contained in this report.

1 This figure includes RPS-qualified generation in solar, wind, hydroelectric, biomass, fuel cell, and anaerobic digestion.

2 http://www.mass.gov/lwd/economic-data/employment-jobs/

3 Installed capacity data is not available for 2015.

4 Renewable Electricity Generation, Electrical Efficiency and Building Envelope, Renewable and Efficient Heating and Cooling, Alternative Transportation, Greenhouse Gas Emissions Accounting and Management (including Sequestration), and Other.

5 Massachusetts Department of Energy Resources, RPS and APS list, available at: http://www.mass.gov/eea/energy-utilities-clean-tech/renewable-energy/rps-aps/

6 Includes those establishments that reported no permanent employees, such as extended proprietorships.

SCHNEIDER ELECTRIC

COMPANY LOCATION: Andover

NUMBER OF MASSACHUSETTS EMPLOYEES: 1,900

Schneider Electric is a global leader in energy management and automation. With revenue of $30 billion in 2014, its 170,000 employees serve customers in over 100 countries, helping them to manage energy in ways that are safe, reliable, efficient and sustainable. From the simplest of switches to complex operational systems, Schneider's technology, software and services improve the way customers manage and automate their operations.

INDUSTRY OVERVIEW

SUMMARY

The Massachusetts clean energy industry continues to grow, now employing 98,895 clean energy workers, an 11.9% growth rate over the past year – the greatest single-year growth since MassCEC began measuring employment in 2010.

These nearly 99,000 clean energy workers are spread out at 6,439 establishments across the state, a 7.6% jump since 2014.

Overall, the Massachusetts clean energy workforce has grown by more than 64%, or 40,000 jobs, since 2010 (see Figure 1). The growth has been remarkably steady since 2011 (the peak year of clean energy related public funding), especially given the fluctuations in the economy, energy prices, overall job growth and public and private investment in clean energy goods and services over the period.

In August 2008, Massachusetts required all economic sectors to reach a 25% reduction in greenhouse gas emissions by 2020 and an 80% reduction by 2050 under the Global Warming Solutions Act.[7] The Acts of 2008 also created the Massachusetts Clean Energy Center (MassCEC) under the Green Jobs Act to administer funds that support clean energy research, education and workforce development.[8] One goal of the legislative acts was to develop and grow a stable and robust clean energy economy in the Commonwealth.

Seven years later, the clean energy sector is an $11 billion industry in Massachusetts, up $900 million from a year ago and accounting for 2.5% of the state's economy. Emerging as a distinct and reliable source of statewide economic activity, clean energy signals growing opportunity for both new business and traditional establishments that realize the benefit of expanding clean energy markets.

The size and growth of clean energy jobs and the industry's impact on the Massachusetts economy make it a marquee industry. At nearly 99,000 jobs, the clean energy industry has more workers than Life Sciences,[9] and about half as many as the Financial Services sector.[10] It has the second-highest per capita clean energy employment (ahead of California and behind only Vermont), is first in per capita early-stage clean energy investment raised, and has a higher proportion of clean energy activity connected to engineering and research than any other state, providing higher than average wages for the state's clean energy workforce.

Pushed by growth in the deployment of renewable energy and energy efficiency technologies, as well as an emerging Alternative Transportation market, the clean energy industry is well-developed, with significant representation across its supply chain. Nearly half of the

industry's suppliers and vendors are in-state, with an equally strong local customer base.

While vigorous clean energy demand provides the greatest employment opportunities for installation, sales and distribution, strong innovative activity has bolstered the manufacturing, research and engineering labor force by 12%. This is certainly a sizable component of the Commonwealth's clean energy employment total, but it is the impact of innovation beyond the sector that underlies its importance to the Massachusetts economy. Innovation organizations, defined as those researching, developing and manufacturing prototypes of pre-commercial clean energy technologies, pay higher wages on average, attract more foreign capital and have higher economic and

capita (second overall, behind California) than any other state.[12] Numerous publications rank Massachusetts at or near the top of clean energy innovation.[13] Approximately 500 engineering and manufacturing companies work with both commercial and pre-commercial activities; 260 early-stage clean energy engineering and manufacturing establishments work exclusively with pre-commercial products. Among the firms that work with pre-commercial products, 36 firms have been awarded a total of 417 patents.[14] This heavy focus on research and innovation has drawn seed investment to the state. In 2014 alone, early-stage investments surpassed $69 million and resulted in 24 deals. In the same year, combined public and private investment in statewide clean energy ventures

FIGURE 1: CLEAN ENERGY INDUSTRY EMPLOYMENT GROWTH, 2010-2015

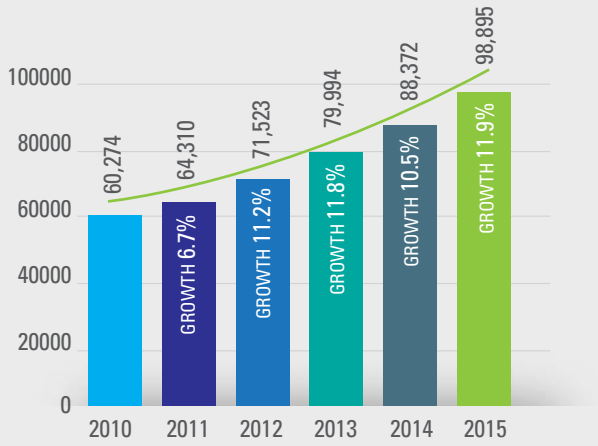
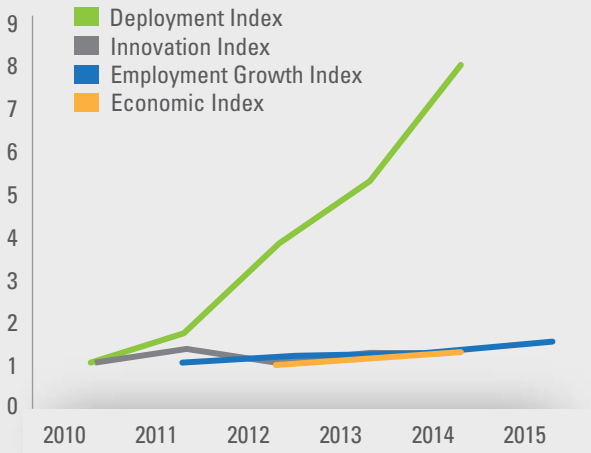


FIGURE 2: MASSACHUSETTS CLEAN ENERGY INDUSTRY INDICES



employment multipliers than establishments in traditional segments of the sector.[11] In other words, the impact of clean energy innovation on jobs and economic growth is far greater than the limited number of establishments and employees working directly in the sector would suggest.

Massachusetts is a leader in clean energy innovation, attracting more early-stage clean energy investment per

reached $549.9 million, a result of 52 deals.

For the first time, this report includes proprietary indices that track the growth of clean energy deployment (number and size of installations, electric vehicle purchases, greenhouse gas emissions diverted, etc.), economic impact (revenues and contributions to Gross State Product), employment (clean energy job growth, change

in percentage of labor hours devoted to clean energy) and innovation (patents, early-stage investments, number of companies working on pre-commercial products). Each index had been developed to show comparable growth (or decline) over time, allowing for deeper context for analysis, and eventually, comparison with other states and regions. Figure 2 illustrates the industry by these various metrics in each category from 2010 to 2015.

Figure 2 illustrates several important trends regarding the history of clean energy activity in Massachusetts over the past five years. First, while clean energy employment has grown remarkably quickly (64% more clean energy jobs in 2015 than in 2010), this growth occurred during historic deployment activity. In other words, the nearly 70% growth in employment activity connected to clean energy occurred over a period where clean energy installations (including the number and size of energy efficiency and renewable energy projects and number of electric vehicles deployed and charging stations built) grew by 800%.

It is clear that significantly more clean energy is being deployed on a per-worker basis each year. The data strongly suggest that clean energy sales and installation employers have become more efficient, whether by driving greater productivity within their workforce through worker efficiency, technological advances, or a combination of factors. However, it is certainly possible that employment began ramping up prior to 2010, in anticipation of employers' expectations regarding a leading clean energy market. It will be important to monitor this and other trends over time to help forecast the potential for clean energy economic and employment growth in the future.

Another important observation is the remarkable consistency of clean energy employment and economic growth. While many believed that the end of federal stimulus spending – together with declines in private investments in clean energy technologies – would result in declines in these metrics, each demonstrates steady growth over time.

7 http://www.mass.gov/eea/air-water-climate-change/climate-change/massachusetts-global-warming-solutions-act/

8 https://malegislature.gov/Laws/SessionLaws/Acts/2008/Chapter307

9 http://pioneerinstitute.org/news/status-report-on-the-job-creation-impact-of-the-life-sciences-act-of-2008/; https://www.tbf.org/~/media/TBFOrg/Files/Reports/LifeSciences_%C6%92.pdf.

10 Bureau of Labor Statistics Quarterly Census of Employment and Wages 2014 data for "Financial Activities."

11 See generally, Moretti, Enrico, The New Geography of Jobs (Houghton Mifflin Harcourt, 2012).

12 Cleantech Group i3 database.

13 See generally, http://cleanedge.com/reports/2015-US-Clean-Tech-Leadership-Index, http://www.pewtrusts.org/~/media/legacy/uploadedfiles/wwwpewtrustsorg/reports/clean_energy/State-rankings-chart.pdf?la=en.

14 The USPTO does not have a clean energy classification for patents. Hence, it is difficult to determine which of these patents are purely clean energy patents.

DEPLOYMENT

Demand for a broad range of clean energy technologies is on the rise as residents and businesses take advantage of the state's incentive and policy programs and invest in energy efficiency upgrades, renewable electricity installations and electric vehicles. Installations grew from 429 installations in 2010 to nearly 8,900 (277 MW) in 2014 (Figure 3). The largest sources are solar, wind and biomass power.[15]

POWERHOUSE DYNAMICS

COMPANY LOCATION: Newton

NUMBER OF MASSACHUSETTS EMPLOYEES: 25

Powerhouse Dynamics develops operational and energy efficiency software for small commercial facilities including restaurants, convenience stores, retailers and others. The company's online and mobile SiteSage platform reduces energy, maintenance and repair expenses by centralizing control, analysis and management of energy-consuming equipment. The system controls major loads, monitors power consumption, provides insight into the performance of equipment and tracks gas and water usage.

SUPPORTING INNOVATION

MASSCEC SUPPORTS EARLY-STAGE COMPANIES SEEKING COMMERCIALIZATION THROUGH ITS *CATALYST* AND *INNOVATEMASS* PROGRAMS. The **Catalyst Program** has awarded grant funding for emerging technologies since 2010, resulting in 51 published papers, 49 patent issuances and applications and more than $45 million in follow-on financing. Launched in 2013, MassCEC's **InnovateMass Program** helps more advanced startups secure critical funds to move technologies out of the lab and into real-world demonstration projects. With future growth in mind, these projects help entrepreneurs produce key data to share with potential investors. Together, these programs have supported 48 Massachusetts cleantech startups across the "valley of death" funding gap.

MassCEC's Equity and Debt **Investments** programs aim to create clean energy jobs in Massachusetts and assist cleantech companies in growing and advancing their technologies, while focusing on products that are commercially viable and likely to generate a financial return in the future. In the face of a broader decline of cleantech investment, particularly at the early stages and among venture capitalists, MassCEC's role of bringing in external capital (often via family offices, strategic investors and angel groups) to support sustainable technologies is increasingly important. With a portfolio spanning energy efficiency, energy storage, materials, solar and wind industries, MassCEC's investment programs fill funding gaps and help build private investor interest in emerging companies that are vital for the health of the cleantech industry.

RESULTS OF THE INVESTMENT PROGRAM

Investment Total	10.4M
Number of Companies	18
Jobs	345
Savings	18-20%
Leveraged External Capital	$395M

Energy efficiency deployment increased as well. Between 2010 and 2014, the number of participating Massachusetts residents and business owners in the MassSave initiative increased by 270%, with nearly 31% of this growth in just the last year. MassSave is an initiative sponsored by utility and service providers to increase savings through energy efficiency. The "stretch code" is an optional appendix to the Massachusetts building energy code that allows cities and towns to choose a more energy-efficient option. This option increases the efficiency requirements in any municipality that adopts it, for all new residential and many new commercial buildings, as well as for those residential additions and renovations that would normally trigger building code requirements. To date, 157 municipalities have adopted the 2009 Energy Efficiency Stretch Code.[16] Between 2013 and 2015, statewide battery electric vehicles (BEVs) and plug-in hybrid vehicles (PHEVs) increased by 195%. In June 2015, the MassDEP Electric Vehicle Rebate program administered or reserved a total of 939 applications for BEVs and PHEVs. As of June 2015, there are 5,360 such vehicles on the road.[17]

15 Department of Energy Resources (DOER), Massachusetts Clean Energy Center (MassCEC)

16 http://www.mass.gov/eea/docs/doer/green-communities/grant-program/stretch-code-qa-feb10-2011.pdf; http://www.mass.gov/eea/docs/doer/green-communities/grant-program/stretch-code-towns-adoption-by-community-map-and-list.pdf

17 http://www.mass.gov/eea/agencies/massdep/air/grants/massevip-municipal.html

FIGURE 3: INSTALLED RENEWABLE ENERGY CAPACITY GROWTH (MW), 2010-2014

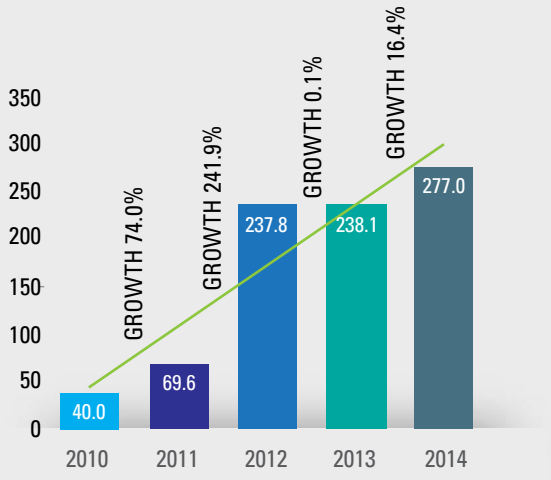
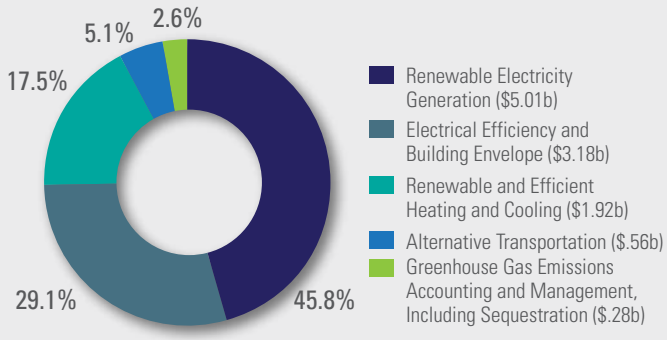


FIGURE 4: MASSACHUSETTS CLEAN ENERGY INDUSTRY GROSS STATE PRODUCT BY TECHNOLOGY



GSP & REVENUES

The clean energy industry contributes nearly $11 billion to the Gross State Product (GSP) in Massachusetts, representing 2.5% of the Commonwealth's economy. The GSP increased by more than $900 million since May 2014, with energy efficiency accounting for over a quarter of the GSP and renewable energy accounting for nearly half the GSP (Figure 4).

JOBS & BUSINESS GROWTH

Clean energy employment grew by its fastest pace over 2014-2015 – up 11.9% – greater than any annual period since MassCEC began tracking jobs in 2010, rising by more than 10,000 to nearly 99,000 workers in the industry. The number of firms engaged in clean energy activities has also risen dramatically, to 6,439 establishments across the Commonwealth, growth of 7.6% since 2014. Since 2010, clean energy employment has grown by 64%, representing an increase of more than 38,000 clean energy workers over the period.

The number of employees that spend a majority of their time (50% or more)[18] on clean energy work jumped from 72.3% to 80.2% between 2014 and 2015, while those that spend all of their time working on clean energy projects increased by 6% (66.0% to 72.2%). The share of workers spending most or all of their time working with clean energy goods and services is higher in Massachusetts than in any other state studied to date.[19]

Employment across the entire clean energy supply chain exhibited healthy growth, from early-stage research and development through installation and maintenance. As Table 1 above illustrates, the largest proportion of employment in the industry is concentrated in sales and distribution (27,489 employees), followed by installation (23,890 employees).

As shown in Figure 5, Massachusetts clean energy establishments continue the trend of becoming more "pure-play," meaning that all of their activities are clean energy related. This reflects the broader market growth trends where an increased demand for clean energy supports businesses completely focused on clean energy, as well as makes them ubiquitous, meaning that more and more traditional businesses are offering clean energy goods and or services to their customers.

FIGURE 5: PERCENTAGE OF PURE-PLAY ESTABLISHMENTS, 2011-2015

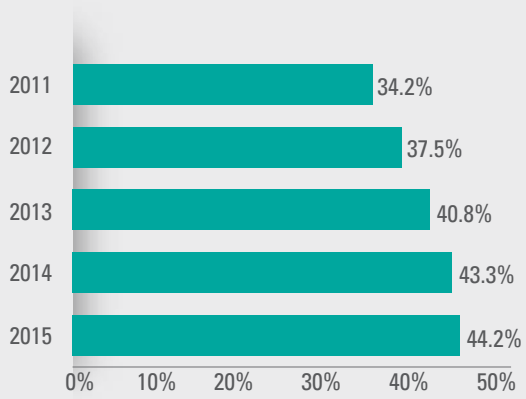


TABLE 1: CLEAN ENERGY JOBS BY ACTIVITY, 2014-2015

FOCUS	2014 EMPMNT	2014-2015 GROWTH	2015 EMPMNT	2015 % OF IND.
Manufacturing	14,596	5.7%	15,435	15.6%
Engineering & Research	17,514	5.8%	18,537	18.7%
Sales & Distribution	23,546	16.7%	27,489	27.8%
Installation	21,454	11.4%	23,890	24.2%
Consulting, Finance, etc.	5,542	34.5%	7,452	7.5%
Other	5,720	6.5%	6,093	6.2%

Clean energy establishments work with many different technologies, and all segments showed growth over the past 12 months. To add more context and clarity, and to reflect the important distinction between technologies focused on electricity and heating/cooling, the research organizes the broad categories slightly differently than in years past, including Renewable and Efficient Heating and Cooling technologies as its own chapter. Traditionally, some of these activities have been included in renewable energy (such as solar thermal), while others were in energy efficiency (such as high-efficiency furnaces and boilers). Table 2 is provided for comparisons to 2014 using the traditional categories.

Renewable energy grew faster in 2014 than in 2013 (28% vs. 18%), while energy efficiency added jobs at a slower pace compared to the previous year (6.6% vs. 11.7%).

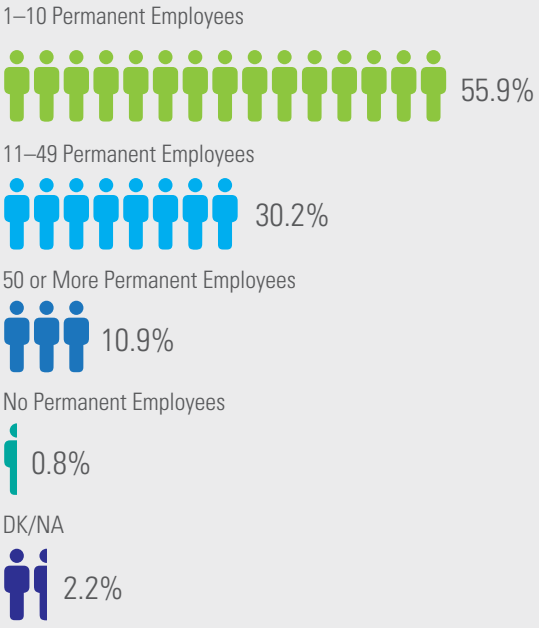
The majority of the businesses are small, with 55.9% having 10 or fewer permanent employees and 76% with fewer than 25.[20] Small businesses tend to be more selective with hires because each hire represents a large percentage of their workforce, and small businesses are much more negatively impacted if they make a "bad hire." At the same time, small businesses typically do not have dedicated personnel for recruiting and training or government affairs, which are important considerations when addressing workforce needs and employer outreach and partnership strategies. A higher proportion of small establishments was found in:

- Engineering and research firms – 82% with 10 or fewer employees
- Legal, finance and other professional services – 77.3% with 10 or fewer employees

TABLE 2: CLEAN ENERGY INDUSTRY TECHNOLOGIES, 2014-2015

TECHNOLOGY	2014	GROWTH 2014-15	2015
Renewable Energy	20,980	28.0%	26,850
Energy Efficiency	65,182	6.6%	69,460
Alternative Transportation	1,290	14.6%	1,478
Greenhouse Gas Emissions Accounting and Management, Including Sequestration	722	18.6%	856
Other	207	21.1%	251

FIGURE 6: SIZE OF EMPLOYMENT AT CLEAN ENERGY ESTABLISHMENTS



87% of energy establishments are reported to be privately owned establishments, and 94.9% of respondents noted that their U.S. headquarters are in Massachusetts. Headquarters typically include professional, managerial, marketing and other office-related tasks that require highly skilled and educated workers and pay higher wages than satellite offices.

Clean energy establishments reported that the majority of their customers (68.8%) are located in-state (slightly higher than 2014 at 64.1%), while just over a quarter (26.7%) are located outside of Massachusetts (lower than 2014 at 33.2%). Suppliers or vendors are more evenly split geographically for clean energy companies between being located in Massachusetts (49.0%) (higher than 2014 at 41.4%) and being located outside of the state (44.9%) (lower than 2014 at 52.0%).

CLEAN ENERGY WORKFORCE

Given the rapid expansion of clean energy-focused jobs in Massachusetts, the report seeks to analyze the composition of the industry's workforce. Based on the current employees and recent hires (defined as workers hired within past 12 months), several findings emerge:

- Clean energy is diverse in terms of its racial and ethnic makeup; however, representation of women lags, as it does in much of the rest of the United States.
- Clean energy establishments generally pay wages that are higher than the state median for all jobs.
- College and work experience are required for a majority of workers, though nearly 30% of new hires achieved only a high school diploma or GED.
- Employers face more difficulty finding workers in a much tighter labor market.

FIGURE 7: CUSTOMER LOCATION, CLEAN ENERGY

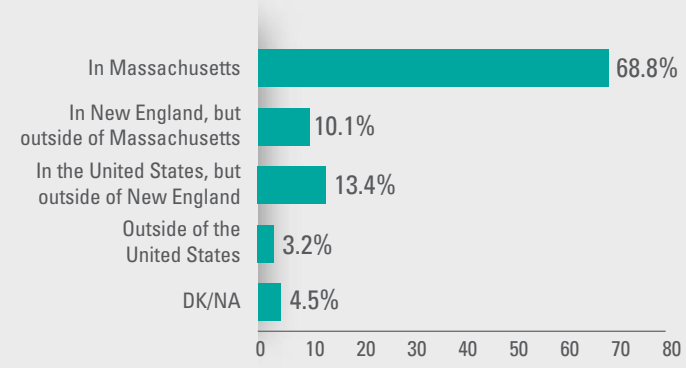


FIGURE 8: VENDOR LOCATION, CLEAN ENERGY

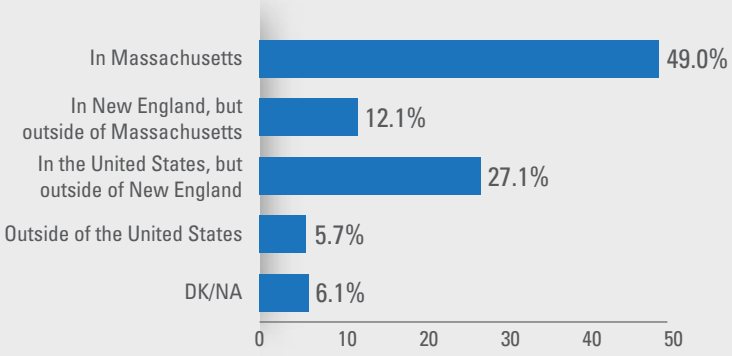


TABLE 3: DIVERSITY OF CLEAN ENERGY WORKFORCE

	% of Current Workforce	% of Engineering & Research Workforce	% of Professional Services Workforce	% of Recent Hires
Women	22.5%	34.9%	31.8%	21.3%
Ethnic or Racial Minorities	16.9%	12.7%	9.8%	22.8%
Veterans of the U.S. Armed Forces	8.2%	3.8%	3.0%	6.9%
55 and Over	17.9%	15.9%	20.1%	5.0%

Clean energy establishments also reported the diversity of their employees and new hires. Women make up 22.5% of the clean energy workforce, which is markedly lower than the proportion of women in the overall Massachusetts workforce (48.7%).[21] Women are more likely to hold positions at professional services and engineering and research firms however, which generally pay higher wages than other segments of the clean energy economy.

Full-time permanent employees at clean energy establishments are paid above the median wage in Massachusetts,[22] with 73.1% earning more than $50,000 per year (Figure 9).

Employers report similar levels of difficulty finding qualified employees to meet their needs when compared to 2014, with 23.7% reporting significant difficulty and 24.4% reporting no difficulty (Figure 11). Employers provided specific reasons that are leading to their difficulty in finding qualified applicants, including:

- Lack of experience (34.0%)
- Insufficient training (or licensing/certification) (24.7%)
- Limited supply of qualified candidates (24.7%)

Perhaps due to difficulty, employers noted one out of every five positions they attempted to fill in Massachusetts went either unfilled or was filled out-of-state (19.6%).

FIGURE 9: FULL-TIME PERMANENT WORKER PAY RANGE, CLEAN ENERGY

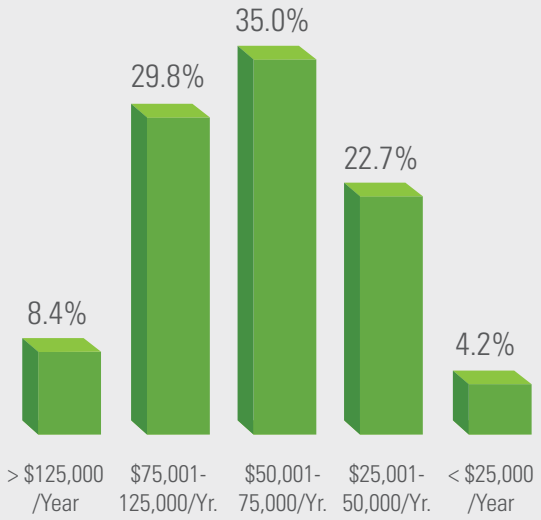
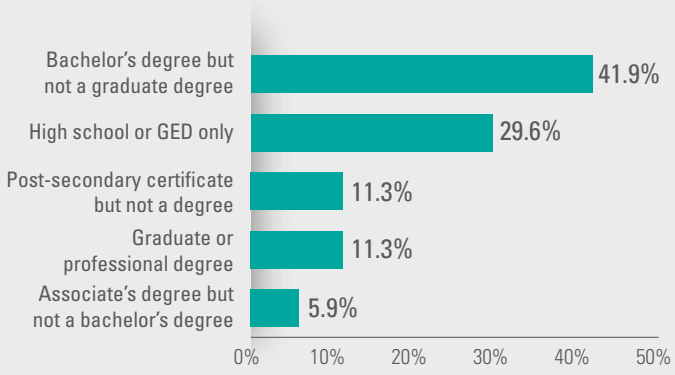


FIGURE 10: EDUCATION ATTAINMENT PREFERENCES FOR RECENT HIRES, CLEAN ENERGY



Clean energy employers hired applicants with previous experience at a similar rate in 2015 (62.0%) when compared to 2014 (60.7%).

As seen in Figure 10, 41.9% of recently hired clean energy workers were hired with a bachelor's degree while 29.6% were hired with a high school diploma or GED.

18 The number of employees spending 50% or more of their time on clean energy has been shown to be a reasonable approximation of FTE employment in other research conducted by the research team.

19 See generally, Clean Jobs Illinois; Clean Jobs Florida; Clean Jobs Missouri; Clean Jobs Tennessee.

20 Includes those establishments that reported no permanent employees.

21 Source: Bureau of Labor Statistics (BLS) employment status of the civilian noninstitutional population by sex, race, Hispanic or Latino ethnicity, marital status, and detailed age, 2014 annual averages. From: http://www.bls.gov/lau/table14full14.pdf

22 $44,678 according to May 2014 State Occupational Employment and Wage Estimate for Massachusetts, from: http://www.bls.gov/oes/current/oes_ma.htm#00-0000

INVESTMENTS

The highlight of investment news in 2014 was that Massachusetts led the per capita early-stage investment in the country ($69.3 million total, $10.28 per capita), outpacing clean energy stalwart California ($160 million total, $4.12 per capita) by 149% on a per capita basis.

FIGURE 11: DIFFICULTY FINDING QUALIFIED EMPLOYEES, CLEAN ENERGY (2014 & 2015)

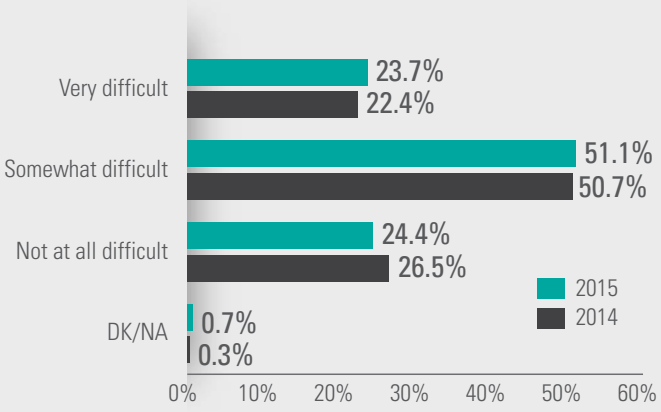
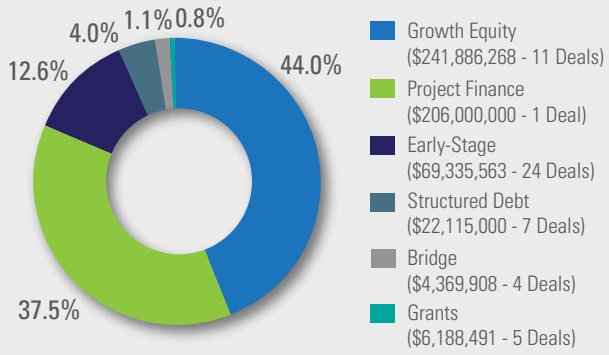


FIGURE 12: CLEAN ENERGY INVESTMENT 2014-2015



Investments were down otherwise in terms number of companies funded, number of deals and total number of dollars – 41 clean energy companies completed 52 deals totaling nearly $550 million (public and private) in 2014. In contrast, 55 clean energy companies completed 70 deals worth $859 million in 2013. Figure 12 breaks out investment by category.

Clean energy companies secured over $541 million in private investment (not including public investment) in 2014 as a result of 45 separate deals. Private investment was down over the previous high of $843 million in 2013 (Figure 13) but 26% above the 2010 level (Figure 14).

Public investment dollars for clean energy companies continued its downward trend in 2014, reaching $8.9 million in seven deals. The apex year of federal funding from the American Recovery and Reinvestment Act (see Figure 15) was 2011 at $162 million. Public investment in Massachusetts was 84% below the total reported in 2010 (Figure 16).[24]

Early-stage investment in clean energy companies surpassed $69 million between January 2014 and December 2014, as the result of 24 deals (see Figure 17). Despite strong numbers compared to other states, early-stage investment in 2014 was 69% below the 2010 level in Massachusetts (Figure 18), in contrast to a rebound in early stage investment in the U.S. and across the globe.

Energy efficiency establishments secured over half (57%) of all clean energy investment in Massachusetts in 2014. In 2014, 26 energy efficiency companies completed 35 deals for a total of nearly $313 million (Figure 19 breaks out this investment by category). Just over $232 million was invested in Massachusetts renewable energy companies in 2014. Investment was spread across 13 companies and was the product of 14 deals. Figure 20 illustrates the distribution of investment by type across renewable energy.

FIGURE 13: PRIVATE INVESTMENT 2005-2014 (DEALS AND DOLLAR AMOUNT), CLEAN ENERGY[23]

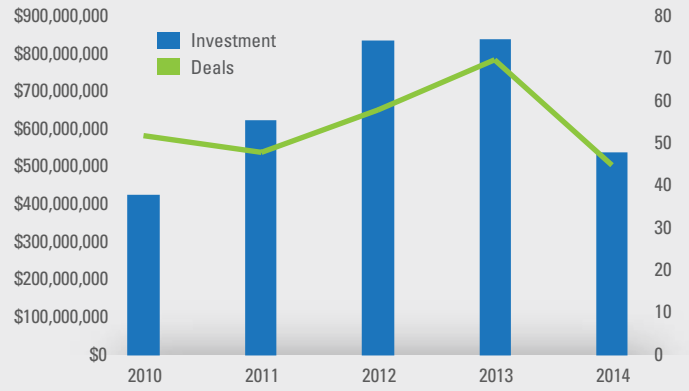


FIGURE 14: CHANGE IN PRIVATE INVESTMENT 2010-2014, CLEAN ENERGY (FROM 2010 BASELINE)

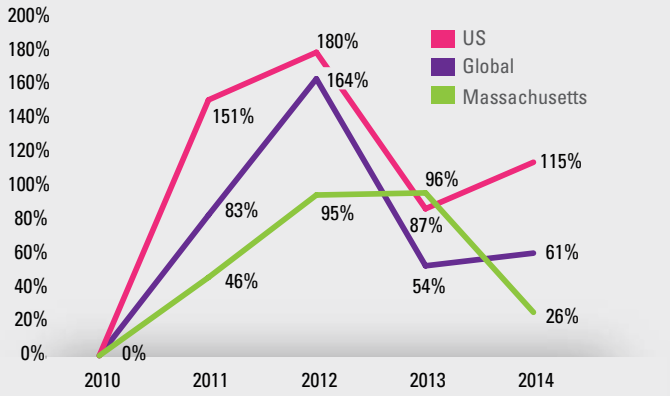


FIGURE 15: PUBLIC INVESTMENT 2010-2014 (DEALS AND DOLLAR AMOUNT), CLEAN ENERGY

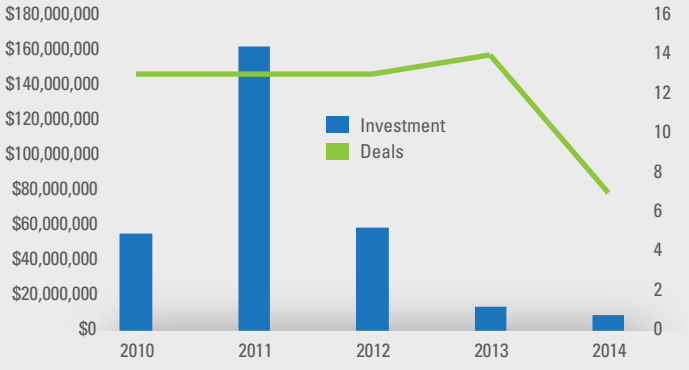
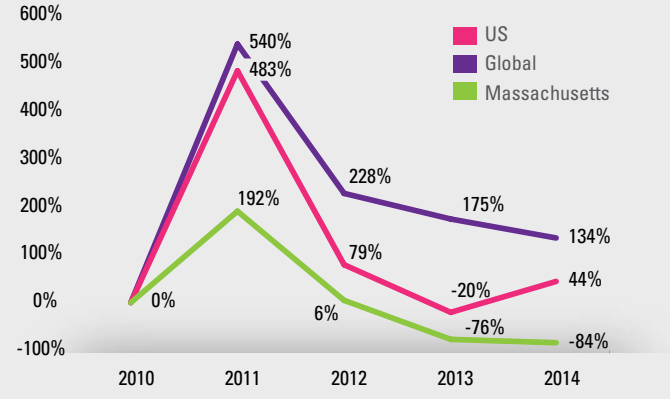


FIGURE 16: CHANGE IN PUBLIC INVESTMENT 2010-2014, CLEAN ENERGY (FROM 2010 BASELINE)



Despite falling from four deals in 2013 to one deal in 2014, project finance was the largest single investment category in 2014 and dominated the renewable energy investment (89% of all renewable energy investment). First Wind received $206 million in the first half of the year, which was the only recorded deal for project finance.[25]

The amount invested in energy efficiency was higher than 2013 but the number of deals completed in 2014 was lower than the deals in the last three years (see Figure 21). Figure 21 also displays total private investment and deals for renewable energy companies from 2010 through 2014. The number of deals in renewable energy has always been lower than energy efficiency and the amount of investment dropped below that of energy efficiency in 2014. The amount invested per deal in renewable energy for the same year was almost twice the amount invested per deal in energy efficiency.

Public investment in energy efficiency companies ($5.3 million) was also up in 2014 relative to 2013 ($4 million) and was spread over four deals. Renewable energy companies received $3.6 million in public investment over the course of three separate deals.

FIGURE 17: EARLY-STAGE INVESTMENT 2010-2014 (DEALS AND DOLLAR AMOUNT), CLEAN ENERGY

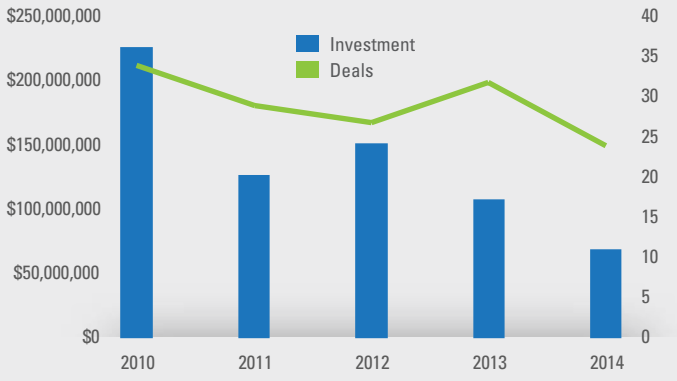


FIGURE 18: CHANGE IN EARLY-STAGE INVESTMENT 2010-2014, CLEAN ENERGY (FROM 2010 BASELINE)

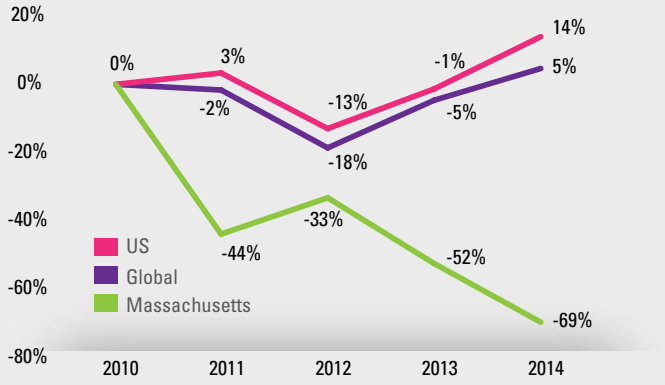


FIGURE 19: ENERGY EFFICIENCY INVESTMENT IN DOLLARS AND DEALS, 2014

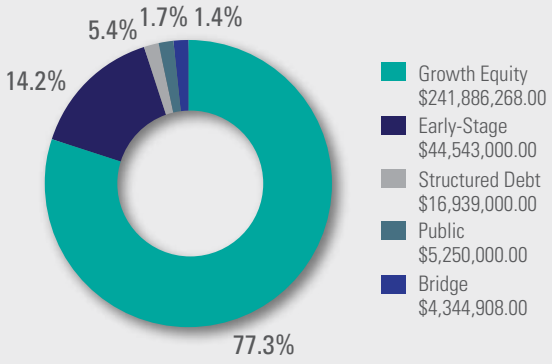
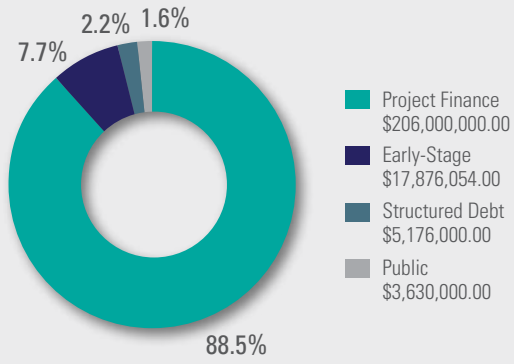


FIGURE 20: RENEWABLE ENERGY INVESTMENT IN DOLLARS AND DEALS, 2014



Early-stage investment in energy efficiency companies surpassed $44 million in the time period between January 2014 and December 2014 (Figure 22). Seed and Series A funding comprised seven deals worth approximately $10.5 million while Series B funding was responsible for 76% of all early-stage investment ($34 million) in Massachusetts over the same 12 months.[26]

Early-stage investment in renewable energy companies in Massachusetts totaled nearly $18 million in 2014 (Figure 22). Series B funding was responsible for the largest proportion (46%) of all early-stage investment ($8.2 million) in Massachusetts in 2014.

23 2012 Private investment excludes the 1,250,000,000 total for GreatPoint Energy.

24 These figures do not include MassCEC or other participatory public investments that are part of larger private deals.

25 Project Finance is the largest and fastest growing category of clean energy investment in the U.S. and abroad; i3 Cleantech Database. Project Finance typically does not apply to Energy Efficiency.

26 i3 Cleantech Massachusetts database, from: https://i3connect.com

FIGURE 21: PRIVATE INVESTMENT 2010-2014 (DEALS AND DOLLAR AMOUNT), ENERGY EFFICIENCY AND RENEWABLE ENERGY

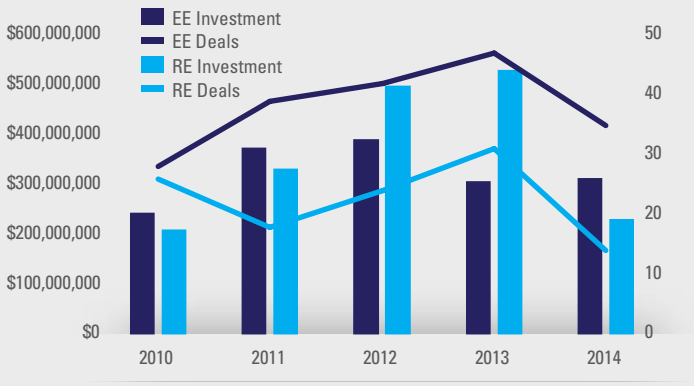
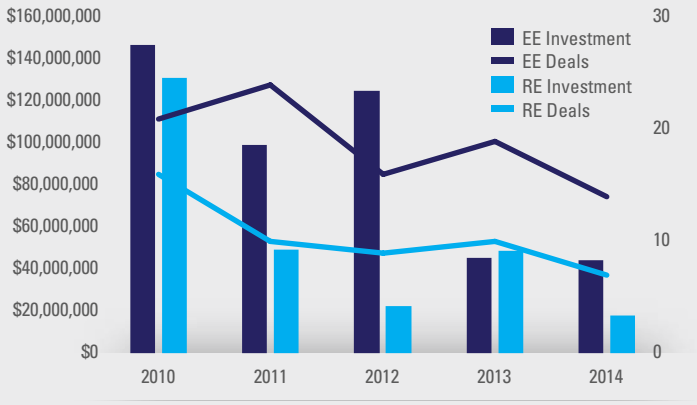


FIGURE 22: EARLY-STAGE INVESTMENT 2010-2014 (DEALS AND DOLLAR AMOUNT), ENERGY EFFICIENCY AND RENEWABLE ENERGY



INNOVATION

Compared to the rest of the country, Massachusetts has an oversized clean energy innovation economy.

The proportion of clean energy workers focused on R&D and engineering is higher in Massachusetts than any other state.

Innovation is an important catalyst for economic growth; companies focused on research, development and prototype manufacturing of new technologies pay high wages, attract foreign capital, and contribute to local ecosystems of vendors, suppliers and professional services.[27] As a result, innovation firms have greater economic multipliers than most traditional industries, meaning that growth of innovation firms tends to have a larger ripple effect on the overall statewide economy.

Massachusetts is home to approximately 498 private sector establishments that work on both pre-commercial and commercial products, that employ approximately 5,500 clean energy workers[29] and are either research and development, engineering or manufacturing firms. An additional 260 establishments work exclusively with pre-commercial products and employ more than 1,500 workers, most of whom are engaged in research and development. Massachusetts is also home to seven federal research academic institutions,[30] all of which conduct foundational or applied clean energy research within their campuses, employing hundreds of additional full-time employees, as well as faculty, graduate and undergraduate students. Just over a third of clean energy establishments derive all of their revenue from purely clean energy activity (Figure 23).

FIGURE 23: PERCENTAGE OF WORK ATTRIBUTED TO PRE-COMMERCIAL ACTIVITIES BY EARLY-STAGE ESTABLISHMENTS, CLEAN ENERGY

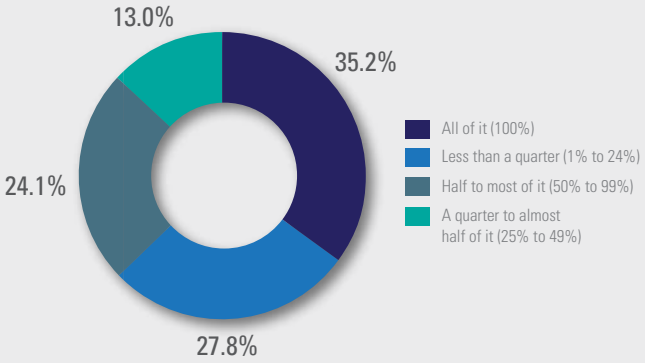
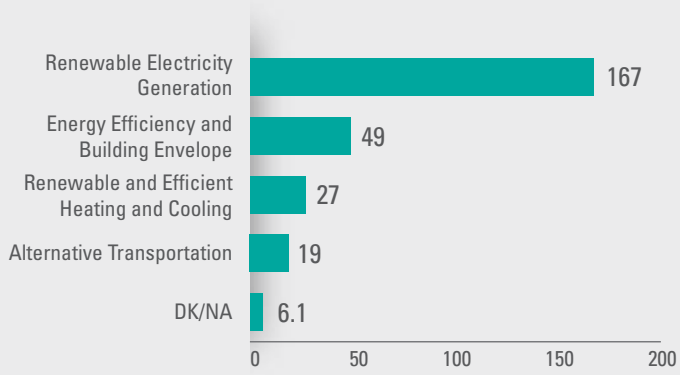


FIGURE 24: EARLY-STAGE ESTABLISHMENTS BY TECHNOLOGY IN MASSACHUSETTS, CLEAN ENERGY



The approximately 760 private sector establishments, as well as the academic research centers that work on pre-commercial products, represent only a fraction of the number of establishments and workers that are supported by these innovation activities both within and outside the clean energy industry. Innovation firms require significant inputs of professional services such as consulting, accounting, legal, finance and other knowledge-based jobs, which are in abundant supply in the Commonwealth.[31] They also serve as catalysts for additional innovative activities by creating a technology and talent driven ecosystem within the state.[32] As seen in Figure 24, the majority of early-stage clean energy establishments are working with pre-commercial products related to renewable energy.

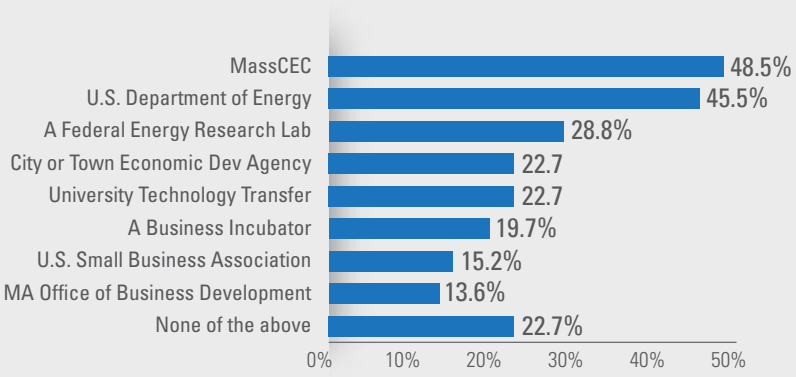
For the first time in 2015, this report includes data on patents, drawn from the U.S. Patent and Trademark Office PAIR system and Cleantech's i3 Data Platform.[33] Among the firms that work with pre-commercial products, 36 firms have been awarded a total of 417 patents. Twenty-six purely pre-commercial clean energy companies in Massachusetts own patents, and 20 of these are "pure-play," or clean energy-only establishments.

Clean energy establishments involved in pre-commercial activities reported working with several different types of business or industry organizations, including MassCEC and DOE (Figure 25).

More than half of companies involved in pre-commercial activities (53.0%) indicated that they need to obtain or generate product performance data in a lab or operational environment in order to achieve their commercialization objectives. Of these, 54.3% of establishments would seek to obtain these data in a state or regional testing lab or certification facility.

From a technology perspective, firms primarily focused on energy efficiency[34] in Massachusetts have a variety of establishments focused on innovation, with approximately 70 establishments in the Commonwealth working exclusively on the development, design or production of pre-commercial products and with a primary focus on energy efficiency. These private sector establishments

FIGURE 25: RESOURCES CONSULTED BY PRE-COMMERCIAL ENTERPRISES, CLEAN ENERGY



employ nearly 500 clean energy workers as of May 2015. In addition, there are at least another 150 energy efficiency establishments working on both commercially available and pre-commercial goods.

Energy efficiency firms hold many patents, with 54% of all of the identified patents held by clean energy companies in Massachusetts. The research discovered at least 229 patents held by firms focused on energy efficiency activities.[35] Establishments engaged only in clean energy work in the efficiency sector (i.e., "pure-play" companies) hold 142 of these patents.

Renewable energy establishments that were identified for this research study hold 131 patents in Massachusetts, 35.5% of all clean energy establishment patents in the state; 25 patents are held by establishments that work exclusively with clean energy goods and services.

27 See generally, Moretti, Enrico, The New Geography of Jobs (Houghton Mifflin Harcourt, 2012).

28 See Id.

29 Among establishments that work with any pre-commercial products, about 60% spend a majority of their time focused on developing new products.

30 Defined as receiving an average of $50m or more in annual federal funding. https://ncsesdata.nsf.gov/profiles/site?method=rankingBySource&ds=fss

31 Bureau of Labor Statistics Quarterly Census of Employment and Wages.

32 See generally, http://www.brookings.edu/reports/2011/0713_clean_economy.aspx

33 Patent data in this year's report includes only those patents held by private establishments that meet the report's definition of clean energy; university and non-profit patent holders are excluded from this analysis.

34 Because of the early-stage nature of these businesses, it is not possible to delineate between those working on heating and cooling versus building controls, so this chapter includes data on innovation establishments primarily focused on saving energy.

35 Total patents from energy efficiency establishments from 1998-2014.

AEGIS ENERGY SERVICES, INC.

COMPANY LOCATION: Holyoke

NUMBER OF MASSACHUSETTS EMPLOYEES: 50

Aegis Energy Services provides commercial combined heat and power (CHP) systems for a variety of facilities seeking sustainable, clean power options. Aegis uses modular systems that reduce both energy costs and emissions for a wide variety of customers in the Northeast and Mid-Atlantic regions including healthcare and assisted living facilities, recreational and multi-unit residential complexes and hotels.

REGIONAL HIGHLIGHTS

"Clean energy establishments exist in every county of Massachusetts"

- One year after being the only region in Massachusetts to show no clean energy employment growth, Central Massachusetts saw strong growth in both the number of clean energy establishments and employment totals. The growth in Central Massachusetts is largely due to an increased number of traditional-economy establishments starting to work with clean energy goods and services for the first time in 2015.
- After four years of steady growth, Western Massachusetts saw flattening employment growth (2.7%) over the last 12 months. Western Massachusetts has the highest density of clean energy employment (as a ratio of total jobs in the region).
- Most of the clean energy innovation activity is happening in the Northeast, which includes greater Boston.
- Investment deals and dollars, initial public offerings (IPOs) and patent activity is largely concentrated from Worcester, east to Boston.
- Middlesex County has the most clean energy establishments and jobs, followed by Suffolk and Norfolk counties, respectively.
- More than half of the clean energy workforce is based in Suffolk and Middlesex counties.
- Clean energy investment, IPOs and patents are heavily concentrated in Eastern Massachusetts.

EMPLOYMENT AND ESTABLISHMENTS BY COUNTY

Over one-third of total Massachusetts clean energy employment (35.3%) and just over 30% of clean energy establishments (30.5%) are concentrated in Middlesex County. As shown in Table 4, Suffolk County has the next highest number of employees (15,712) and establishments (783), followed by Norfolk County (8,745 employees, 644 establishments).

TABLE 4: CLEAN ENERGY EMPLOYMENT AND ESTABLISHMENTS BY COUNTY, 2015

COUNTY	Clean Energy Establishments	Clean Energy Employment
BARNSTABLE	265	3,582
BERKSHIRE	143	1,947
BRISTOL	402	4,804
DUKES	40	576
ESSEX	617	8,174
FRANKLIN	77	1,347
HAMPDEN	351	4,708
HAMPSHIRE	140	2,442
MIDDLESEX	1,965	34,917
NANTUCKET	25	165
NORFOLK	644	8,745
PLYMOUTH	370	3,441
SUFFOLK	783	15,712
WORCESTER	616	8,335
TOTAL	**6,439**	**98,895**

EMPLOYMENT AND ESTABLISHMENTS BY REGION

Northeastern Massachusetts experienced the fastest growth among all regions in both employment (16.8%) and number of establishments (10.2%). Central Massachusetts rebounded from no growth between 2013 and 2014 to post an overall employment gain of 13.6% in the last year. Western Massachusetts grew five years in a row but underwent the slowest employment growth among the four regions from 2014 to 2015 (2.7%). Its overall establishment total declined by two percent.

CENTRAL MASSACHUSETTS

Electrical Efficiency and Building Envelope is concentrated at a higher rate (60.1%, as seen in Figure 28) in Central Massachusetts when compared to the other regions in Massachusetts. As shown in Figure 29, Central Massachusetts installation jobs make up the largest portion of clean energy employment. Only Western Massachusetts has a higher proportion of installation jobs.

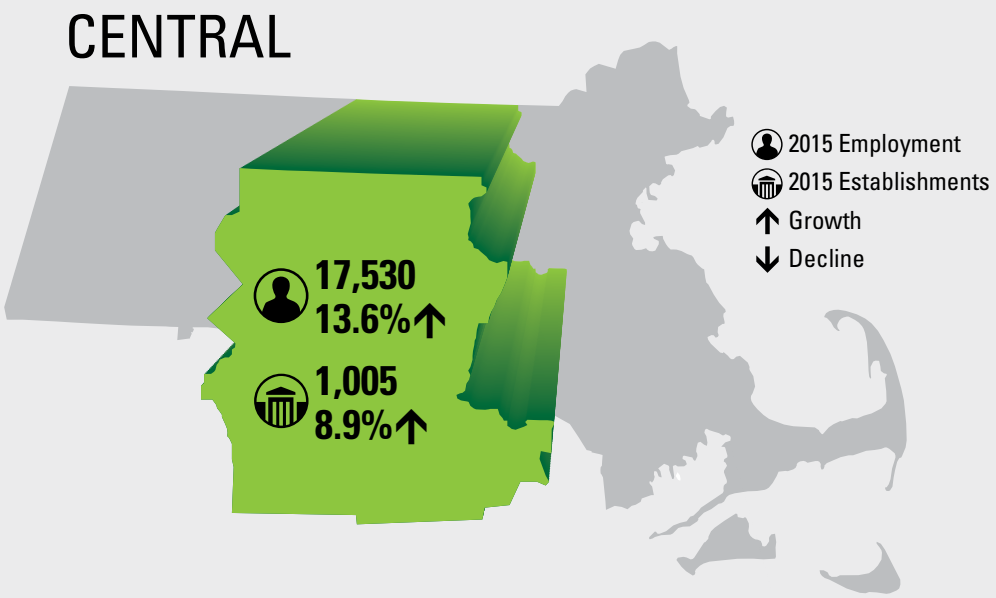


FIGURE 28: EMPLOYMENT BY TECHNOLOGY, CENTRAL REGION

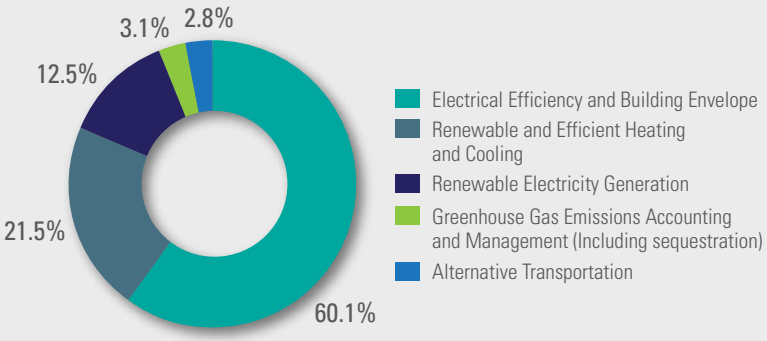
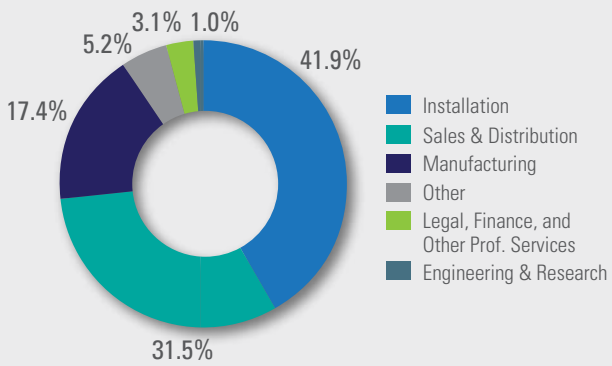


FIGURE 29: EMPLOYMENT BY ACTIVITY, CENTRAL REGION



NORTHEASTERN MASSACHUSETTS

Clean energy establishments in Northeastern Massachusetts have the majority of their employment involved in Electrical Efficiency and Building Envelope (48.8%, as shown in Figure 30) and Renewable Electricity Generation (37.6%) technologies, whereas employment by activity is more spread out (Figure 31).

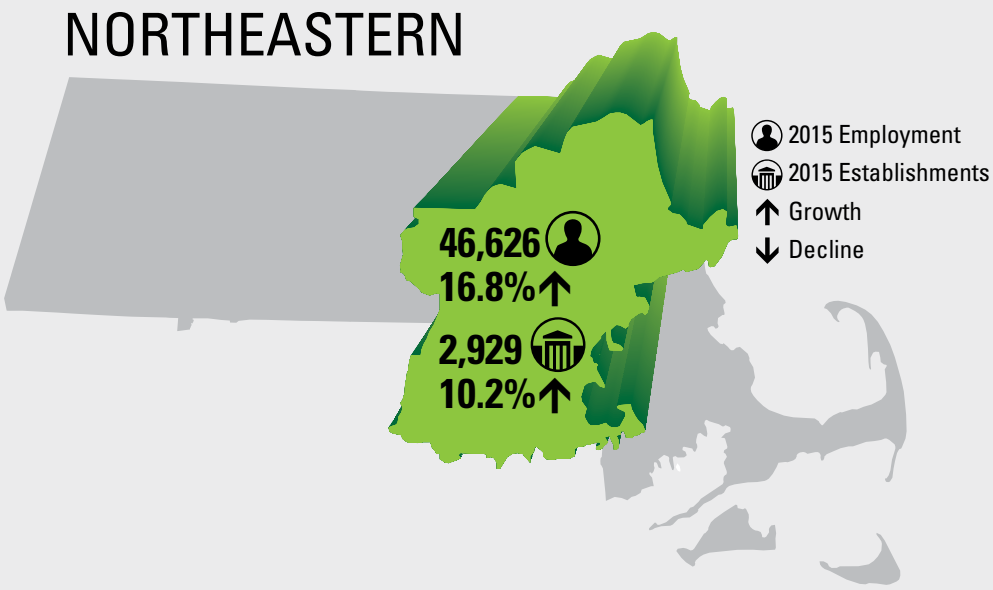


FIGURE 30: EMPLOYMENT BY TECHNOLOGY, NORTHEASTERN REGION

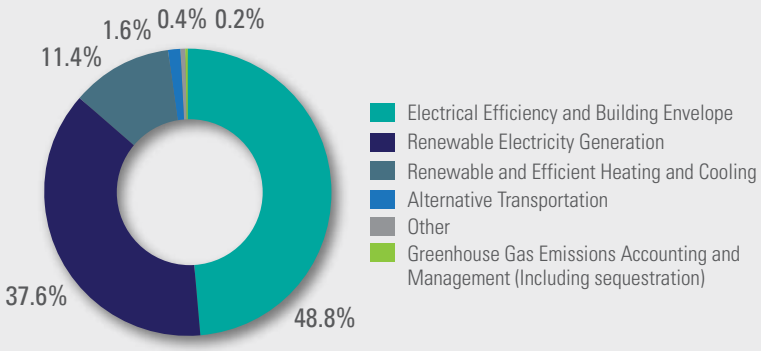
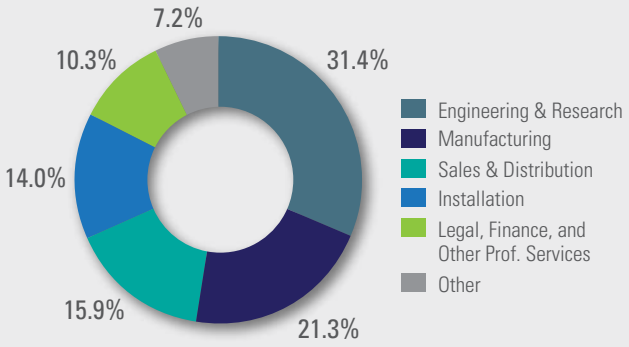


FIGURE 31: EMPLOYMENT BY ACTIVITY, NORTHEASTERN REGION



SOUTHEASTERN MASSACHUSETTS

More than half of clean energy employment in Southeastern Massachusetts is within Renewable and Efficient Heating and Cooling (50.5%, as shown in Figure 32), the highest of any region in the state. Clean energy sales and distribution employment is also at its highest concentration in Southeastern Massachusetts comparatively (58.7%, as shown in Figure 33).

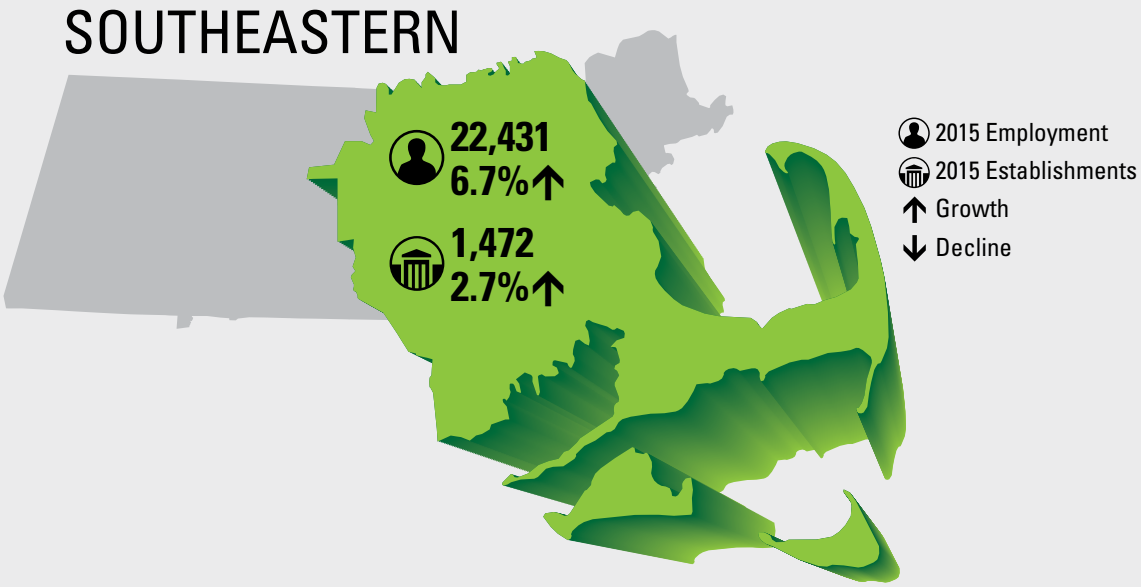


FIGURE 32: EMPLOYMENT BY TECHNOLOGY, SOUTHEASTERN REGION

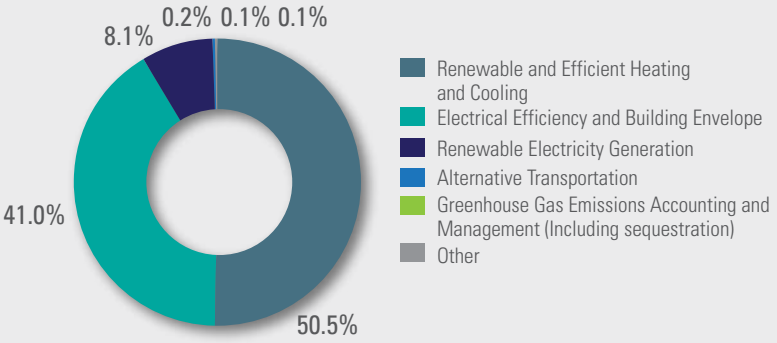
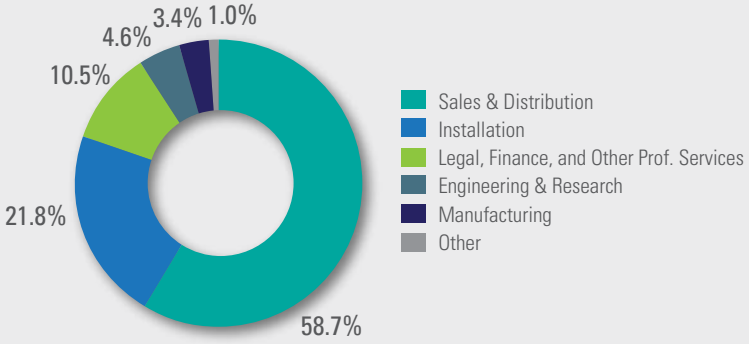


FIGURE 33: EMPLOYMENT BY ACTIVITY, SOUTHEASTERN REGION



WESTERN MASSACHUSETTS

Electrical Efficiency and Building Envelope workers are employed at the highest concentration in Western Massachusetts (42.5%, as shown in Figure 34) by clean energy establishments. Installation employees make up the largest proportion of clean energy employment in the region (45.9%, as shown in Figure 35).

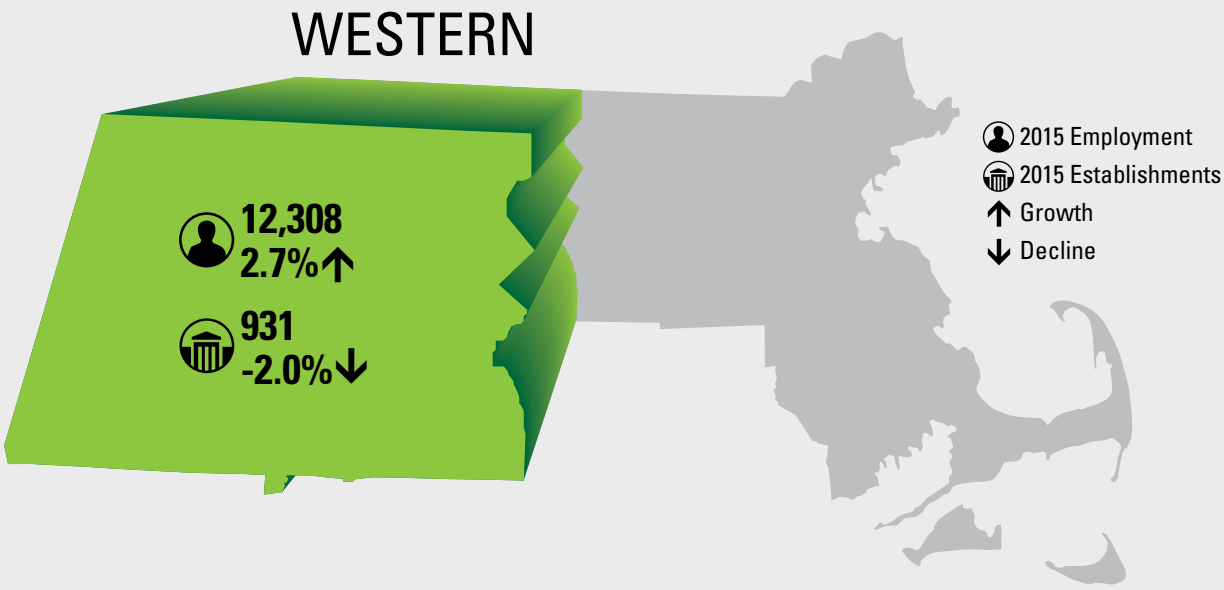


FIGURE 34: EMPLOYMENT BY TECHNOLOGY, WESTERN REGION

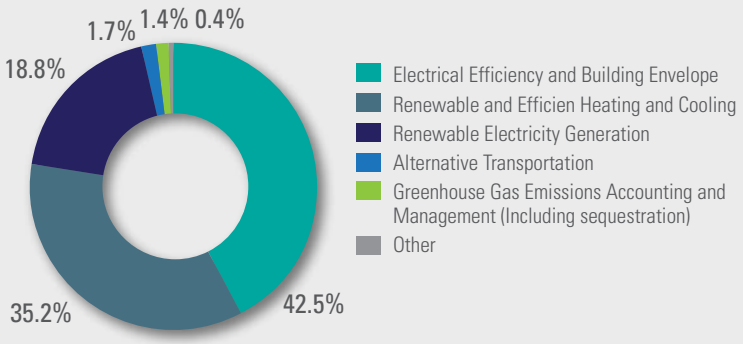
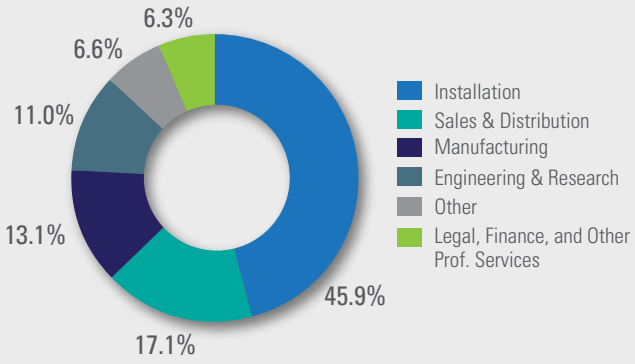
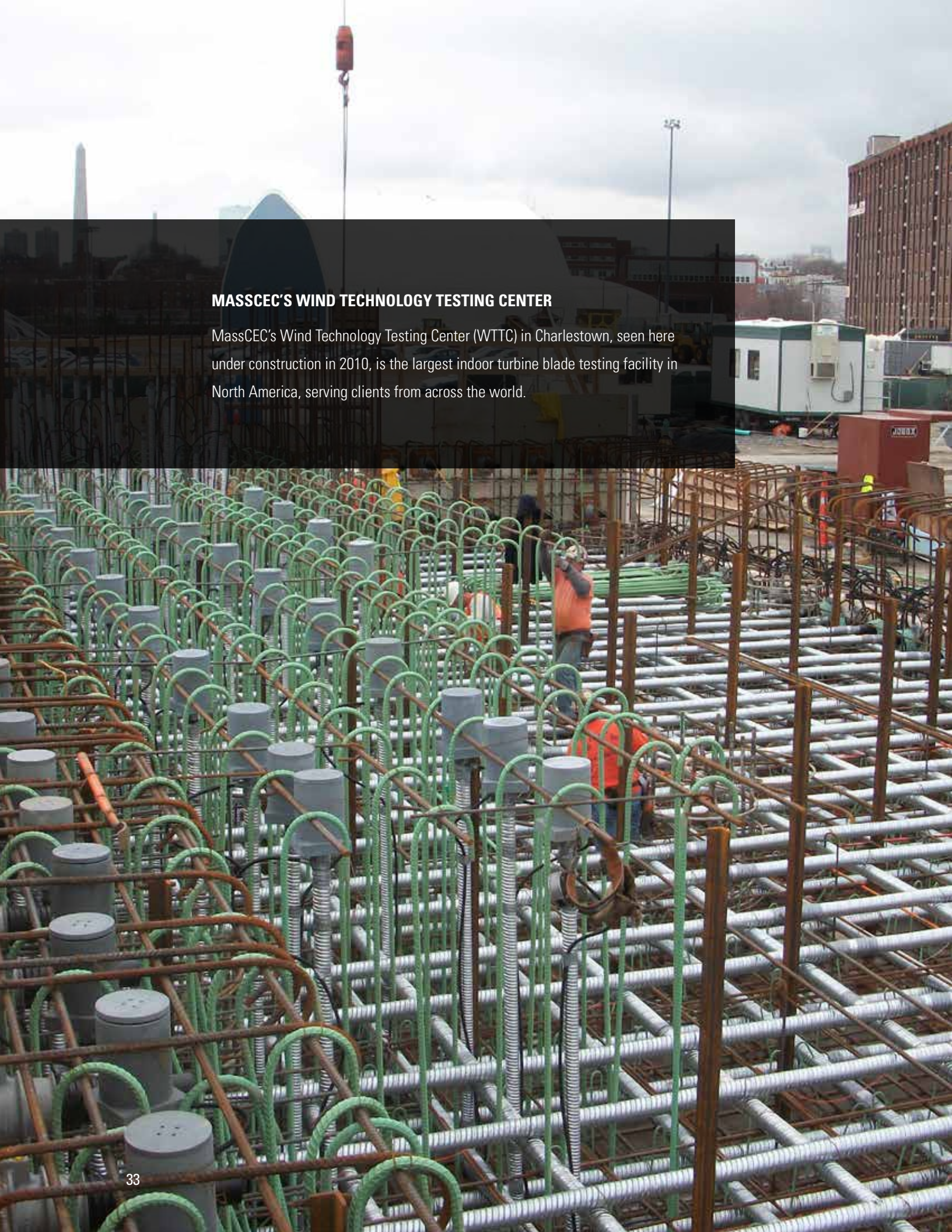


FIGURE 35: EMPLOYMENT BY ACTIVITY, WESTERN REGION





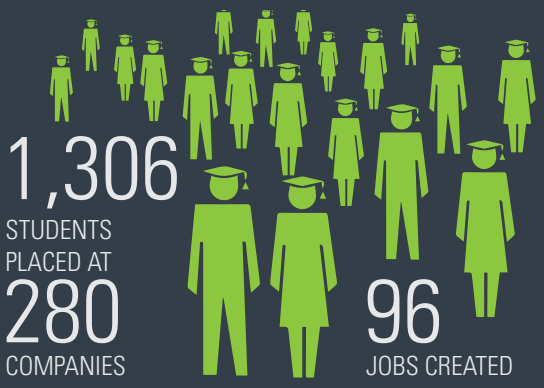
MASSCEC'S WIND TECHNOLOGY TESTING CENTER

MassCEC's Wind Technology Testing Center (WTTC) in Charlestown, seen here under construction in 2010, is the largest indoor turbine blade testing facility in North America, serving clients from across the world.

CREATING JOBS AND TALENT PIPELINE

THE WIDE RANGE OF *MASSCEC WORKFORCE DEVELOPMENT PROGRAM*S BRINGS AWARENESS OF CLEAN ENERGY EMPLOYMENT OPPORTUNITIES TO HELP JOB SEEKERS OF ALL BACKGROUNDS OBTAIN CLEAN ENERGY JOBS IN MASSACHUSETTS.

One of MassCEC's most popular programs is its **Clean Energy Internship Program**. Designed to help train a qualified clean energy workforce, the program has placed 1,306 students in internships with 280 different clean energy employers across the state since its inception in 2011. From July 2014 to June 2015, a record 2,361 students applied to the program, with 421 students gaining internships at 167 unique employers. During that time, 33% of all placed interns were pursuing engineering degrees, 21% were business majors and 16% were studying the natural sciences. 39.5% of all placed interns in fiscal year 2015 were women, a greater proportion than the industry average. The internship program provides valuable support to small businesses of all sectors, with 63.5% of all participating companies during that time period employing fewer than 10 workers. Most interns – 40% of all placements over that period – worked at renewable energy companies with 35% at energy efficiency companies.



MassCEC also maintains a **Clean Energy Jobs Board** (www.masscec.com/jobs) for job seekers and clean energy employers, which receives about 2,000 views per month. Employers can post available full and part-time positions to find the talent that they need in order to grow their workforces in Massachusetts.

As part of the effort to build a robust clean energy workforce pipeline, in 2014 MassCEC launched the **Learn and Earn Program**, which funded projects at Brockton High School, Greater Lawrence Vocational Technical-High School and Northeastern University. Through the program, 84 high-school students were employed and received training with Advanced Placement curriculum focused on clean energy.

Launched in 2015, MassCEC's **Successful Women in Clean Energy (SWICE)** program will prepare qualifying low and moderate-income women for clean energy positions in sales and business management. The individuals trained will be placed into six-month paid fellowships at Massachusetts clean energy companies.

MENCK WINDOWS

COMPANY LOCATION: Chicopee

NUMBER OF MASSACHUSETTS EMPLOYEES: 15

Menck Windows manufactures energy-efficient windows, doors and curtain walls for residential, commercial and institutional buildings. In manufacturing custom energy and heat efficient products in either wood or wood with aluminum cladding, Menck has imported both product technology and manufacturing technology from its joint venture partner, Menck Fenster of Hamburg, Germany.

ELECTRICAL EFFICIENCY & BUILDING ENVELOPE

Previous Massachusetts Clean Energy Industry Reports used a broad definition of energy efficiency, which included technologies focused on saving electricity (e.g., LED light bulbs), enhancing the building envelope (e.g. insulation and weatherization) and generating heat or cooling by using less energy (e.g. high-efficiency boilers and furnaces).[36] For the first time, this year's report disaggregates the data for technologies focused on Electrical Efficiency and Building Envelopes from Renewable and Efficient Heating and Cooling. The remainder of this chapter, unless otherwise specified, includes data on Electrical Efficiency and Building Envelope activities, which excludes efficient heating and cooling technologies.[37]

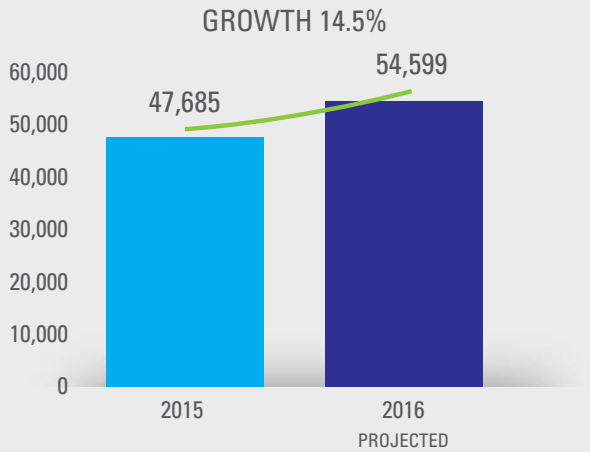
SUMMARY

Electrical Efficiency and Building Envelope jobs reached 47,685 workers in 2015 – making it the largest clean energy technology employer in the state. These employees work in retrofitting and retrocommissioning, storage and demand response services, among others. Employers primarily engaged in Electrical Efficiency and Building Envelope (at approximately 1,700 locations) work expect to increase employment by 14.5% over the next 12 months, or approximately 6,900 additional employees.

Data from 2012 through 2014 indicate that both deployment activity and the economic impact of energy efficiency retrofits are poised to rise faster than employment growth (see Figure 36). Clear and increasing demand for energy-efficient products coupled with continued research and innovation will likely support continued employment gains and increased economic contribution to the Commonwealth's economy.

Figure 37 demonstrates the relative growth of four key metrics: employment, deployment, innovation and economic impact. Each index is derived from the annual change in variables for each segment (such as employment, patents, early-stage investments and contribution to Gross State Product); they have been weighted to allow for meaningful comparison.[38]

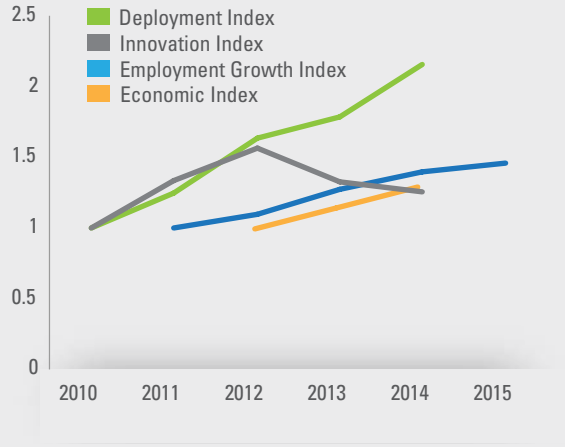
FIGURE 36: ELECTRICAL EFFICIENCY AND BUILDING ENVELOPE PROJECTED GROWTH, 2015-2016



Electrical Efficiency and Building Envelope deployment has grown at a rate nearly double that of employment growth; the sector has added thousands of jobs and businesses over the past five years, and workers are now installing double the measures per person than in 2010. This suggests either that energy efficiency workers have become more productive by driving greater productivity within their workforce through worker efficiency, technological advances or a combination of factors. At the same time, innovation activity has shown volatility. The dramatic peaks and valleys are typical of early-stage, research and development focused companies. Yet despite these trends, innovation activity overall is 20% greater than in 2010.

36 Lighting, HVAC and building controls, energy-efficient appliances, energy- efficient processes and machinery, energy storage, demand response services, smart grid, weatherization services, energy-efficient building materials, water and wastewater technologies related to conserving energy or energy efficiency.

FIGURE 37: ELECTRICAL EFFICIENCY AND BUILDING ENVELOPE INDICES 2010-2015



37 For a breakdown of sub-technologies, refer to Table 7. Because data on innovation activities is limited to the previous definition of energy efficiency, and data is limited for Electrical Efficiency and Building Envelope, this chapter does not include an innovation section.

38 See the Methodology Appendix for additional information.

DEPLOYMENT

As Electrical Efficiency and Building Envelope (EEBE) markets expand across the United States,[39] installation and production of EEBE products and services in the Commonwealth mirrors nationwide growth. The MassSave Program, a rate-payer funded initiative sponsored by gas and electric utilities and energy efficiency service providers, notes marked growth in energy efficiency consumers. Between 2010 and 2014, participating customers have grown by 270%, with nearly 31% of growth occurring in the last year. Simultaneously, MassSave incentives and annual megawatt hour savings have increased in dollar value.[40]

In just the first year of the Statewide Three-Year Energy Efficiency Plan (2013-2015), MassSave surpassed its participation goal by 20%, accumulating 3 million residential participants. As of 2013, electrical savings are enough to fuel 146,900 homes per year, while natural gas savings heat approximately 26,200 homes.[41]

Residential homes built to either Energy Star standards or the 2006 Stretch Code[42] show compliances rates of over 90%, while IECC 2006 homes have compliance rates of over 80%. Of the 140 municipalities that have adopted the 2009 Stretch Code, compliance is estimated to be close to 100%.[43]

39 http://www.iea.org/Textbase/npsum/EEMR2013SUM.pdf

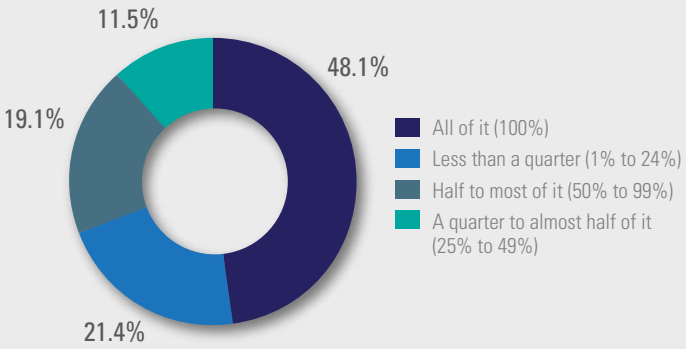
40 http://masssavedata.com/Public/Home.aspx

41 Energy Efficiency Sets the Stage for Sustainable, Long-Term Savings, MA EEAC; http://www.mass.gov/eea/docs/doer/energy-efficiency/eeac-annual-report-2013.pdf

42 The Stretch Code is optional for municipalities that wish to achieve 20% more energy efficiency than the base IECC code.

43 ACEEE State Energy Efficiency Scorecard 2014, Massachusetts, Buildings; http://database.aceee.org/state/massachusetts

FIGURE 38: ESTABLISHMENT REVENUE ATTRIBUTED TO CLEAN ENERGY, ELECTRICAL EFFICIENCY AND BUILDING ENVELOPE



GSP AND REVENUES

The Electrical Efficiency and Building Envelope sector contributes $3.2 billion to GSP, or approximately 29% of the total clean energy contribution to the state's economy. This is largely due to the high concentration of export establishments in manufacturing, research and development and engineering.

Figure 38 shows that more than two-thirds of establishments conducting Electrical Efficiency and Building Envelope work in Massachusetts earn a majority of their revenues from clean energy activities and almost half (48%) earn all their revenue from clean energy goods and services.

JOBS & BUSINESS GROWTH

Electrical Efficiency and Building Envelope establishments also reported the diversity of their employees and new hires. Ethnic or racial minorities accounted for nearly a quarter (23.9%) of new hires over the last 12 months by Electrical Efficiency and Building Envelope establishments in Massachusetts (Table 6).

TABLE 6: DEMOGRAPHICS OF CURRENT WORKFORCE AND RECENT HIRES, ELECTRICAL EFFICIENCY AND BUILDING ENVELOPE

	% of Current Workforce	% of Recent Hires	% of MA Workforce
Women	20.9%	19.5%	48.0%
Ethnic or Racial Minorities	15.0%	23.9%	15.1%
Veterans of the U.S. Armed Forces	4.6%	7.5%	n/a
55 and Over	14.4%	3.3%	16.0%

67%
OF NEW HIRES

EARN BETWEEN
$50,001-$125,000
PER YEAR

New hires are paid well above the median wage in Massachusetts, with 67% of new hires earning between $50,001-$125,000 per year. Fewer than 5% of Electrical Efficiency and Building Envelope workers earn less than $13.50 per hour, which is significant given that the

living wage in Massachusetts for a single adult is $12.60 per hour[44] (see Figure 39).

Employers report significant and growing difficulty finding qualified applicants to meet their needs; 36% report significant difficulty and 92% report some difficulty. This level of difficulty rose significantly since 2014 and is higher than the difficulty faced by the industry overall (Figure 40 and Figure 41).

Perhaps due to their difficulty, employers noted one out of every five positions that they attempted to fill in Massachusetts went either unfilled or were filled by out of state residents. As these positions become more difficult to fill, Electrical Efficiency and Building Envelope employers seem willing to hire applicants with less experience, reporting this year that only 56.7% of new hires had previous experience related to the position, compared to over 70% in 2014. While employers were not asked directly about their reasons for seemingly requiring less experience, it appears that as the unemployment rate drops and the pool of available applicants shrinks, employers are willing, or are forced, to accept workers with fewer qualifications. Statewide unemployment dropped 1.1% to 4.7% from April 2014 to April 2015, which is the most plausible explanation for the lower experience levels of new hires in the industry.

Of interesting note, Electrical Efficiency and Building Envelope (Figure 41) establishments were most active

FIGURE 39: FULL-TIME PERMANENT WORKER PAY RANGE, ELECTRICAL EFFICIENCY AND BUILDING ENVELOPE

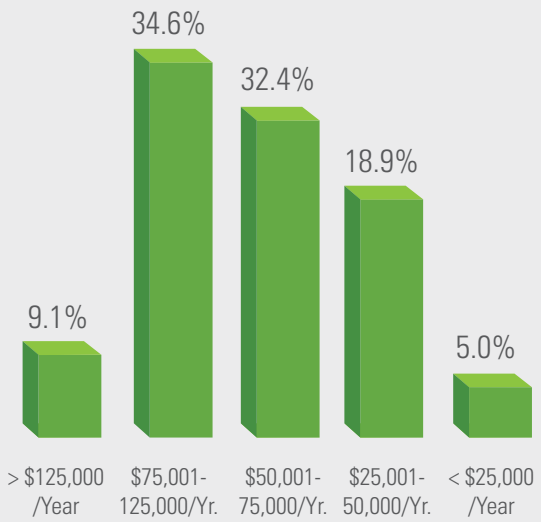


FIGURE 40: DIFFICULTY FINDING QUALIFIED EMPLOYEES, ELECTRICAL EFFICIENCY AND BUILDING ENVELOPE (2014 & 2015)[45]

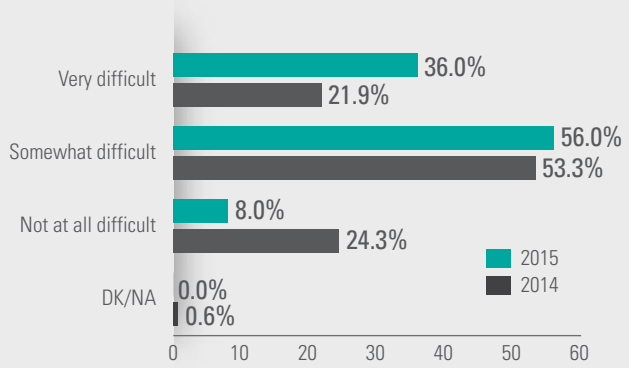
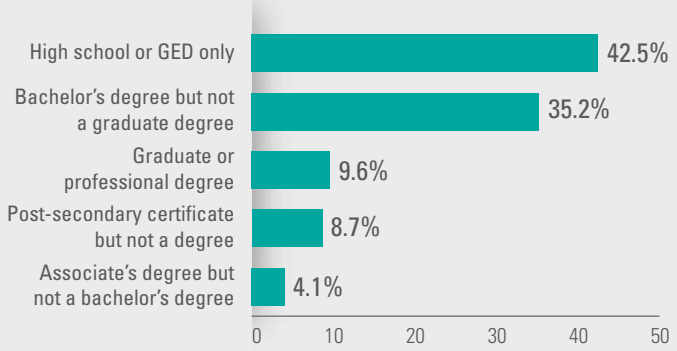


FIGURE 41: EDUCATION ATTAINMENT FOR RECENT HIRES, ELECTRICAL EFFICIENCY AND BUILDING ENVELOPE



hiring people with either a high school diploma (42.5%, more than overall industry numbers), or a bachelor's degree (35.2%). 9.6% had a master's or graduate or professional degree. At 12.8%, community colleges and other short-term vocational programs still do not seem to be filling a major need for Electrical Efficiency and Building Envelope employers in Massachusetts.

Electrical Efficiency and Building Envelope workers are primarily focused on clean energy work, with 86.3% reported to spend a majority of their time focused on clean energy related tasks, and 80.4% spending all of their time on clean energy work.

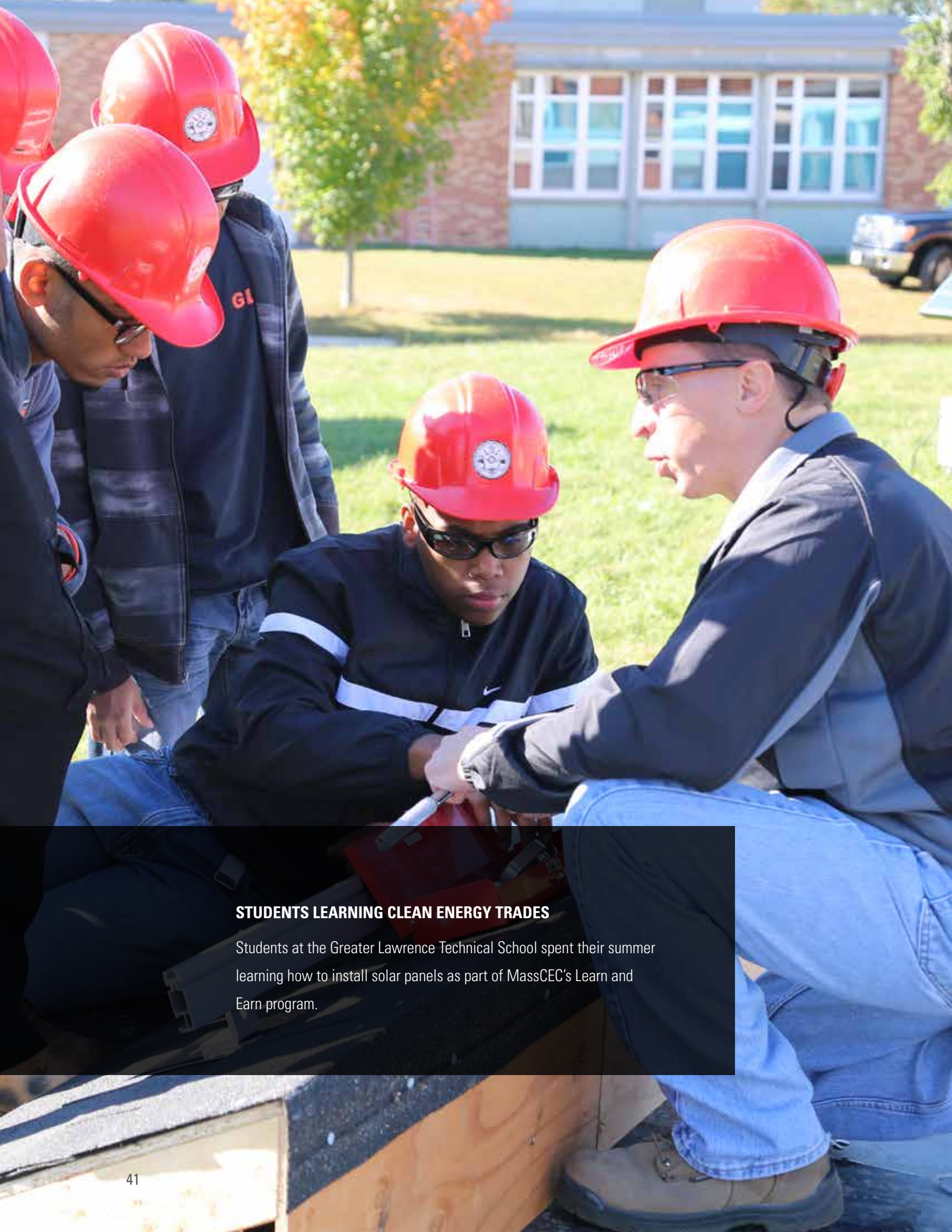
Most Electrical Efficiency and Building Envelope jobs and establishments are focused on retrofitting and retrocommissioning (Table 7). The establishments work across the entire supply chain, from early-stage research and development through installation and maintenance. As Table 8 below illustrates, nearly 31% of employment in the sector is concentrated in installation (14,638 employees), with manufacturing representing the second-largest segment by employment (17.9%). The majority of the businesses are small, with 83.8% having fewer than 50 employees (Figure 42). Not surprisingly given the number of small establishments, nearly all (92.4%) are reported to be privately-owned establishments.

TABLE 7: ELECTRICAL EFFICIENCY AND BUILDING ENVELOPE (EEBE) JOBS AND BUSINESSES BY SUB-TECHNOLOGIES

SUB-TECHNOLOGY	2015	2015 % of EEBE Emp	2015 Estabs[46]
Energy Efficiency Upgrades to Existing Buildings (Retrofitting and Retrocommissioning)	38,043	79.8%	3,717
Energy Storage	3,717	7.8%	370
Demand Response Services	634	1.3%	253
Smart Grid (Smart Computing/ Software)	3,015	6.3%	359
Water and Wastewater Technologies Related to Conserving Energy	1,013	2.1%	465
Other	1,265	2.7%	634

TABLE 8: ELECTRICAL EFFICIENCY AND BUILDING ENVELOPE JOBS AND BUSINESSES BY ACTIVITY

SUPPLY CHAIN ACTIVITY	2015 Jobs	% of 2015 Jobs	2015 Estabs	% of 2015 Estabs
Manufacturing	8,526	17.9%	163	8.3%
Engineering & Research	7,731	16.2%	226	11.5%
Sales & Distribution	7,342	15.4%	286	14.5%
Installation	14,638	30.7%	820	41.8%
Legal, Finance, and Other Prof. Services	6,065	12.7%	261	13.3%
Other	3,382	7.1%	207	10.5%



STUDENTS LEARNING CLEAN ENERGY TRADES

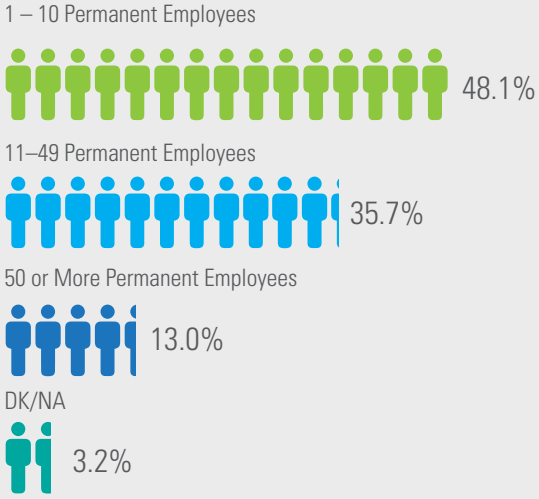
Students at the Greater Lawrence Technical School spent their summer learning how to install solar panels as part of MassCEC's Learn and Earn program.

44 http://livingwage.mit.edu/states/25 (Massachusetts Institute of Technology Living Wage Calculator)

45 2014 difficulty is based on the energy efficiency technology category from the previous year (2014).

46 Establishment totals indicate locations that are involved in each specific Energy Efficiency and building envelope sub-technology, therefore establishment totals overlap among categories.

FIGURE 42: ELECTRICAL EFFICIENCY AND BUILDING ENVELOPE PERMANENT EMPLOYMENT



POLICY ENVIRONMENT

Multiple clean energy studies illustrate that states ambitious energy efficiency standards and high ACEEE ranking show equally strong employment growth in the sector.[47] For five consecutive years, Massachusetts has ranked number one in the nation for successful energy efficiency policies and programs.[48] The state passed stringent standards for public buildings and fleets, benchmarks energy use and mandates energy savings performance contracts. State-operated buildings must reduce overall energy consumption by 35% by 2020, while newly constructed state buildings and renovations are required to meet the Massachusetts LEED Plus building standard and perform 20% better than the 2012 base energy code.

Massachusetts was the first state to allow municipalities to adopt the Stretch Code. As of June 2015, 156 cities have adopted the 2012 Stretch Code. The Board of Building Regulations and Standards and DOER provide free energy efficiency training for building officials.[49]

47 http://cleanjobsmissouri.com; http://www.masscec.com/content/2014-clean-energy-industry-report; http://info.aee.net/hs-fs/hub/211732/file-2173902479-pdf/PDF/aeei-california-advanced-energy-employment-survey-fnl.pdf; http://www.cleanjobsflorida.com; http://www.cleanjobsillinois.com

48 ACEEE State Energy Efficiency Scorecard 2015; http://database.aceee.org/state/massachusetts

49 http://www.mass.gov/eea/energy-utilities-clean-tech/energy-efficiency/policies-regs-for-ee/building-energy-codes.html

SOLAR ARRAY

A solar electric installation on a capped landfill in Methuen.

RENEWABLE ELECTRICITY GENERATION

Renewable Electricity Generation includes solar (PV or photovoltaic), wind power (onshore and offshore), low-impact[50] hydropower or hydrokinetic (river, wave, tidal), biomass (landfill gas, biogas, anaerobic digestion, woody biomass) and other related subtechnologies.

SUMMARY

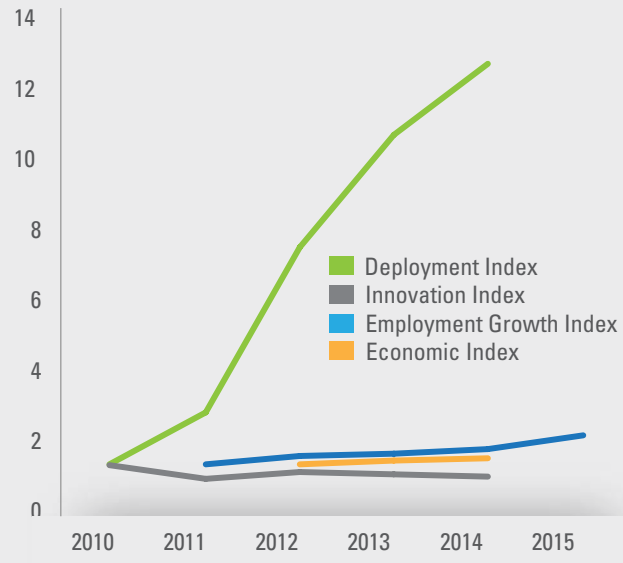
Renewable Electricity Generation, which includes utility-owned electricity generation as well as private distributed generation sources, contributes over $5.01 billion to Gross State Product. About 62% of the 2,627 establishments in Massachusetts derive all of their revenue from Renewable Electricity Generation activities. Renewable Electricity Generation establishments support 23,658 jobs, a 28% employment increase since 2014. Nearly all renewable electricity employees earn greater than $25,000 per year with 74% of the workforce earning more than $50,000 a year.

Figure 43 below illustrates the growth in activity by several key metrics, including deployment, economic impacts, innovation and employment growth. Each index is derived from the annual change in specific activities, including employment growth, installed projects, patents and investment deals and amounts.

Massachusetts has experienced massive growth in deployment of Renewable Electricity Generation. Installation activity was 12 times greater in 2014 than in 2010. Although Renewable Electricity Generation employment has nearly doubled since 2011, growth in the number and size of installations has far outpaced employment.

The interplay between the deployment and employment metrics is indicative of rapid and substantial efficiency gains among employers. Some contributing factors to the increased efficiency are likely advances in technology, business processes and on-site labor efficiency. The data clearly indicate that the average worker is installing and producing significantly more megawatts of renewable electricity, which should lead to decreased soft costs over time.[51]

FIGURE 43: RENEWABLE ELECTRICITY GENERATION INDICES



LEVERAGING FEDERAL FUNDING

TO BOOST FEDERAL FUNDING FOR EARLY-STAGE CLEANTECH STARTUPS, MASSCEC LAUNCHED ITS AMPLIFYMASS PROGRAM IN THE FALL OF 2014.

Designed to help companies and research teams leverage competitive federal funding, AmplifyMass provides between $100,000 to $300,000 in matching funds that companies need to participate in the U.S. Department of Energy's ARPA-E advanced technology grant programs.

The program has awarded $1 million to seven Massachusetts-based recipients representing technologies including carbon-free aluminum production and hybrid fuel cell battery devices. A popular program, **AmplifyMass** has already leveraged $14 million in additional federal (and other) funds in less than a year.

In 2015, MassCEC introduced the **Leveraging Federal Opportunities Program** with dedicated funds to help Massachusetts companies attract federal research funding. The program is designed to strengthen applications for any federal clean energy-related grants, including but not limited to the U.S. Department of Energy, the National Science Foundation and the U.S. Department of Defense. To date, MassCEC has committed $650,000 and leveraged millions of U.S. Department of Energy and private-sector dollars to support companies working on hybrid automobile technology, building energy efficiency, solar and storage integration and hydrogen fuel cells.

With Massachusetts' world-renowned universities and research centers, clean energy innovation is broad in the Commonwealth, ranging from wind technologies to battery recycling and wave energy. As these innovators aim to bring their technologies to the marketplace, MassCEC will continue to provide financial backing to supplement federal funding.

At the same time, it is evident that the economic impact is greater, on a per-employee basis, in Renewable Electrical Generation than in other segments. This is due to several factors, including that Renewable Electrical Generation has a higher proportion of professional services and other knowledge based activities, which tend to pay higher wages (increasing local economic activity) and are more likely to serve out-of-state customers, drawing revenues from outside the Commonwealth's borders. In addition, there is a greater proportion of innovation-focused firms (and more broadly, manufacturing and engineering and research firms) in Renewable Electricity Generation, leading to higher economic multipliers, meaning more economic activity per establishment and worker.

Massachusetts has historic strength in Renewable Electricity Generation innovation, with more startup businesses in this technology than any other clean energy technology. Innovation activity is down slightly in Renewable Electricity Generation, however, when measured by patents, early stage investments (deals and dollar amounts) and other activities, such as initial public offerings (IPOs) and mergers and acquisitions.

Massachusetts' Renewable Electricity Generation industry is creating jobs faster than overall state and nationwide employment growth. With substantial representation across the supply chain, continued investment in manufacturing, research and engineering can poise Massachusetts to supply not only to regional businesses but also to the global marketplace. As deployment climbs and capital is locally reinvested, Renewable Electricity Generation will become a sustainable engine for statewide economic prosperity.

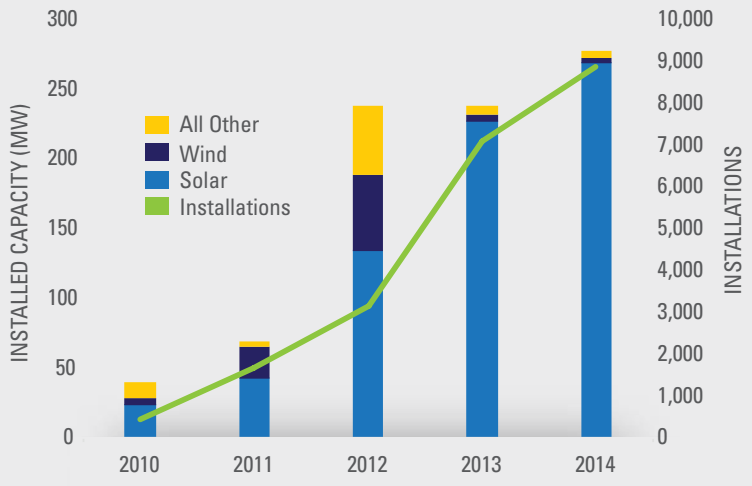
50 Massachusetts requires hydropower facilities to be certified as low impact by the Low Impact Hydropower Institute to be qualified for the Renewable Portfolio Standard (RPS). http://lowimpacthydro.org/project-map/

51 See generally, Ardini, et. al, Benchmarking Non-Hardware Balance of System (Soft) Costs for U.S. Photovoltaic Systems Using a Data-Driven Analysis from PV Installer Survey Results, National Renewable Energy Laboratory, 2008.

DEPLOYMENT

Renewable electricity installed capacity has grown rapidly in Massachusetts, from 429 installations adding 40 MW of installed renewable power in 2010 to nearly 8,900 installations with 277 MW in 2014 alone (Figure 44). As of May 2015, Massachusetts surpassed 850 MW of cumulative installed solar electric generation capacity, by far the largest source of Renewable Electricity Generation in the Commonwealth followed by wind and biomass generation.

FIGURE 44: INSTALLED CAPACITY AND NUMBER OF INSTALLATIONS FROM 2010 TO 2014, RENEWABLE ELECTRICITY GENERATION



Solar and wind generation in Massachusetts now power the equivalent of 168,000 homes[52] and avert 432,250 tons of carbon dioxide annually, the equivalent of taking 91,000 cars off the road.[53]

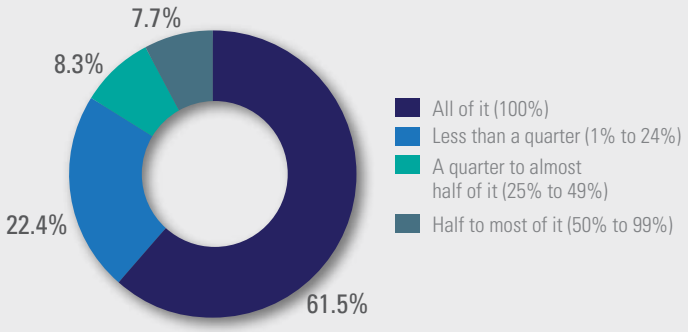
52 Assumes 13.21% Avg Capacity factor, Average household usage of 7,600 kWh per year.

53 Assumes GHG emissions from CY2014; MassDEP estimate, 4.75 Tons average Car CO2 emissions.

GSP AND REVENUES

Renewable Electricity Generation is responsible for 46% of clean energy contribution to the state GSP, or just over $5 billion. This is the largest contribution of any clean energy technology segment. Renewable Electricity Generation establishments are more likely to derive total revenue from clean energy activity than other technologies, with 61.5% earning all of their income from clean energy activities (Figure 45).

FIGURE 45: REVENUE ATTRIBUTED TO RENEWABLE ELECTRICITY GENERATION



JOBS & BUSINESS GROWTH

Establishments focused solely on Renewable Electricity Generation account for 2,113 establishments and 23,658 clean energy workers.

Solar PV makes up more than half of the total, accounting for nearly 15,000 Renewable Electricity Generation workers (Table 8).

Nearly all Renewable Electricity Generation employees spend the majority of their time focused on clean energy activities, with 93.5% spending more than 50% of their labor hours and 89.7% spending all of their time doing so. These figures continue to increase each year.

Renewable Electricity Generation establishments are involved across the value chain in Massachusetts. Manufacturing and engineering and research employ over 5,000 workers each. Sales and distribution and installation are individually responsible for one-fifth of all employment in the sector (Table 9).

The majority of the establishments are small, with 85.5% having less than 50 permanent employees.

Renewable Electricity Generation establishments employ a higher proportion of ethnic or racial minorities when compared to the state economy as a whole (18.9% vs. 15.1%). More than one-fifth (22.3%) of employees

hired over the past 12 months at Renewable Electricity Generation establishments were ethnic or racial minorities, further increasing overall diversity. These same establishments have a lower proportion of women compared to the overall Massachusetts workforce.

somewhat difficult) is down by over 12 percentage points when compared to last year.

About one in five Renewable Electricity Generation occupations in Massachusetts either went unfilled or filled by out-of-state applicants. The profile of new hires across all renewable establishments resembled data from 2014;

TABLE 8: RENEWABLE ELECTRICITY GENERATION EMPLOYMENT AND ESTABLISHMENT, BY SUB-TECHNOLOGIES

SUB-TECHNOLOGY	2015	2015 % of Tech Emp	2015 Estabs
Solar (PV or Photovoltaic)	14,820	62.6%	1,619
Wind Power	2,618	11.1%	750
All Other	6,220	26.3%	760

93.5%
OF RENEWABLE ENERGY EMPLOYEES SPEND MORE THAN
50%
OF THEIR LABOR HOURS ON CLEAN ENERGY ACTIVITIES

89.7%
SPEND ALL OF THEIR LABOR HOURS ON CLEAN ENERGY ACTIVITIES

TABLE 9: RENEWABLE ELECTRICITY GENERATION JOBS AND BUSINESSES BY ACTIVITY

SUPPLY CHAIN ACTIVITY	2015 Jobs	% of 2015 Jobs	2015 Estabs	% of 2015 Estabs
Manufacturing	5,793	24.5%	214	10.1%
Engineering & Research	5,384	22.8%	435	20.6%
Sales & Distribution	4,982	21.1%	226	10.7%
Installation	4,852	20.5%	850	40.2%
Legal, Finance, and Other Prof. Services	2,201	9.3%	306	14.5%
Other	445	1.9%	83	3.9%

As shown in Figure 47, Renewable Electricity Generation jobs are among the higher paying jobs among the different clean energy technologies. Nearly three-quarters (73.6%) of employees at these establishments earn more than $50,000 per year.

Renewable Electricity Generation establishments have generally had less difficulty finding qualified applicants, with only 14% reporting significant difficulty (down from nearly 20% in 2014). Overall difficulty (very difficult and

a majority had prior experience (66.4%) and nearly half had a bachelor's degree (47.1%). These data suggest that a large proportion of Renewable Electricity Generation establishments value experience and education when hiring.

54 Recent hires refer to those workers hired over the previous 12 months.

55 Bureau of Labor Statistics (BLS), 2013 annual averages of employment status of the civilian noninstitutional population, Massachusetts, from: http://www.bls.gov/lau/home.htm#ex14

56 2014 difficulty is based on the energy efficiency technology category from the previous year (2014).

INNOVATION

Massachusetts is home to nearly 180 establishments working on pre-commercial applications in Renewable Electricity Generation (64% of all pre-commercial clean energy establishments). These private sector establishments employ more than 900 clean energy workers (59% of all pre-commercial clean energy employment).

FIGURE 46: RENEWABLE ELECTRICITY GENERATION ESTABLISHMENTS

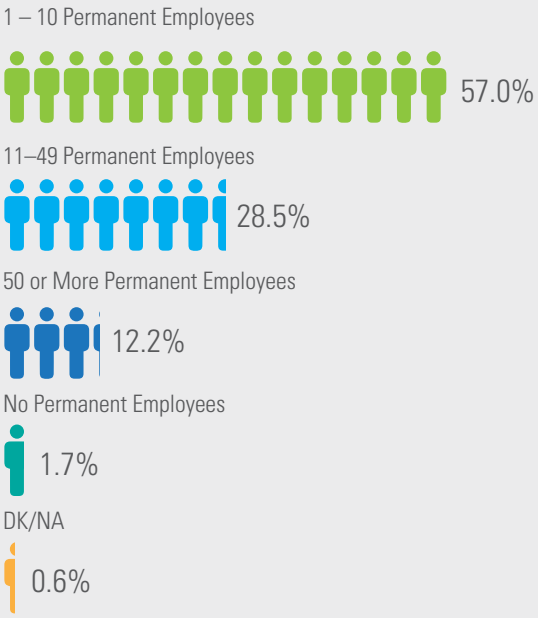


FIGURE 47: FULL-TIME PERMANENT WORKER PAY RANGE, RENEWABLE ELECTRICITY GENERATION

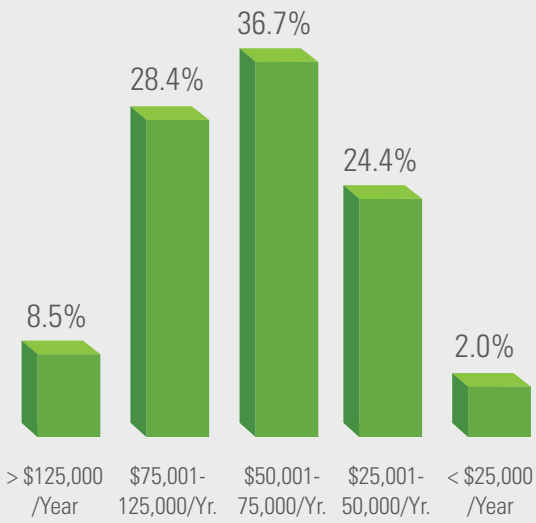
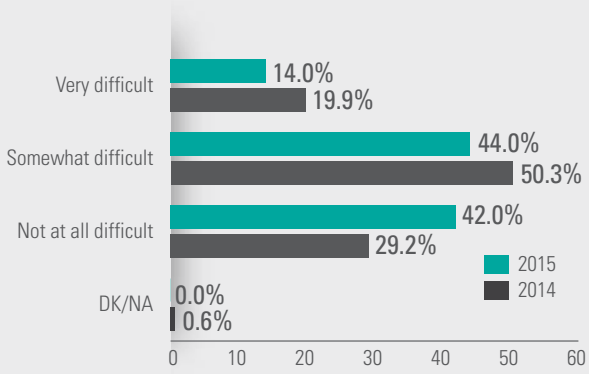


TABLE 10: DEMOGRAPHICS OF CURRENT WORKFORCE AND RECENT HIRES,[54] RENEWABLE ELECTRICITY GENERATION

	% of Current Workforce	% of Recent Hires	% of MA Workforce[55]
Women	21.9%	20.7%	48.0%
Ethnic or Racial Minorities	18.9%	22.3%	15.1%
Veterans of the U.S. Armed Forces	10.3%	6.7%	n/a
55 and Over	18.9%	5.5%	16.0%

FIGURE 48: DIFFICULTY FINDING QUALIFIED EMPLOYEES, RENEWABLE ELECTRICITY GENERATION (2014 & 2015)[56]



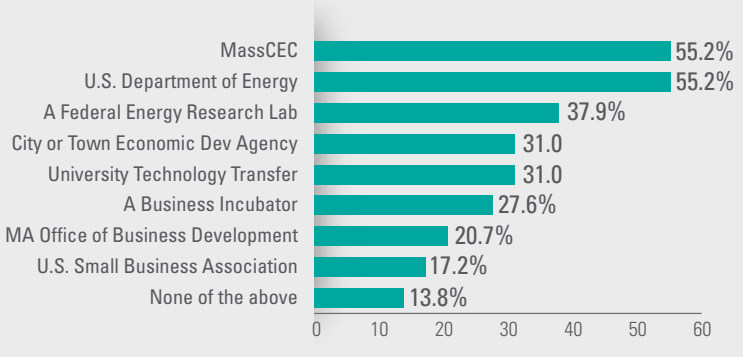
Though many professional services and other related firms support innovation, they are not included in this direct count. Thus, innovation firms have much larger economic and employment impacts across the rest of the economy than the conservative figures reported herein, which include only direct jobs at firms researching, developing, or manufacturing pre-commercial goods.

Renewable Electricity Generation consists of mostly small businesses (over half report one to 10 employees as shown in Figure 46) and supports sustainable wages for its employees (almost 74% of workers are earning greater than $50,000 as shown in Figure 47). The sector diversity, shown in Table 10, is comparable to the entire clean energy workforce (Table 3). Renewable Electricity Generation employers value both education and work experience (Table 11). The establishments report that they have worked with various local, state and federal entities, with 55% reporting that they have connected with MassCEC and the U.S. Department of Energy (Figure 49).

TABLE 11: RECENT HIRE EXPERIENCE AND EDUCATION ATTAINMENT, RENEWABLE ENERGY

	% of Recent Hires
Entry-Level	33.6%
Experienced	66.4%
EDUCATION ATTAINMENT	
High school or GED only	20.9%
Post-secondary certificate but not a degree	12.9%
Associates degree but not a bachelor's degree	8.0%
Bachelor's degree but not a graduate degree	47.1%
Graduate or professional degree	11.1%

FIGURE 49: ESTABLISHMENTS REPORTING CONNECTIONS WITH LISTED ENTITIES, RENEWABLE ELECTRICITY GENERATION



POLICY ENVIRONMENT

As part of the deregulation of the state's electric utility market in 1998, Massachusetts created the Renewable Energy Trust Fund. The trust is funded by a small surcharge on electric ratepayers.[57] MassCEC is authorized to distribute funds to support clean energy research and education, including Renewable Electricity Generation activities. The Green Communities Act of 2008 also provides financial support to Renewable Electricity Generation projects.[58] The statewide Renewable Portfolio Standard (RPS) requires that all utilities supply a percentage of their electricity from renewable energy sources. The RPS is broken down into Class I and II; Class I is set to increase by 1% annually. Each Class has varying supplier compliance percentages.[59]

57 http://www.masscec.com/content/financial-information

58 https://malegislature.gov/Laws/GeneralLaws/PartI/TitleII/Chapter23J/Section9

59 http://www.mass.gov/eea/energy-utilities-clean-tech/renewable-energy/rps-aps/rps-and-aps-program-summaries.html

DEEP DIVE: SOLAR TECHNOLOGIES

SUMMARY

Solar, a sub-technology of Renewable Electricity Generation, has experienced dramatic growth in Massachusetts – adding approximately 4,000 new employees between the end of 2013 and the end of 2014, a 33% growth rate.

Massachusetts trailed only California, North Carolina and Nevada[60] in annual installed solar capacity in 2014 (269 MW, see Figure 50), and is expected to add nearly 350 MW by the end of 2015 and to equal that over the course of 2016. Solar jobs continue to pay well – over 95% of solar establishments reported paying their solar installation workers more than $40,000 a year. Solar establishments tend to be smaller, with over two-thirds reporting 10 permanent employees or less (see Figure 51).

DEPLOYMENT

Since 2012, Massachusetts has been one of the top five states in annual installed capacity. By May 2015, the state's cumulative solar capacity amounted to over 850 MW, after experiencing a 19% increase over 2014 and apparent strong growth in the first two quarters of 2015.[62] The 269 MW of installed capacity was mostly in the commercial sector. In contrast, California had mostly utility-scale installations (Figure 52).

60 SEIA/GTM Research. (2010-2015). U.S. Solar Market Insight series. Available at: www.seia.org/research-resources/us-solar-market-insight

61 DOER. Available at: http://www.mass.gov/eea/docs/doer/renewables/installed-solar.pdf. Data through the end of Q2 2015 are not available at the time of publication.

62 SEIA/GTM Research U.S. Solar Market Insight 2014 Year-in-Review and DOER

FIGURE 50: MASSACHUSETTS ANNUAL INSTALLED CAPACITY, 2010-2016 (ESTIMATED)[61]

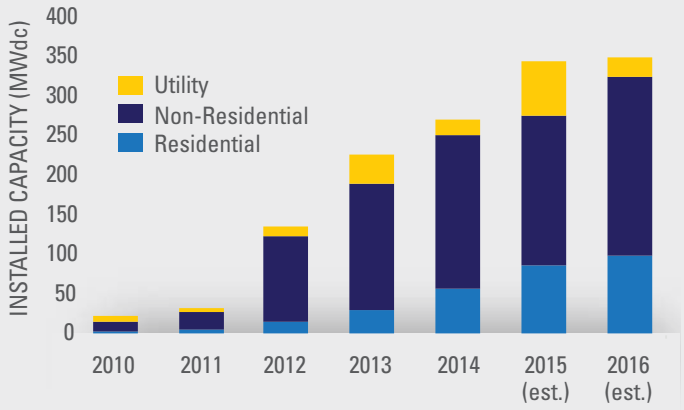
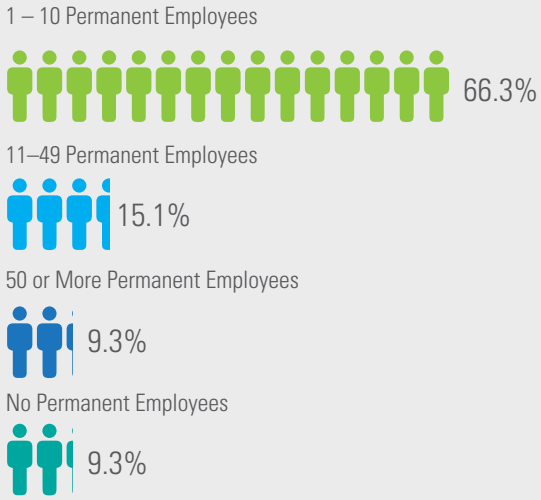


FIGURE 51: SOLAR ESTABLISHMENTS, PERMANENT EMPLOYMENT



JOBS & BUSINESS GROWTH

Massachusetts is home to the second-largest solar workforce in the country.[63] The state employs 16,145 solar workers, an increase of 33% since 2013.[64] Most employees (14,820) are primarily involved in photovoltaic (PV) technologies; roughly 1,300 work with solar thermal technologies (Table 12).

In 2014, 95% of solar installation workers made $20 or more per hour, with 60% earning between $20 and $29.99 per hour. A majority of positions (56%) require previous work experience related to the position while only 1.7% require an associates degree or certificate and 12.3% require a bachelor's degree.[66]

TABLE 12: SOLAR ENERGY EMPLOYMENT, BY SUB-TECHNOLOGIES

SUB-TECHNOLOGY	2015	2014	Growth 2014-2015
Solar (PV or Photovoltaic)	14,820	12,122	33.4%
Solar Thermal	1,345		

FIGURE 53: TOTAL INVESTMENT 2010-2014 (DEALS AND DOLLAR AMOUNT), SOLAR ENERGY[68]

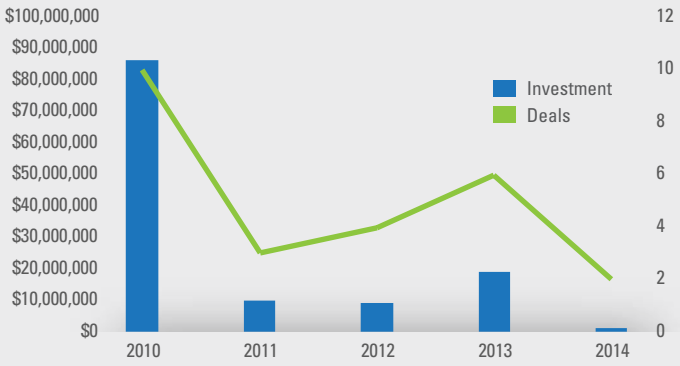
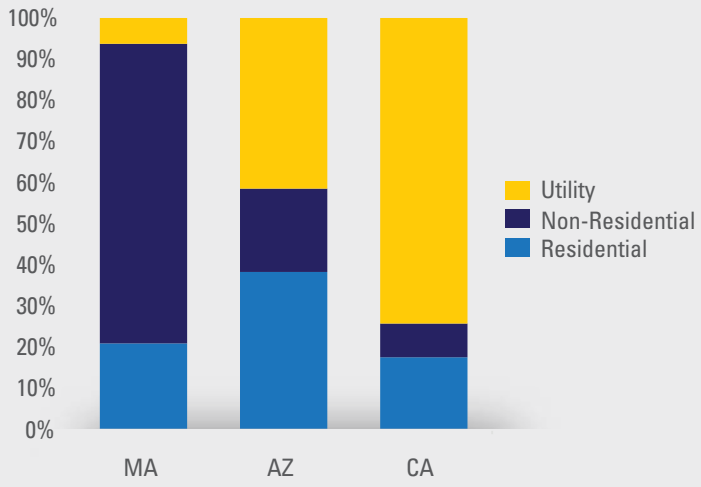


FIGURE 52: MARKET SEGMENT AS A PERCENTAGE OF 2014 INSTALLED CAPACITY[67]



INVESTMENTS

Total solar investments in Massachusetts in 2014 totaled $1.4 million. Investment was the product of only two deals and was markedly lower than the $19 million invested in 2013 (see Figure 53).

POLICY ENVIRONMENT

State support for solar technologies dates back to the 1980s when the state instituted its first net metering policy, covering renewable energy systems up to 30 KW in size. By 1997, the cap was doubled and customers were allowed to forward any net excess generation to their next utility bill.[68]

In 2010, a Solar Carve-Out was established within the state's RPS, requiring 400 MW of installed solar capacity by 2020. In April 2014, the state expanded the requirement to 1,600 MW with the Solar Carve-Out II. Electric providers with qualifying systems receive Solar Renewable Energy Certificates (SREC II) which can be purchased by other electric suppliers in order to satisfy the RPS. One SREC is created for each MWh of energy generated. Should utilities not meet their quota, the state established a Solar Alternative Compliance Payment, the cost of which is higher than the current market price of SRECs. The state also has a solar easement and rights law in place preventing unreasonable restrictions on solar energy systems.[69]

The Commonwealth Solar II Rebate program (which ended in early 2015) provided rebates for over 13,000 solar systems across the state. Under this program, installation costs for small-scale systems dropped by nearly 30%.[70] Now in its fourth year, Solarize Mass, which is sponsored by DOER and MassCEC has resulted in over 2,400 solar installations for homes and business.[71]

63 The Solar Foundation. (2015). National Solar Jobs Census 2014. Available at: www.tsfcensus.org

64 2014 Massachusetts Clean Energy Industry Report. Available at: www.masscec.com/content/2014-clean-energy-industry-report

65 http://www.thesolarfoundation.org/national-solar-jobs-census-2014/

66 SEIA/GTM Research U.S. Solar Market Insight 2014 Year in Review

67 Cleantech Group i3 Data

68 http://programs.dsireusa.org/system/program/detail/281

69 http://www.mass.gov/eea/energy-utilities-clean-tech/renewable-energy/solar/rps-solar-carve-out-2/about-solar-carve-out-ii.html

70 www.masscec.com/news/masscec-ends-successful-solar-rebate-program

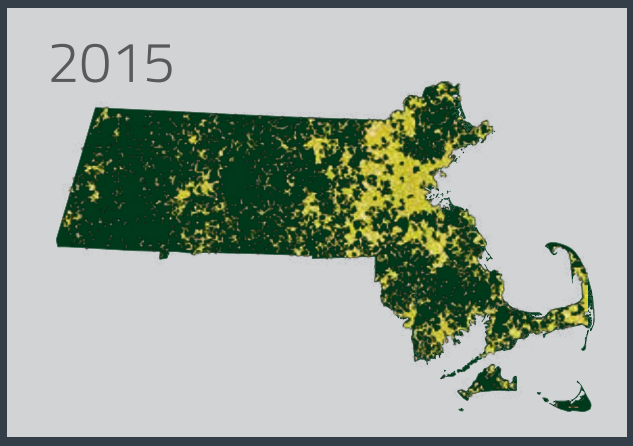
71 www.masscec.com/solarizemass

SOURCE: MASSCEC

SUPPORTING SOLAR DEPLOYMENT

MASSACHUSETTS HAS SEEN AN IMPRESSIVE ELEVEN-FOLD INCREASE WITH SOLAR TECHNOLOGY DEPLOYMENT IN THE PAST FIVE YEARS. BETWEEN 2010 AND 2014, THE STATE ADDED 20,000 SYSTEMS (730 MW); THIS IS ENOUGH TO POWER MORE THAN 111,000 AVERAGE MASSACHUSETTS HOMES. During that time, MassCEC launched two flagship programs designed to leverage private investment and increase deployment and consumer access of small-scale solar electric systems.

(NUMBER OF SYSTEMS)



(NUMBER OF SYSTEMS)

Launched in 2010, the Commonwealth Solar II program offered rebates for the installation of small-scale solar electric systems at homes and businesses across Massachusetts. This program was designed to closely follow the market's lead and transition away from large upfront grants and solar electric demonstration programs. Project costs declined an average of 6% per year during the course of the program and, in response to this trend, incentive levels were correspondingly reduced. As project costs continued to decline and the solar market became more robust, MassCEC closed the program in January 2015, having awarded $34.5 million dollars in rebates to support 13,549 solar electric projects, leveraging $422 million in private investment.

Solarize Massachusetts drives adoption of solar in participating communities by pairing outreach and education with a competitive tiered pricing model that provides greater savings as more people sign contracts. Piloted in 2011, Solarize Massachusetts has been successfully deployed in 51 Massachusetts cities and towns, doubling the number of installed solar systems in nearly all of these communities. The initiative has been replicated in other states, including Connecticut and New York, and in various municipalities across the country.

SOLARIZEMASS PROGRAM RESULTS

Communities (Towns and Cities)	51
Contracts	2400
Contracted Capacity	16MW
Savings	18-20%
Leveraged Private Investment	$54M

As the market continues to mature, MassCEC will continue to support the installation of solar projects through its program, including a new program aimed at making solar electric ownership more affordable to residents of the Commonwealth.

Mass Solar Loan will connect Massachusetts residents with low-interest loans to help finance solar electric installations. The $30 million program is a partnership between MassCEC and the Massachusetts Department of Energy Resources to facilitate banks and credit unions providing low-interest loans, with greater incentives for low- and moderate-income residents.

CLEAN HEATING AND COOLING

MASSCEC SUPPORTS THE GROWTH OF THE CLEAN HEATING AND COOLING MARKET THROUGH A VARIETY OF PROGRAMS THAT PROVIDE INCENTIVES FOR INSTALLATION OF TECHNOLOGIES THAT MEET THE HIGHEST EFFICIENCY AND PERFORMANCE STANDARDS. These technologies produce thermal energy from naturally-occurring temperature differences, sustainable biomass fuels or solar energy and include high-efficiency cold-climate air-source heat pumps, ground-source heat pumps, central biomass heating systems and solar hot water. In August 2015, MassCEC announced a five-year, $30 million commitment to increase the use of clean heating and cooling systems across the Commonwealth.

- **MassCEC's Clean Heating and Cooling[1] Program** offers rebates for the installation of high-efficiency air-source and ground-source heat pumps and biomass pellet boilers across the Commonwealth. A suite of pilot programs launched in 2012 funded more than 250 residential and commercial-scale projects statewide. Clean heating and cooling technologies can reduce household heating costs - especially for households replacing traditional oil, electric, or propane heat.
- **The Commonwealth Solar Hot Water Program** offers funding for the installation of solar heating systems for homes and businesses. Since its inception in 2011, this program has supported the installation of over 800 residential and commercial projects.
- **The Commonwealth Woodstove Change-Out Program**, a partnership between MassCEC and the Massachusetts Departments of Environmental Protection and Energy Resources, offers rebates for Massachusetts residents to replace non-EPA-certified wood stoves with cleaner, more efficient EPA-certified wood or pellet stoves. Since its launch in 2012, this program has supported over 1,150 change-outs, which cut greenhouse gas emissions and reduce fuel costs by 33%.

To ensure equitable access to clean energy choices, each of these programs offers enhanced incentives to low- and moderate-income consumers.

1 MassCEC programs support renewable heating and cooling technologies which produce thermal energy from naturally-occurring temperature differences, sustainable biomass fuels, or solar energy. These include high-efficiency cold-climate air-source heat pumps, ground-source heat pumps, central biomass heating systems, and solar thermal. Renewable and Efficient Heating and Cooling (REHC) technologies include these technologies as well as efficient heating and cooling technologies, which utilize traditional fossil fuels but in a more efficient manner, such as high-efficiency fossil fuel boilers and furnaces.

RENEWABLE AND EFFICIENT HEATING AND COOLING

This 2015 report provides, for the first time, detailed and specific insight on the Massachusetts Renewable and Efficient Heating and Cooling (REHC) sector. The REHC sector encompasses a wide range of technologies that are distinguished from conventional alternatives by their high-performance and efficiency. REHC technologies produce thermal energy to heat and cool buildings and include emerging technologies such as solar thermal systems, air- and ground-source heat pumps, biomass pellet boilers and high-efficiency fossil fuel boilers and furnaces. These technologies reduce the total amount of energy required for heating and cooling, which can in turn lower energy costs for homes and businesses while reducing their carbon footprint.

In prior reports, these and other REHC technologies were distributed between the energy efficiency and renewable energy chapters, reflecting the wide range of energy services they provide. Their combination this year into a single Renewable and Efficient Heating and Cooling chapter is a reflection of the significant role they play in Commonwealth's multi-faceted strategy to reduce the state's greenhouse gas emissions by 25% by 2020 and 80% by 2050 as well as to more coherently organize businesses and employees by their activities (i.e., firms and employees working with air-source heat pumps generally have more in common with those working with high-efficiency air conditioners, boilers and furnaces than they do with solar or insulation activities).[72]

Currently, about one-half of Massachusetts residents heat their homes with fuel oil, electricity or propane, with likely higher-than-average energy costs and increased exposure to price volatility. REHC technologies have the ability to broaden access for residents throughout the state to clean, cost-effective renewable and energy-efficient heating and cooling, a further advancement to achieving the Commonwealth's clean energy and climate goals.

72 Innovation data for Renewable and Efficient Heating and Cooling are unavailable or insufficient to provide meaningful analysis at this time.

SUMMARY

The REHC sector supports nearly 25,000 jobs across 1,450 establishments. This technology adds nearly $1.5 billion to the GSP, about 13.5% of total clean energy revenue. Slightly fewer than half of establishments derive 50% of their revenues or more from clean energy activity. It is comprised of mostly small businesses; nearly 29% have five or fewer employees and 79% report less than 25.

Most employees work with high-efficiency heat pumps and other efficient HVAC and building controls. These technologies together comprise 64% of the REHC sector workforce. The sector spans the entire supply chain, but is dominated by installation and sales. This suggests that the sector is heavily involved in clean energy deployment.

DEPLOYMENT

As of early 2015, there are 800 solar thermal systems, more than 10,000 high-efficiency air-source heat pumps, 86 ground-source heat pumps, and 62 biomass boilers in Massachusetts that have received rebates or incentives through various programs in the Commonwealth.[73] As seen in Figure 54, between 2006 and 2013, state utilities issued a total of $185.7 million in loans to finance a number of Renewable and Efficient Heating and Cooling upgrades including heating systems, hot water systems, solar hot water systems and air conditioning.

73 Source: MassCEC and DOER

GSP & REVENUES

Renewable and Efficient Heating and Cooling activities add nearly $1.5 billion to the GSP in Massachusetts, representing 13.5% of the clean energy total.

Unlike the other segments of the clean energy economy, where most establishments are predominantly focused on clean energy goods and services, many Renewable and Efficient Heating and Cooling establishments receive less than 50% of their revenues from clean energy activities. Data collected for this report only include activities directly related to clean energy (Figure 55).

JOBS & BUSINESSES

Renewable and Efficient Heating and Cooling accounts for nearly 25,000 jobs and 1,450 establishments. The majority of these jobs are associated with air-source heat pumps, though rebate-eligible wood stoves and pellets and biodiesel are both large segments as well (see Table 14). Employers primarily engaged in

FIGURE 54: TOTAL STATEWIDE CLOSED LOANS, 2006-2013

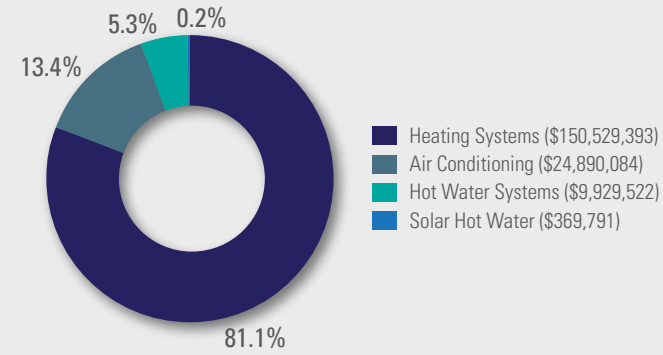


FIGURE 55: REVENUE ATTRIBUTED TO CLEAN ENERGY, RENEWABLE AND EFFICIENT HEATING AND COOLING

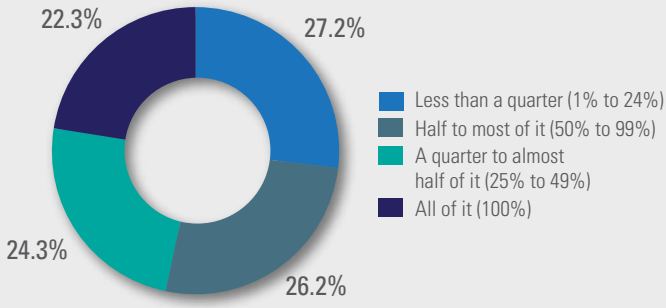


Table 13: DEMOGRAPHICS OF CURRENT WORKFORCE AND RECENT HIRES, RENEWABLE AND EFFICIENT HEATING AND COOLING

	% of Current Workforce	% of Recent Hires	% of MA Workforce
Women	19.4%	20.5%	48.0%
Ethnic or Racial Minorities	11.8%	12.2%	15.1%
Veterans of the U.S. Armed Forces	8.4%	9.8%	n/a
55 and Over	21.4%	11.4%	16.0%

FIGURE 56: FULL-TIME PERMANENT WORKER PAY RANGE, RENEWABLE AND EFFICIENT HEATING AND COOLING

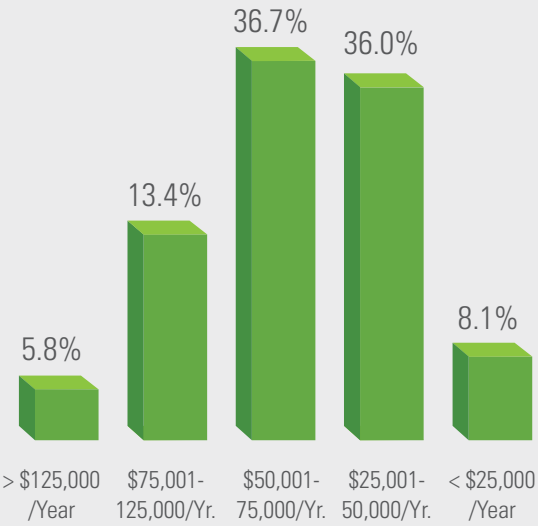


FIGURE 57: DIFFICULTY FINDING QUALIFIED EMPLOYEES, RENEWABLE AND EFFICIENT HEATING AND COOLING

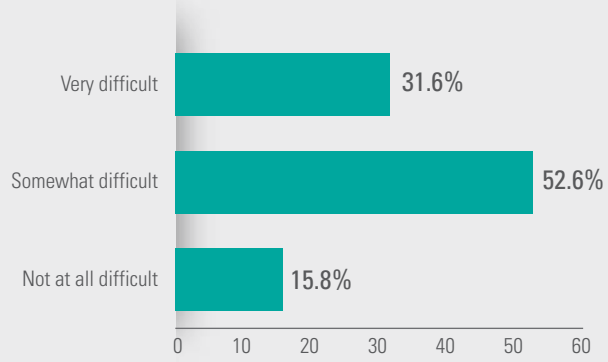
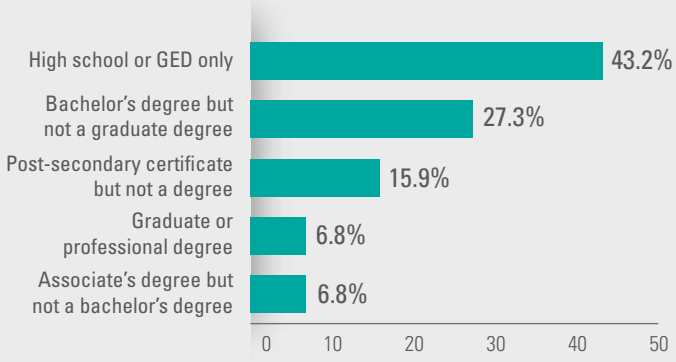


FIGURE 58: EDUCATION ATTAINMENT FOR RECENT HIRES, RENEWABLE AND EFFICIENT HEATING AND COOLING



Renewable and Efficient Heating and Cooling expect employment to increase by 8.6% over the next 12 months, or approximately 2,100 additional employees.

REHC establishments employ a lower proportion of women and ethnic or racial minorities when compared to the Massachusetts workforce, however, the sector has a slightly higher proportion of workers that are 55 and over (Table 13).

Almost 56% of the new hires earn more than $50,000 per year (Figure 56), which is higher than the $44,678 median wage in Massachusetts.[74]

In finding qualified applicants to meet their needs, 84% of employers reported some difficulty, with 31.6% reporting significant difficulty (Figure 57).

This difficulty is also seen in the number of unfilled jobs or those filled by out-of-state applicants; there was one unfilled or out-of-state filled job for every three new hires. Establishments are reporting that they are relying less on experience (45% of new hires had no prior experience).

As shown in Figure 58, nearly half, or 43.2%, of new hires did not attain education beyond high school, while 27.3% held a bachelor's degree.

Table 14 displays employees by their primary sub-technology within REHC. It also includes the number of establishments that work (at least partially) within each sub-technology. Establishment totals include overlap (sum exceeds 1,450).

Of the 24,966 workers in REHC, 70.2% spend a majority of their time working in clean energy, and 46.3% spend all of their time conducting clean energy work.

REHC establishments work across the entire supply chain, from early-stage research and development

through installation and maintenance. As Table 15 below illustrates, 83% of the jobs in this segment are dominated by installation and sales and distribution.

The majority of the businesses are small, with 83.6% having less than 50 employees (Figure 59).

74 According to May 2014 State Occupational Employment and Wage Estimate for Massachusetts, from: http://www.bls.gov/oes/current/oes_ma.htm#00-0000

75 Establishment totals indicate locations that are involved in each specific Renewable and Efficient Heating and Cooling sub-technology, therefore establishment totals overlap among categories.

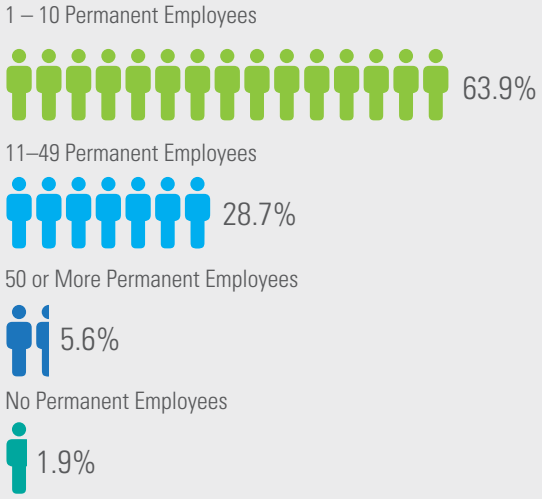
TABLE 14: RENEWABLE AND EFFICIENT HEATING AND COOLING SUB-TECHNOLOGIES

SUB-TECHNOLOGY	2015 Jobs	% of 2015 Jobs	2015 Estabs[75]
Solar Thermal	1,345	5.4%	457
High Efficiency Air-Source Heat Pumps	8,596	34.4%	793
Other Efficient HVAC and Building Controls	7,389	29.6%	745
Ground-Source Heat Pumps	462	1.8%	360
Woody Biomass (Wood, Wood Pellets) for Heat	3,516	14.1%	296
Biofuels (Biodiesel for Heating)	1,243	5.0%	224
RE Combined Heat and Power	604	2.4%	200
Other	1,811	7.3%	96

TABLE 15: RENEWABLE AND EFFICIENT HEATING AND COOLING JOBS AND BUSINESSES BY ACTIVITY

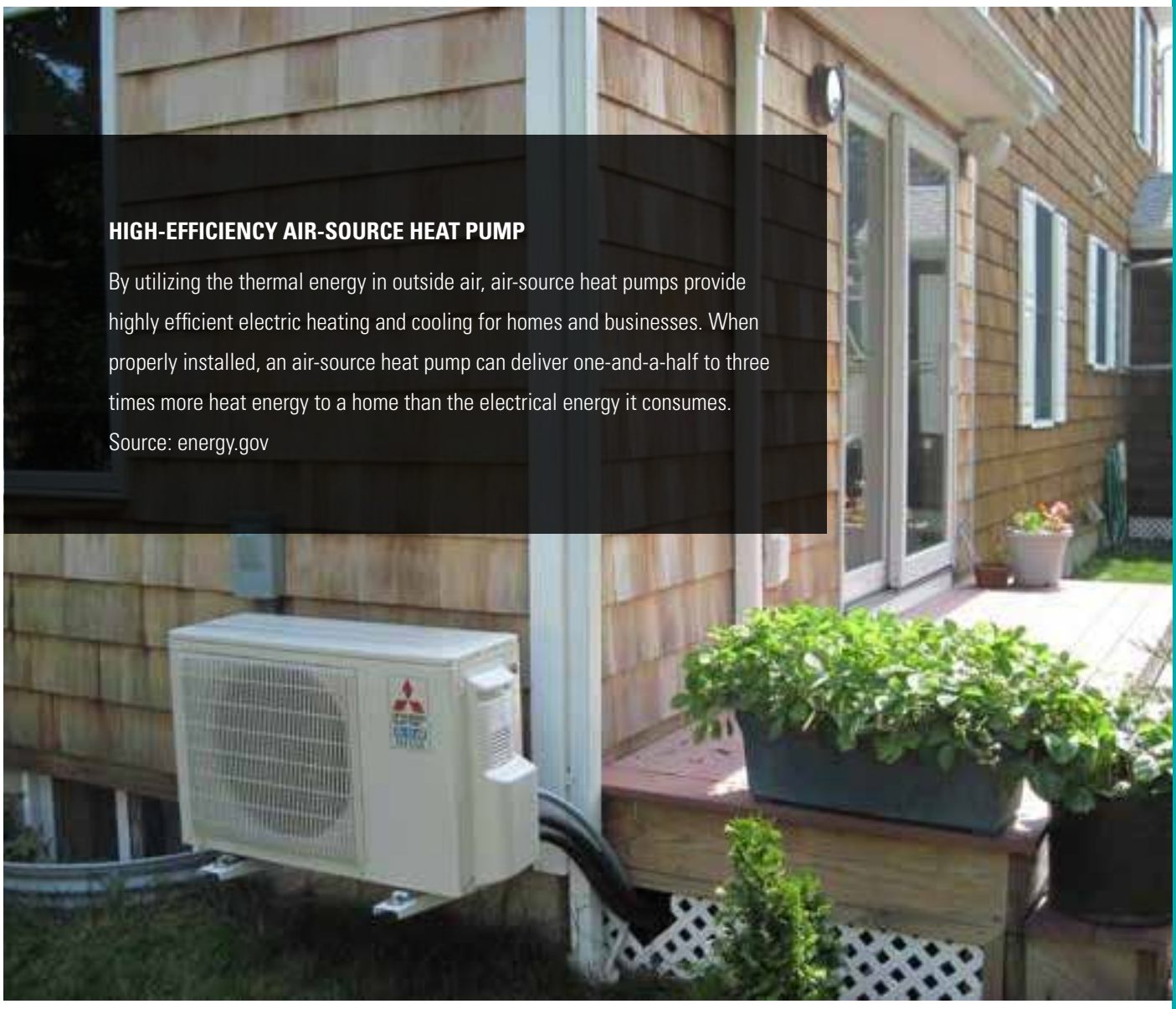
SUPPLY CHAIN ACTIVITY	2015 Jobs	% of 2015 Jobs	2015 Estabs	% of 2015 Estabs
Manufacturing	1,634	6.5%	75	5.2%
Engineering & Research	3,876	15.5%	70	4.8%
Sales & Distribution	9,914	39.7%	369	25.5%
Installation	7,964	31.9%	850	58.6%
Legal, Finance, and Other Prof. Services	1,013	4.1%	45	3.1%
Other	565	2.3%	41	2.9%

FIGURE 59: RENEWABLE AND EFFICIENT HEATING AND COOLING PERMANENT EMPLOYMENT



POLICY ENVIRONMENT

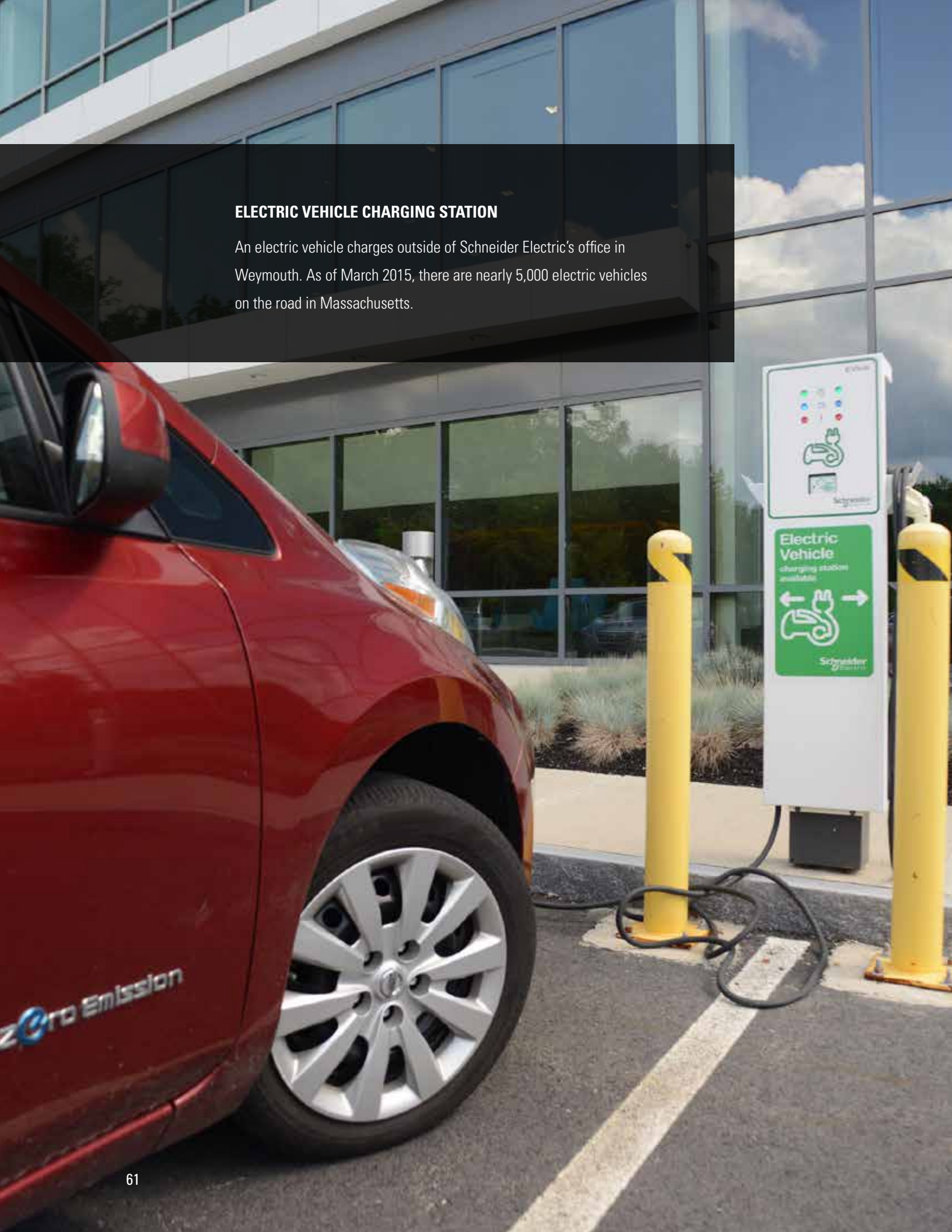
The Alternative Energy Portfolio Standard (APS) was established to complement the RPS Program, providing requirements and incentives for alternative electricity technologies. In 2014, the APS was expanded to include some REHC technologies including geothermal heat pumps and renewable thermal energy. When implemented, this will provide an important financial incentive to residents and businesses who adopt qualifying technologies and encourage further growth of the REHC market. The 2014 Commonwealth Accelerated Renewable Thermal Strategy (CARTS) advises on which policies and programs the Commonwealth can deploy in order to grow the REHC market. The report provides a set of concrete recommended priority strategies to grow the market for REHC in the state.



HIGH-EFFICIENCY AIR-SOURCE HEAT PUMP

By utilizing the thermal energy in outside air, air-source heat pumps provide highly efficient electric heating and cooling for homes and businesses. When properly installed, an air-source heat pump can deliver one-and-a-half to three times more heat energy to a home than the electrical energy it consumes.

Source: energy.gov



ELECTRIC VEHICLE CHARGING STATION

An electric vehicle charges outside of Schneider Electric's office in Weymouth. As of March 2015, there are nearly 5,000 electric vehicles on the road in Massachusetts.

ALTERNATIVE TRANSPORTATION

SUMMARY

Alternative Transportation accounts for 1,500 jobs in the Commonwealth across 467 establishments. Employers expect an 11.5% growth in the next 12 months. Alternative Transportation establishments are largely concentrated in repair and fleet maintenance, followed by sales and distribution and engineering and research. There are about 20 early-stage establishments that employ 100 workers; investments in these companies reached $21 million in 2014.

DEPLOYMENT

Massachusetts is one of only 19 states in the nation with at least one to two electric vehicles per 1,000 registered vehicles.[76] In 2011, the state housed about 1% of the nation's alternative fuel vehicles and about 3% of total battery electric vehicles.[77] Between 2003 and 2011, the statewide Alternative Transportation fleet[78] increased from 10,108 to 11,161, about 10.4%.[79]

As of June 2015, the Electric Vehicle Rebate program has administered or reserved a total of 939 applications for battery electric (BEV) and plug-in hybrid vehicles (PHEV).[80] Between 2013 and 2015, statewide BEVs and PHEVs increased by 195%. There are nearly 5,360 electric vehicles on the road as of June 2015.[81]

76 http://www.eia.gov/todayinenergy/detail.cfm?id=19131

77 http://www.eia.gov/tools/faqs/faq.cfm?id=93&t=4; http://www.eia.gov/renewable/afv/users.cfm

78 Fuel types include compressed natural gas (CNG), electricity (EVC), ethanol (E85), liquefied natural gas (LNG), hydrogen (HYD), liquefied petroleum gas (LPG), and other biofuels.

79 http://www.eia.gov/renewable/afv/users.cfm

80 https://mor-ev.org/

81 http://www.mass.gov/eea/agencies/massdep/air/grants/massevip-municipal.html

GSP AND REVENUES

Alternative Transportation has traditionally been a much smaller segment of the Massachusetts clean energy economy, in terms of the size and number of establishments throughout the state. With only 1.5% of statewide clean energy employment, Alternative Transportation contributes $577 million to the Gross State Product - 5.3% of the total clean energy contribution - likely due to greater export and innovation focus.

Establishments engaged in Alternative Transportation activity work on many different technologies, and a majority earn less than half of their revenues from clean energy goods and services (Figure 60).

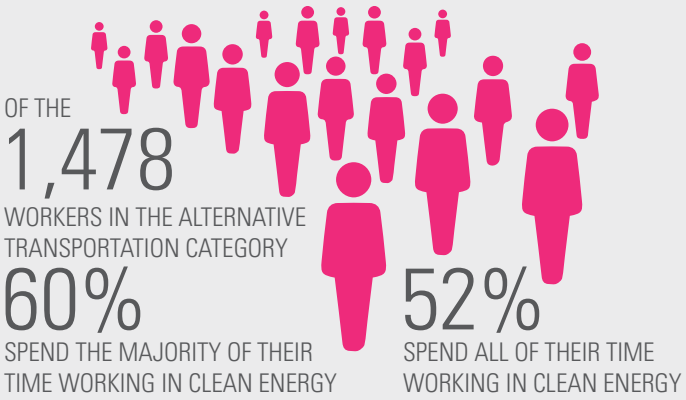


FIGURE 60: REVENUE ATTRIBUTED TO CLEAN ENERGY, ALTERNATIVE TRANSPORTATION

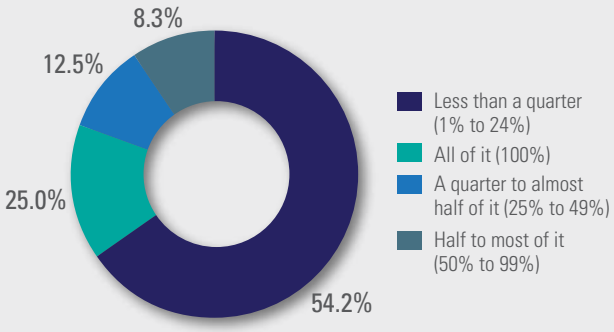
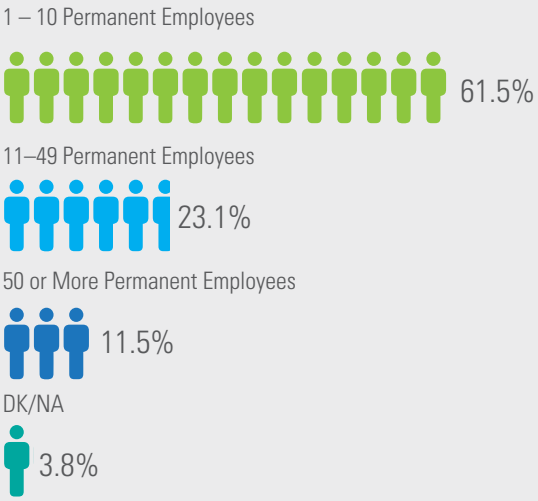


TABLE 16: ALTERNATIVE TRANSPORTATION ESTABLISHMENTS BY ACTIVITY

SUPPLY CHAIN ACTIVITY	2015 Estabs	% of 2015 Estabs
Manufacturing	38	8.1%
Engineering & Research	70	14.9%
Sales & Distribution	83	17.8%
Installation	44	9.4%
Legal, Finance, and Other Prof. Services	25	5.5%
Other, Including Repair and Fleet Maintenance	207	44.3%

FIGURE 61: ALTERNATIVE TRANSPORTATION PERMANENT EMPLOYMENT

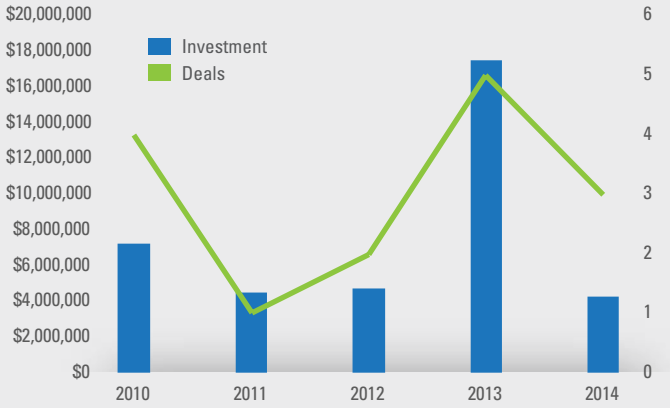


JOBS & BUSINESS GROWTH

Alternative Transportation accounts for nearly 1,500 jobs and 467 establishments. About half of these establishments focus primarily on electric vehicles, with the remainder primarily engaged in biodiesel, hydrogen-fuel vehicles, charging and refueling stations and other, new emerging transportation technology. Employers that are primarily engaged in Alternative Transportation expect to increase employment by 11.5% over the next 12 months, or approximately 170 additional employees. While this expectation is slightly lower than last year's projected employment growth, no specific reasons were provided by employers.

As with revenues, a smaller portion of workers in Alternative Transportation spend a majority of their time on clean energy activities. Of the 1,478 workers in this category, 60.0% spend a majority of their time working in

FIGURE 62: TOTAL INVESTMENT 2010-2014 (DEALS AND DOLLAR AMOUNT), ALTERNATIVE TRANSPORTATION



clean energy, and 52.0% spend all of their time doing so.

Alternative Transportation establishments are much less focused on installation and maintenance than other segments of the clean energy economy, with more focused on engineering and research and sales and distribution (Table 16).

Alternative Transportation establishments are generally small, with about half employing fewer than five permanent workers and approximately 75% with fewer than 25 (Figure 61).

INVESTMENTS

Alternative Transportation companies in Massachusetts secured all their investment through private sources in 2014 ($4.3 million). All investment came through early-stage deals. Total funding for this period was less than the $17.4 million invested in 2013 (see Figure 62).

A total of four public deals have been completed for Alternative Transportation companies in Massachusetts since 2005 (2013: $1 million; 2011: $6 million; 2010 – two deals: $450,000).

INNOVATION

Alternative Transportation has a small but significant innovation core, with approximately 20 early-stage establishments employing about 100 workers. This is second-highest as a share of total establishments (4.1%) and the highest as a share of total employment (6.5%) among clean energy technologies. Because other services that support pre-commercial technology development are not included in this count, innovation companies have larger economic and employment impacts across the economy than the limited scope of jobs reported herein.

POLICY ENVIRONMENT

In 1994, Boston became the seventh city in the United States to join the Clean Cities Coalition; five years later Clean Cities became a statewide initiative.[82] Administered by the U.S. Department of Energy, the Massachusetts Clean Cities Coalition sponsors programs and incentives for both electric vehicles and infrastructure development.[83]

In 2013, the governors of Massachusetts and seven other states, joined the Multi-State Zero Emissions Vehicle (ZEV) Action Plan. These states are collectively committed to putting at least 3.3 million electric vehicles on the road by 2025.[84] Massachusetts set a goal of 300,000 ZEVs in the next 10 years.[85] As of June 2015, there are nearly 5,360 electric vehicles on the road, an increase of 195% since July 2013.[86]

Applications are currently being accepted for two electric vehicle incentive programs. The MOR-EV (Massachusetts Offers Rebates for Electric Vehicles) program provides consumer incentives of up to $2,500 for the purchase or lease of electric vehicles, including battery electric, plug-in hybrid electric and fuel cell electric. The program budget includes $3.72 million in incentives, with 42% of funds remaining. Since June 2015, the program has administered or reserved 939 applications,[87] totaling $2,219,000 in rebates.[88] MassEVIP (Massachusetts Electric Vehicle Incentive Program) was developed to advance the installation of charging stations at establishments, nonprofits or state agencies with 15 or more employees. The Massachusetts Department of Environmental Protection (MassDEP) will cover up to $25,000 of installation costs for employers that invest in electric vehicle charging stations. Since 2013, the program has had three application cycles, providing over $1 million in financial incentives.[89] The Massachusetts Bay Transportation Authority (MBTA) also provides charging stations for customers with electric vehicles. Certain MBTA parking spaces are reserved for electric vehicles only, allowing customers to charge their cars while they are parked at rapid transit or commuter rail stations.[90]

In May 2015, the Massachusetts Department of Energy Resources (DOER) submitted a Program Opportunity Notice (PON) for its Clean Vehicles Program. This program is open to bus operators for grants of up to $750,000 that will replace current fleets with electric buses and install wireless charging equipment along fixed bus routes. Available funding totals to $2.25 million.[91] The DOER also released a Solar Photovoltaic Canopy Grant Program this past May. The program requires all applicants to install electric vehicle charging stations as part of the solar photovoltaic parking canopy.[92]

82 http://www.mass.gov/eea/energy-utilities-clean-tech/alternative-transportation/clean-cities-coalition.html#clean

83 http://www.mass.gov/eea/energy-utilities-clean-tech/alternative-transportation/clean-cities-coalition.html#grant

84 http://www.mass.gov/eea/docs/dep/air/community/zevplan14.pdf

85 http://www.mass.gov/eea/docs/dep/air/community/zevplan14.pdf

86 http://www.mass.gov/eea/agencies/massdep/air/grants/massevip-municipal.html

87 Includes Battery Electric Vehicles (BEV), Plug-in Hybrid Electric Vehicles with battery capacity > 10kWh (PHEV+), and Plug-in Hybrid Electric Vehicles with battery capacity <10kWh (PHEV)

88 https://mor-ev.org/

89 http://www.mass.gov/eea/agencies/massdep/air/grants/workplace-charging.html

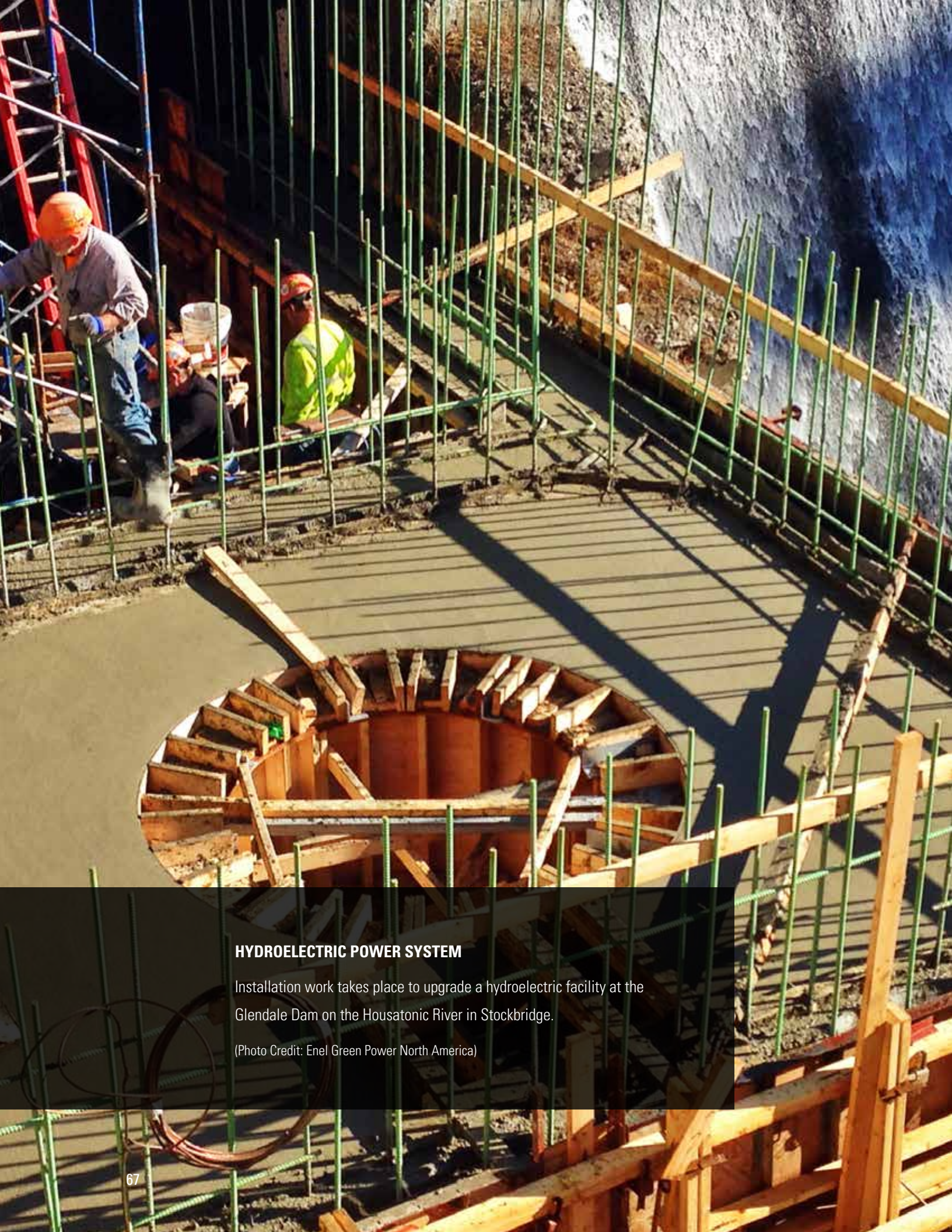
90 http://www.mass.gov/eea/docs/dep/air/community/zevplan14.pdf

91 http://www.mass.gov/eea/docs/doer/renewables/battery-electric-buses-w-wireless-charging-pon-ene-2015-028-050515-082330.pdf

92 http://www.mass.gov/eea/docs/doer/procurement/pon-ene-2015-029-grant-application-solar-canopy-050715-065406.pdf

ELECTRIC VEHICLES

Argonne National Laboratory's green fleet and solar power electric vehicle charging station (Photo Credit: U.S. Department of Energy).



HYDROELECTRIC POWER SYSTEM

Installation work takes place to upgrade a hydroelectric facility at the Glendale Dam on the Housatonic River in Stockbridge.

(Photo Credit: Enel Green Power North America)

GREENHOUSE GAS EMISSIONS ACCOUNTING AND MANAGEMENT

Greenhouse Gas Emissions Accounting and Management includes establishments focused on activities related to renewable energy and carbon credit trading, carbon footprint accounting and carbon sequestration. This segment of activities represents a decreasing share of establishments and employment, as many of these activities have been subsumed by establishments engaged in other core clean energy technologies.[93]

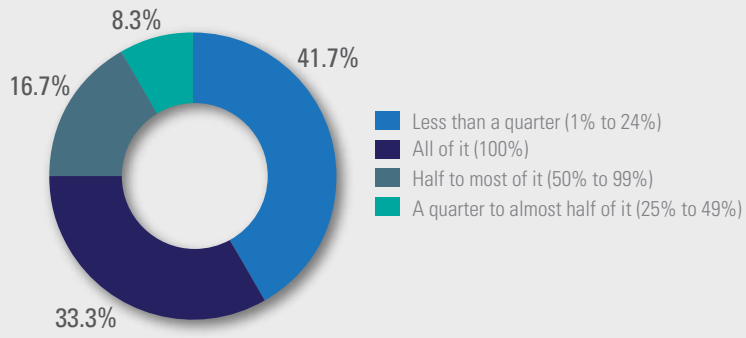
DEPLOYMENT

To date, there are 10,570 projects qualified under the Solar Carve-Out II, generating 289 MW of energy; 2,830 projects (59MW) are currently under review.[94] As of June 2015, the market price of SRECs is set at $300 and will decrease according to a yearly schedule to $189 by 2025.[95]

GSP AND REVENUES

Establishments engaged in Greenhouse Gas Emissions Accounting and Management (including sequestration) activity work with several different sub-technologies, with half earning 50% or more of their revenue from clean energy related projects, and another half attributing less than 50% of revenue to clean energy work (see Figure 63).

FIGURE 63: REVENUE ATTRIBUTED TO CLEAN ENERGY, GREENHOUSE GAS EMISSIONS ACCOUNTING AND MANAGEMENT



JOBS AND BUSINESS GROWTH

Greenhouse Gas Emissions Accounting and Management (including sequestration) accounts for approximately 850 jobs at 150 establishments.[96] These establishments focus on carbon capture and storage, secondary carbon market, coal gasification and other Greenhouse Gas Emissions Accounting and Management (including sequestration) technologies.

93 This phenomenon has led many clean energy organizations to include the employment in Greenhouse Gas Emissions Accounting and Management to the "other" category.

94 http://www.mass.gov/eea/energy-utilities-clean-tech/renewable-energy/solar/rps-solar-carve-out-2/current-statis-solar-carve-out-ii.html

95 http://www.srectrade.com/srec_markets/massachusetts; http://www.mass.gov/eea/energy-utilities-clean-tech/renewable-energy/solar/rps-solar-carve-out-2/current-statis-solar-carve-out-ii.html

96 While the establishment total appears to be down significantly from 2014, further probing of the data indicate that much of the difference in establishments can be explained by establishments engaged in greenhouse gas emissions related to automobiles identifying as "alternative transportation" establishments where previously they reported as greenhouse gas management establishments.

SOFTWARE ANALYTICS IN CLEAN ENERGY

IN THE LAST SEVERAL YEARS, SMART METERS AND INFORMATION TECHNOLOGIES HAVE FLOURISHED, ENABLING A VARIETY OF DATA ANALYSIS AND MOBILE TECHNOLOGY TO RESHAPE THE ENERGY EFFICIENCY LANDSCAPE. Real-time usage data empowers consumers to make informed decisions about managing their own energy use, and networked mobile technologies help service providers increase efficiency. In 2013, MassCEC invested in Boston-based **Retroficiency**, which uses computer-based remote control and automation to help building operators assess which buildings are best suited for energy efficiency upgrades. The company's software then tracks and verifies the progress of the implemented energy efficiency measures over time. Currently used by major utilities, such as Duke Energy and ConEdison, the technology enables deep building efficiency savings, cost-effectively and at scale by enabling utilities to adjust individual devices from a central location in response to peak demands of energy use.

Cambridge-based **eCurv**, another software company in MassCEC's portfolio, developed an algorithm to eliminate peak demand spending. Its cloud-based tool monitors electrical load from various appliances. The system's network database characterizes each device by its service requirements and maintenance schedule, then monitors and controls the system for peak demand, leading to significant savings both in energy consumed and dollars expended.

With companies like these capitalizing on the availability of data to develop advanced energy savings strategies, Massachusetts is poised to have a big impact on the development of the $370 billion global energy efficiency market.

DIGITAL LUMENS, INC.

COMPANY LOCATION: Boston

NUMBER OF MASSACHUSETTS EMPLOYEES: 108

Digital Lumens is a global supplier of enterprise-scale intelligent light-emitting diode (LED) wireless lighting and software systems for commercial and industrial customers. With 200 million square feet of deployments across 45 countries, Digital Lumens technologies can generate energy savings of up to 90%.

STRENGTHS, BARRIERS AND OPPORTUNITIES

Employers noted opportunities and barriers specific to the Massachusetts clean energy industry.

Many reported advantages included high demand (26%), a conducive business climate (26%), consumer incentives (19%), legislative support (18%) and local talent (16%) (Figure 64). Though not necessarily clean energy-specific, the most cited disadvantages were high cost of business and insufficient access to capital. Clean energy-specific disadvantages included insufficient marketing or consumer education (14%) unavailable skilled workforce (14%), and insufficient or unstable policy support (11%) (Figure 65). Consumer incentives are reported to have the greatest potential impact to the state's clean energy economy by just over 60% of employers (Figure 66). More than a quarter of employers find that working with utilities (30.8%), access to skilled labor (25.3%) and identifying first customers or early adopters (25.3%) are significant barriers to company growth (Figure 67).

REHC establishments were more likely to select customer incentives to have the greatest potential impact (74%) while REG employers were less likely (50%). Almost 25% of REG employers felt that consumer incentives were an advantage to operating in Massachusetts, compared to only 19.4% for EEBE and 19.7% for REHC.

As shown in Figure 65, more employers in EEBE rated the unavailability of skilled workers as a disadvantage (20.3%) compared to REHC (15%) and REG (11.1%). In fact, 46.4% of EEBE establishments cited that access to skilled labor is a significant barrier to company growth; only 11.4% of REG employers felt similarly. Conversely, 51.4% of REG establishments found that working with utilities is the greatest barrier compared to 25% of EEBE employers. Nearly 27% of REHC employers noted insufficient marketing, consumer demand and education to be a disadvantage; this was 22 percentage points greater than EEBE employers and 19 percentage points greater than REG employers. More REG employers found insufficient or unstable policy support to be a disadvantage (18.1%) than EEBE (7.8%) and REHC (10%).

FIGURE 64: REPORTED ADVANTAGES TO OPERATING IN MASSACHUSETTS, CLEAN ENERGY

Educated customer base, green culture, high demand	26.0%
Thriving clean energy business environment, good network, high growth/profits	26.0%
Consumer incentives (utility support, state support, etc.)	19.2%
Legislative support	18.3%
Talent, education	16.0%

FIGURE 65: REPORTED DISADVANTAGES TO OPERATING IN MASSACHUSETTS, CLEAN ENERGY

High cost of business, insufficient access to capital	30.8%
Regulatory/tax burdens (including utilities)	18.3%
Insufficient marketing, consumer demand/education	14.3%
Unavailable skilled workforce	14.3%
Insufficient/unstable policy support	11.2%
Insufficient consumer incentives	11.2%

FIGURE 66: POLICY OR PROGRAM WITH GREATEST POTENTIAL IMPACT, CLEAN ENERGY

Consumer incentives	60.3%
Lower regulatory burdens	26.4%
Marketing/public engagement	4.0%
Workforce development	3.4%

FIGURE 67: SIGNIFICANT BARRIERS TO COMPANY GROWTH, CLEAN ENERGY

Working with utilities	30.8%
Access to skilled labor	25.3%
Identifying first customers/early adopters	25.3%

MASSCEC'S 4TH ANNUAL BOSTON CLEANWEB HACKATHON

In April 2015, MassCEC's Fourth Annual Boston Cleanweb Hackathon brought together more than 70 innovators from the energy, technology and business sectors to create 16 new clean energy mobile and online technologies. Participants had just one weekend to create their web-based energy apps before pitching a panel of judges, who awarded more than $11,000 in prizes. Participating teams were also able to participate in the Cleanweb Haccelerator, an eight-week business accelerator program, to continue their project development and compete for an additional $5,000.

CONCLUSIONS

As in-state clean energy deployment climbs, employers continue to tap into the local labor force to satisfy demand. Rapidly growing markets, coupled with research and development, are reflected in continued employment, establishment and economic growth across every county in the Commonwealth. Together, this developing cluster of clean energy activity provides immediate statewide economic benefits. More importantly, these trends signify a future in which Massachusetts sits on the cutting edge of clean energy leadership, supplying regional and global markets with knowledge, experience, goods and the example for cost-effective and efficient economic advancement.

The research conducted for this report suggests several conclusions, including:

- Clean energy employment growth has been remarkably consistent since 2010, steadily climbing by double digits despite volatility in public and private investment, energy prices and overall economic and employment growth across the Commonwealth and beyond.
- Clean energy deployment has risen sharply, far outpacing other clean energy growth metrics such as employment and economic impact.
- Clean energy establishments are significantly more efficient in deploying clean energy, as the amount of product sold or installed per worker has grown dramatically each year since 2010.
- Clean energy growth is statewide and in every county, with Central and Northeastern Massachusetts expanding by double digits (13.6% and 16.8%, respectively).
- Early-stage investment in clean energy in the Commonwealth is impressive. In 2014, Massachusetts investment was #1 per capita and #2 overall among all states for Seed, Series A, and Series B investment ($69 million, $10.28 per capita) and outpaced clean energy stalwart California ($160 million, $4.12 per capita) by 149% on a per capita basis.
- Innovation establishments are represented in renewable energy (177) at a rate more than two and a half times than that of energy efficiency (66).
- Renewable Electricity Generation accounts for half of all clean energy gross state product (GSP), driven primarily by its share of engineering, research and innovation establishments and highlights the importance of fostering innovation in Massachusetts.
- Clean energy employment is expected to grow as demand increases for the installation of clean energy systems in energy efficiency, Renewable and Efficient Heating and Cooling, and Renewable Electricity Generation, as well as the increased deployment of clean vehicles in the Commonwealth.
- Pay for clean energy workers is above the median wage of $44,000 per year and well above the sustainable wage in Massachusetts, with 73% of all workers earning more than $50,000 per year.

- Employers desire skilled workers, but are hiring people with less experience and education, indicating a deficit in the skilled labor supply for clean energy.
- Most clean energy activity is located in Eastern Massachusetts. Clean energy jobs, innovation activity and investment is clustered near the population dense areas of Cambridge, Boston and Worcester.
- Energy efficiency establishments experienced greater ease in securing financing over the last 12 months (39.5% reported difficulty) compared to renewable energy establishments (62.3%).
- For Renewable and Efficient Heating and Cooling, there was one unfilled or out-of-state job for every three new hires, the highest of any technology area.

Massachusetts' clean energy economy is a vibrant network of industries from Renewable Electricity Generation to Greenhouse Gas Accounting and Management and Alternative Transportation. Since 2010, clean energy continues to supply a growing number of jobs that offer sustainable wages to strengthen the middle class. With healthy representation across the entire supply chain and five-year recorded growth, establishments are optimistic and project an additional 10,000 workers by 2016. Public support invites consumer demand and boosts establishment revenue; clean energy-focused businesses are adequately supported, while traditional establishments are encouraged to compete in the expanding market. A healthy ecosystem of research and innovation encourages investors and supplies the marketplace with new clean energy patents. As the state maintains consumer demand and innovative breakthroughs, Massachusetts' clean energy economy will continue to prosper.

METHODOLOGY

GLOSSARY OF TERMS

Activity: For the purposes of this report, an establishment's activity refers to the primary value-chain industry to which it most associates its work. Activities include research, development, engineering, manufacturing, sales and distribution, installation and maintenance, legal, finance and other professional services, and other.

Administrative Hires: Workers who perform secretarial or assistant level tasks.

Alternative Transportation: Alternative Transportation includes non-fossil fuel related vehicles, including electric rail and electric vehicles. This includes:

- **Electric Vehicles:** Passenger or freight cars, trucks or buses that use electric drive systems and electric motors for propulsion.
- **Electric Rail:** Passenger or freight trains or trolleys that operate with electric motors for propulsion.

Clean Energy Industry: The aggregate of establishments that are directly involved with researching, developing, producing, manufacturing, distributing or implementing components, goods or services related to renewable energy, energy efficiency or conservation, smart grid, energy storage, carbon management and/or electric or hybrid vehicles.

Clean Energy Establishment: For the purposes of this report, an establishment or establishment that is involved with an activity related to the clean energy industry.

Clean Energy Worker: Full-time and part-time permanent employees who support the clean energy portion of the business, including administrative staff, excluding interns and other temporary workers.

Cluster: A geographic concentration of interconnected businesses in related industries.

Deal: An investment of capital from one or more institutions to a single company.

Early-Stage Investment: Investments including Seed, Series A and Series B investments.

Electrical Efficiency and Building Envelope: Goods and services that reduce electricity demand. This includes:

- Energy efficiency upgrades to existing buildings (retrofitting and retrocommissioning)
- **Energy Storage:** Devices or physical media that store energy.

- **Demand Response Services:** Operations that balance energy supply and demand. Include offering time-based rates such as time-of-use pricing, critical peak pricing, variable peak pricing, real time pricing and critical peak rebates. It also includes direct load control programs which provide the ability for power companies to cycle air conditioners and water heaters on and off during periods of peak demand in exchange for a financial incentive and lower electric bills.
- **Smart Grid:** Automated, computer-based electricity delivery, including smart computing and software.
- **Water and Wastewater Technologies Related to Conserving Energy:** Products related to reducing energy for water purification, distribution or treatment.

Establishment: For the purposes of this report, a business location in Massachusetts with at least one employee.

Greenhouse Gas Emissions Accounting and Management: Primarily includes carbon capture and storage, secondary carbon markets (such as RGGI) and coal gasification. This includes:

- **Carbon Capture and Storage:** The process of capturing waste carbon dioxide from large point source emitters and depositing it in a location that cannot enter the atmosphere, such as in deep geological formations. Also referred to as sequestration.
- **Secondary Carbon Markets:** Trade of carbon credits in a cap and trade or similar system.
- **Coal Gasification:** The production of synthetic gas from coal via thermo-chemical processes.

Management/Professional Hires: Workers who supervise others and or work in an professional position such as accountant, attorney or executive.

Sales: Workers who predominantly sell products or services.

Pre-Commercial: Work that has yet to reach market or products that are in the development phase.

Production/Technician Hires: Workers in the field or on the floor, generally working in assembly, installation, or other technical, non-managerial tasks.

"Pure-Play": Refers to a company or establishment that has or is very close to possessing a single business focus, i.e. a "pure-play" energy efficiency establishment would be only associated with energy efficiency work.

Renewable and Efficient Heating and Cooling: Refers to establishments that are involved with heating, ventilation and air conditioning (HVAC) from renewable energy sources or work that increases the energy efficiency of HVAC systems.

REHC includes the following sub-technologies:

- **Solar Thermal:** Uses the sun's energy to generate thermal energy.
- **High-Efficiency Air-Source Heat Pumps:** Transfers heat between a structure and the outside air efficiently.
- **HVAC and Building Controls:** Heating, ventilation and air conditioning systems (HVAC), including building retro-commissioning and retrofits connected to heating and cooling.
- **Ground-Source Heat Pumps:** Central heating and/or cooling that moves heat from or to the ground from a structure.
- **Woody Biomass (wood, wood pellets)**
- **Biofuels (biodiesel for heating)**
- **Renewable Combined Heat and Power**: Production of electricity and usable heat from renewable sources. Also called cogeneration.

Retrocommissioning: refers to the process of improving a building or structures operating process by increasing occupant comfort and saving energy usually through energy efficiency measures (weatherization, lighting, etc.).

Stretch Energy Code: The Stretch Code is at least 20% more energy efficient than the state's base IECC code; it is optional for municipalities that wish to achieve higher energy efficiency than the baseline.

Sub-Technology: For the purposes of this report, sub-technology refers to the specific technologies with which an establishment works, within each technology area. The sub-technologies for energy efficiency and renewable energy are listed under the respective definitions.

Technology: For the purposes of this report, technology refers to the primary application or end use of a establishment's produced goods or services. Technologies include energy efficiency, renewable energy, Alternative Transportation, Greenhouse Gas Management and Accounting or other.

GROSS STATE PRODUCT

The clean energy portion of Gross State Product calculated for this report was derived from survey incidence rates and proportional revenue reporting, together existing data from the Bureau of Economic Analysis, calculated by NAICS code. Utility data and state government spending were included as direct inputs (rather than using a proportional analysis).

SURVEY METHODOLOGY

As with previous years' editions of the Clean Energy Industry Report, the primary data included in this study are derived from a comprehensive survey of business establishments in Massachusetts. Surveys were administered online and by telephone to a list of known employers as well as to a representative, clustered sample of companies from the North American Industry Classification System (NAICS) identified by the Bureau of Labor Statistics (BLS) and BW Research Partnership as being potentially related to the renewable energy, energy efficiency and Alternative Transportation

technologies. The research methodology employed for this report has been used increasingly as a tool for measuring clean energy industry jobs and businesses, including in California, Florida, Illinois, Iowa, Missouri, Ohio, Pennsylvania, Rhode Island, Tennessee and Vermont.

In 2015, the research team placed 15,609 telephone calls and sent 2,107 emails to employers. The survey effort, with a combined margin of error of approximately +/-2.74% at a 95% confidence interval, yielded 2,262 survey responses The survey fielded from April 22 to May 19 and averaged 15.4 minutes in length.

In addition to providing overall totals, survey respondents were asked to select the technology to which their establishment's work is most closely associated, from a list including renewable energy, energy efficiency, Alternative Transportation or Greenhouse Gas Emissions Accounting and Management (including sequestration). Based on their selection(s), respondents were offered lists of specific sub-technologies that fit within each technology. Respondents were provided the following descriptions upon request.

Establishments in manufacturing and research, design and engineering were asked a specific question about whether they worked with any goods that are not yet commercially available, to gain insight into how research, development and engineering startups and other early-stage, pre-commercial establishments might respond differently to survey questions from other established establishments with commercially available products.

"Known Universe" – Establishments Previously Identified by Researchers as Clean Energy Companies

The original list, developed from previous work efforts and databases from the Massachusetts Clean Energy Center (MassCEC) and partner organizations, contains companies that are more likely to be active in the clean energy economy. After duplicate cleaning and applying estimates from the survey data to account for companies that are no longer in business, do not have at least one Massachusetts location or do not identify as in the clean energy industry, as well as improvements and additions since the first survey effort, the 2015 "known universe" of establishments is estimated at 2,270 companies.

All establishments in the database with addresses were sent a letter from MassCEC with respondent-specific instructions for taking the survey. In addition, all businesses with email information were sent multiple online invitations. Establishments in the database that did not complete an online survey and those without email information were called up to six times and asked to complete by telephone.

Of the estimated 2,270 establishments in the known universe, 503 completed a survey, up 30 responses from last year. The 2015 data show that there are 47,098 workers in the known universe, an increase of 4%. The margin of error at a confidence level of 95% is approximately +/- 4.01%.

"Unknown Universe" – Establishments Not Previously Identified by Researchers as Clean Energy Companies

This database for the "unknown universe" was drawn from BLS NAICS industries and InfoUSA business listings. The incidence rates (i.e., the percentage of establishments that identified as clean energy) for the 18 NAICS industries were

updated from past years using the 2015 findings from the calling to the previously unknown 1,400 establishments (that indicated whether or not they were in clean energy). The overall margin of error for the updated incidence rate analysis is estimated at approximately +/- 3.18 at the 95% confidence level.

In addition, 228 establishments from the "unknown universe" identified as clean energy and completed full surveys. Compared to the known universe, the mean number of clean energy employees at "unknown" establishments is lower by a significant margin, depending on the specific industry. Compared with 2014, the mean employment growth and increased number of clean energy establishments in the unknown universe results in 51,027 workers, up from 43,081, an increase of 18.4%.

Surveys were administered in accordance with the Code of Standards and Ethics for Survey Research (CASRO), which includes stringent guidelines for maintaining respondent confidentiality. As a result, employer lists and disaggregated data are not available for public release.

MASSCEC CONTRIBUTIONS

Some of the material (marked with SOURCE: MassCEC) in the report was contributed by MassCEC. The contributed material includes activities that MassCEC supports through its programs or has been involved in.

DATA SOURCES AND LIMITATIONS

FEDERAL DATA SOURCES

The federal sources used include the Quarterly Census of Employment and Wages, Current Employment Statistics, and Occupational Employment Statistics all available publicly at http://bls.gov.

INPUT-OUTPUT DATA (GROSS STATE PRODUCT)

The input-output data for Gross State Product is derived from data from the Bureau of Economic Analysis.

STATE DATA SOURCES

This report uses state data provided by the Massachusetts Executive Office of Labor and Workforce Development and the Department of Energy Resources.

INVESTMENT DATA SOURCES

This report uses Cleantech Group's i3 Platform for all investment data that is used in the Investment Capital section.

PATENT DATA SOURCES

This report uses data filings from the US Patent and Trademark Office (USPTO) Patent Application Information Retrieval System. Not all patents at clean energy establishments were deemed to address clean energy processes, therefore the database was cleaned to only include those that were.

INVESTMENT CAPITAL DATA

As with previous years, this report's Investment Capital data include only "new energy" investments, which is in stark

contrast to other widely circulated studies on clean energy investment trends. Most of those reports, including the Bloomberg New Energy Finance Reports, are heavily influenced by asset finance deals. Unfortunately, asset finance is not further delineated between new project financing and existing entity debt restructuring or other business lines of credit not focused on new energy.

There is sound justification for separating project finance from a broader category of asset finance. The first is in the nature of the investment. Whereas asset financing is commonly a debt-only transaction involving one or more banks, project finance typically involves both debt and equity, with project sponsors pledging 10-40% equity and banks or other lenders covering the remainder. A second justification for separating project finance is that in clean energy markets, it typically is used for "new" energy production rather than for restructuring "old" energy projects.

This report selected Cleantech Group's i3 Data Platform for the analysis because every investment included in the database is independently cited and can be verified, unlike many reports that do not disaggregate the data.

The i3 data include a wide range of investment types, and also includes technologies that are outside of the scope of this report. As a result, Cleantech Group's publicly reported data will differ from the results included in this report.

For the purposes of this study, the following filters were applied:

Investment Type: Early-Stage (Seed, Series A, Series B), Structured Debt, Growth Equity, Project Finance, Grants, Loans, and Guarantees

Technologies: Energy Efficiency (Energy Storage, Smart Grid), Renewable Energy (Geothermal, Hydro and Marine Power, Solar, Wind, Biofuels and Biochemicals, Biomass Generation), Transportation (Fuel Cells and Hydrogen, Transportation)

BW RESEARCH INDICES

For the first time in 2015, BW Research Partnership included specific indices to illustrate annual changes in employment, innovation, deployment and economic activity. Each index includes a weighted mix of annual data that include job growth, change in the percentage of employees that spend 100% of their time conducting clean energy work, patent approvals, early-stage investment dollars and deals, mergers and acquisitions and contributions to GSP, among others. These data points are weighted and normalized to provide contextual, comparative data on growth trends.

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